Appendix B – Technical Documents

This appendix contains two technical memorandums prepared during the watershed management plan preparation process. The first is the Subwatershed Strategies Technical Memorandum, dated June 11, 2009. This memo provides detail on the project selection process.

The second memorandum is the Project Prioritization Technical Memorandum, dated January 7, 2011. This memo provides detail on the project prioritization and cost benefit analysis.

Memo

To	**Eric Forbes, Fairfax County, SWPD**	File no	
From	**Lynne Mowery, PE, AMEC Earth and Environmental, Inc.**	cc	
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Date	**June 11, 2009**		

Subject **Little Rocky Run/Johnny Moore Creek Subwatershed Strategies Technical Memorandum**

Introduction

Subtask 3.2 requires that subwatershed strategies be developed as a precursor to identifying candidate projects. Once strategies are in place, selection of candidate projects from the 'universe' of potential projects becomes more straightforward. Subwatershed strategies were developed utilizing the subwatershed ranking (Subtask 2.7), SPA priority elements, WAG input, and field reconnaissance data.

Watershed Restoration Strategies

Strategies for restoration of the watershed were presented to the Watershed Advisory Group (WAG) and have been condensed into categories:

- Stream/Buffer Restoration
- Pond Retrofits
- New Stormwater Management (SWM) Facilities – LID, Ponds, Culvert Retrofits, Outfall Treatment

Another strategy not yet discussed with the WAG but important in meeting the County's goals and objectives is flooding mitigation. Flooding mitigation will address both structural flooding and road crossing flooding. Table 3 shows the relationship between the County's goals and objectives and the restoration strategies.

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Table 1 - Restoration Strategies

	Restoration Strategies			
County Goals & Objectives	**Stream/ Buffer Restoration**	**Pond Retrofits**	**New SWM Facilities**	**Flooding Mitigation**
Minimize impacts of stormwater runoff on stream hydrology to promote stable stream morphology, protect habitat, and support biota – Stormwater Runoff	■	■	■	
Minimize flooding to protect property, human health, and safety -				■
Provide for healthy habitat through protecting, restoring, and maintaining riparian buffers, wetlands, and instream habitat	■			
Improve and maintain diversity of native plants and animals in the County	■			
Minimize impacts to stream water quality from pollutants in stormwater runoff		■	■	
Minimize impacts to drinking water sources from pathogens, nutrients, and toxics in stormwater runoff		■	■	
Minimize impacts to drinking water storage capacity from sediment in stormwater runoff	■	■	■	
Encourage the public to participate in watershed stewardship	■	■	■	■
Coordinate with regional jurisdictions on watershed management and restoration efforts such as Chesapeake Bay initiatives	■	■	■	■
Improve watershed aesthetics in Fairfax County	■	■	■	■

The restoration strategies encompass many different project types. Table 2 provides a summary of project types for each restoration strategy.

Table 2 - Project Types

Restoration Strategy	Project Type
Stream/Buffer Restoration	Stream/Bank Stabilization Stream Realignment Pipe Outfall Stabilization Buffer Reforestation
Pond Retrofits	Regrade pond to provide more storage Remove concrete trickle ditches Redesign pond to include micropools and wetland areas Redesign quantity only ponds to provide water quality storage
New SWM Facilities	Bioretention areas Grassed swales Green roofs Underground storage Manufactured BMPs Stormwater Ponds – extended detention dry ponds, wet ponds Constructed wetlands Tree box filters Rain barrel programs
Flooding Mitigation	Resize road crossing structures to convey design discharge Floodproof or purchase structures located in the floodplain

Candidate Project Selection Procedure

In general, the watersheds were analyzed using the subwatershed ranking results. Those subwatersheds with a poor overall composite score are likely to be deficient for at least one, if not more, county-defined objectives. At this point, individual objectives were analyzed more closely to determine those which were not being achieved. Each objective score is comprised of a combination of individual metrics. Those metrics contributing to a poor objective score help define the strategy for that particular subwatershed as well as bringing to light potential project sites. A similar technique is used when evaluating potential stressors. The overall source composite score was considered initially, in order to address subwatersheds clearly contributing to watershed degradation, but individual source metrics were also analyzed to ensure that any specific stressors were identified.

The Johnny Moore Creek WMA will be provided as an example of the candidate project selection. Table 3 shows the objective composite scores as well as the overall and source composite scores for the Johnny Moore WMA. Scores have been assessed on a scale of 10 in quartiles (0-2.5 registering “very low”, 2.5-5.0 “low”, and so on). The lowest Overall Impact Composite score occurs in JM-JM-0001. Inspection of the Objective Composite scores reveals deficient areas. For the purpose of this example, we will focus on the lowest Objective score –

which is Storage Capacity. Storage Capacity is a measure of the sediment contribution to the Occoquan reservoir and is comprised of two metrics, In-stream Sediment and Upland Sediment. Though this subwatershed scores in the high quartile for Source Composite (see Table 4), this score is tied for the lowest in this WMA.

Table 3 – Composite Summary for Johnny Moore

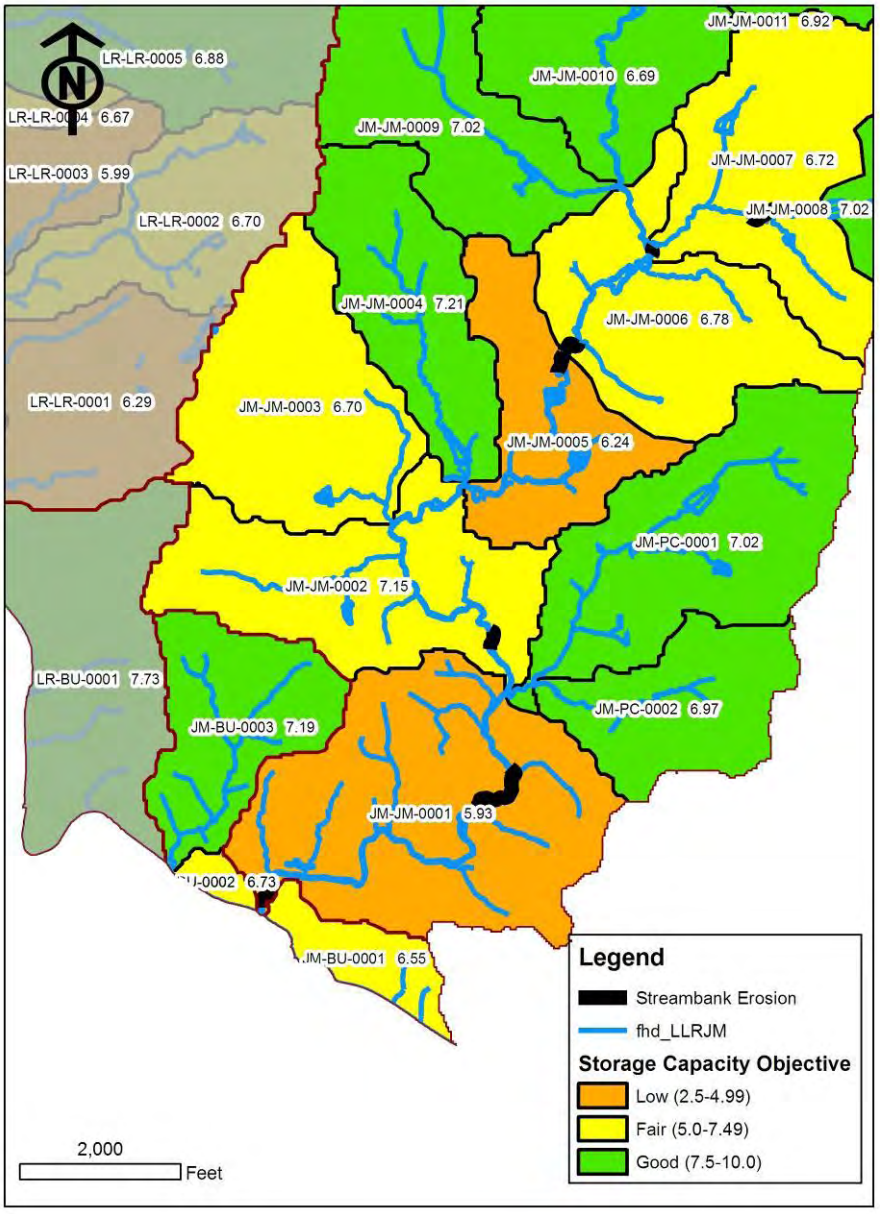
Subwater-shed ID	Stormwater Runoff	Flooding Hazards	Habitat Health	Habitat Diversity	Stream WQ	Drinking WQ	Storage Capacity	Overall Impact Composite
JM-BU-0001	6.17	10	7.6	6	6	6.25	5	6.94
JM-BU-0002	6.17	10	8	6	6.36	6.88	5	7.12
JM-BU-0003	5.75	10	6.4	6	6.71	6.88	8.75	7.40
JM-JM-0001	4.92	8.5	7.2	6	4.93	4.38	3.75	5.86
JM-JM-0002	5.25	10	6.8	7	7	7.5	6.25	7.31
JM-JM-0003	4.92	10	4	7	6.64	6.88	6.25	6.76
JM-JM-0004	5.33	10	6.8	7	7	7.5	7.5	7.48
JM-JM-0005	4.92	8	7.2	7	5.57	5	3.75	6.06
JM-JM-0006	4.92	10	6.4	7	6.29	6.25	6.25	6.95
JM-JM-0007	5.33	10	5.6	7	6.29	6.25	6.25	6.90
JM-JM-0008	4.92	10	5.6	7	6.64	6.88	7.5	7.14
JM-JM-0009	5.33	10	6	7	6.64	6.88	7.5	7.25
JM-JM-0010	5.33	9	6	7	6.64	6.88	7.5	7.05
JM-JM-0011	5.42	9.5	5.2	7	6.64	6.88	7.5	7.05
JM-JM-0012	5.75	10	6.4	7	6.64	6.88	7.5	7.36
JM-JM-0013	5.42	9	4.8	7	8.07	8.75	8.75	7.51
JM-JM-0014	5.42	10	4	7	8.07	8.75	8.75	7.60
JM-JM-0015	5.75	8.1	6.4	7	8.07	8.75	8.75	7.58
JM-PC-0001	5.33	10	6	7	6.64	6.88	7.5	7.25
JM-PC-0002	4.92	10	5.6	7	6.64	6.88	7.5	7.14

A closer inspection shown in Table 4 reveals that the Source Composite score is being weighed down by poor scores for Upland Sediment. The Upland Sediment metric is a combination of the TSS output from STEPL (nutrient loading spreadsheet model), and the sediment contribution of streambank erosion sites (a combination of SPA sites and those identified during Task 2 field reconnaissance). The STEPL results are driven by soil type and landuse, neither of which is distinct in these two subwatersheds when compared to their surroundings. A closer inspection of the Map 1 reveals two significant streambank erosion sites contributing to the high sediment load for these two subwatersheds.

Table 4 – Source Metrics for Johnny Moore

SITE_CODE	DCIA	Total Imp.	Stream Buffer Deficiency	SW Outfalls	VPDES	Total Urban Area	Upland Sediment	Total Nitrogen	Total Phosphorus	Septic	Channelized/ Piped Streams	Composite Score
JM-JM-0001	10.00	10.00	10.00	10.00	10.00	10.00	**2.50**	7.50	2.50	2.50	10.00	7.73
JM-JM-0002	10.00	10.00	10.00	10.00	10.00	10.00	7.50	10.00	7.50	2.50	10.00	8.86
JM-JM-0003	10.00	10.00	7.50	2.50	10.00	10.00	7.50	10.00	5.00	10.00	10.00	8.41
JM-JM-0004	10.00	10.00	10.00	2.50	10.00	10.00	10.00	7.50	7.50	5.00	10.00	8.41
JM-JM-0005	10.00	10.00	10.00	7.50	10.00	10.00	**2.50**	7.50	5.00	2.50	10.00	7.73
JM-JM-0006	10.00	10.00	10.00	2.50	10.00	10.00	7.50	7.50	5.00	2.50	10.00	7.73
JM-JM-0007	10.00	10.00	10.00	2.50	10.00	10.00	7.50	7.50	5.00	2.50	10.00	7.73
JM-JM-0008	10.00	10.00	10.00	2.50	10.00	10.00	10.00	7.50	5.00	2.50	10.00	7.95
JM-JM-0009	10.00	10.00	10.00	2.50	10.00	10.00	10.00	7.50	5.00	5.00	10.00	8.18
JM-JM-0010	10.00	10.00	10.00	7.50	10.00	10.00	10.00	7.50	5.00	2.50	10.00	8.41
JM-JM-0011	10.00	10.00	7.50	2.50	10.00	10.00	10.00	7.50	5.00	2.50	10.00	7.73
JM-JM-0012	10.00	10.00	10.00	7.50	10.00	10.00	10.00	7.50	5.00	5.00	10.00	8.64
JM-JM-0013	10.00	10.00	2.50	2.50	10.00	10.00	7.50	10.00	7.50	7.50	10.00	7.95
JM-JM-0014	10.00	10.00	2.50	2.50	10.00	10.00	10.00	7.50	5.00	10.00	10.00	7.95
JM-JM-0015	10.00	10.00	10.00	2.50	10.00	10.00	10.00	7.50	5.00	7.50	10.00	8.41
JM-PC-0001	10.00	10.00	10.00	10.00	10.00	10.00	10.00	7.50	5.00	2.50	10.00	8.64
JM-PC-0002	7.50	7.50	10.00	10.00	10.00	10.00	10.00	7.50	5.00	2.50	10.00	8.18
JM-BU-0001	10.00	10.00	10.00	10.00	10.00	10.00	5.00	7.50	7.50	10.00	5.00	8.64
JM-BU-0002	10.00	10.00	10.00	10.00	10.00	10.00	5.00	10.00	7.50	10.00	10.00	9.32
JM-BU-0003	7.50	7.50	10.00	10.00	10.00	7.50	10.00	7.50	5.00	2.50	10.00	7.95

Map 1 – Storage Capacity Objective



In this example, we used the indicators to help identify potential stressors. The streambank erosion sites will be investigated for stream restoration opportunities. In addition to addressing the Storage Capacity Objective by reducing the sediment load, stream restoration projects are directly related to habitat improvements, see Table 1 – Restoration Strategies for a link between objectives and strategies.

By all accounts, the Johnny Moore watershed is in relatively good condition and is classified as a Watershed Protection Area in the Stream Protection Strategy report. The limited habitat data available shows Johnny Moore to be deficient in some locations and the majority of surveyed reaches are undergoing active channel widening. The link between channel degradation, sediment, and habitat is clear. In general, stream restoration will be investigated throughout the WMA as a way to not only address the source, but to minimize or negate the impact. Fortunately, the entire WMA is within a designated Occoquan downzoned area, meaning radical changes in land use are not expected. There are a number of subwatersheds in nearly pristine condition which will eventually be developed as Estate Residential. A non-structural recommendation for these subwatersheds could be to ensure that stormwater management measures are addressed as these areas are developed. One of the main obstacles throughout this WMA is access. Many ideal project locations are on privately owned land.

The subwatershed ranking results will be used in combination with 'severe' SPA inventory points, concerns identified by both the WAG and the public forum, and sites discovered during Task 2 field reconnaissance and subsequent field efforts to develop projects. Projects best justified by the subwatershed ranking will likely be identified as priority projects. Considering the relative small size of the watershed to be analyzed, threshold values were not established for strategy development. In other words, candidate projects were considered in all subwatersheds to address identified deficiencies not just those subwatersheds that ranked poorly. With only 3 fairly homogenous WMAs and a majority of subwatersheds classified as headwater subbasins, all 52 subwatersheds were analyzed for their restoration/protection potential using this procedure.

Candidate Projects

A description of the candidate projects selected using the procedure is provided below. The attached maps show the location of these candidate projects.

Id	Subwatershed	Type	Comments
1	JM-JM-0014	Stream Restoration	Very Poor SPA Habitat Score, issues with golf course, engineered channel
4	JM-JM-0011	Stream Crossing	Moderate to Severe Impact (SPA)
7	JM-JM-0014	Head Cut	No evidence, did it migrate to upstream crossing?
8	JM-JM-0009	New SWM	Facility Treating School, retrofit, educational opportunities?
9	JM-JM-0003 LR-LR-0001	New SWM	Golf Course clubhouse, parking lot, etc. confirm treatment
10	JM-JM-0003	Pond Retrofit	Golf Course Ponds
11	JM-JM-0014	New SWM	Daylight pipe - add bioretention, grassed swale
12	JM-JM-0013 JM-JM-0014	Buffer	Plant trees along stream and ponds where possible
13	JM-JM-0005 JM-JM-0006	Stream Restoration/Buffer Restoration/Culvert	Significant erosion identified - flooding noted during field investigation
14	JM-PC-0001	Road Culvert	Pro rata project - comment in WAG#2
15	JM-PC-0001	Buffer Restoration	Plant trees - private property
17	JM-JM-0001	Stream Restoration	Significant bank erosion - access issues
19	LR-LR-0003	Buffer/Stream Restoration	Buffer and stream erosion - on private property
20		Pond Retrofit	Pond not in stormnet - plantings, regrading to treat larger area
21	LR-LR-0005	Pond Retrofit	Clogging problem - review design to address problem - erosion issues north of pond. Recently retrofitted - sedimentation issues
22	LR-LR-0007	Bioretention	Bioretention to treat back side of townhouses
23	LR-LR-0007	New SWM	Add tree box filters or treatment at culvert outlet for untreated system
24	LR-LR-0006	New SWM	Combination of bioretention, tree box filters for untreated area
25	LR-LR-0010	New SWM	Treatment at culvert outlet, upstream opportunities - community not supportive of regional pond in area
26	LR-LR-0007	Culvert retrofit	Flooding complaint at WAG - retrofit area u/s of culvert for SWM
27	LR-LR-0007	New SWM	Retrofit opportunities at school
28	LR-LR-0009	New SWM	Add treatment for untreated system
29	LR-LR-0009	Pond Retrofit	Retrofit to add plantings - address erosion in pond ditch
30	LR-LR-0004	New SWM	Add treatments at inlets/outlet for untreated system

Id	Subwatershed	Type	Comments
31	LR-LR-0004	Litter Control	North Hart Run & Compton Valley Estates - Neighborhood cleanups to control litter - interior townhouse streets not VDOT - install gutter guards similar to Union Mills shopping center
38	JM-JM-0003	Dump Site	Hot tub couches in stream
39	JM-JM-0003	Pond Retrofit	Existing pond with dam break on golf course property near piplines - repair/retrofit to provide treatment
40	LR-LR-0003	Culvert Retrofit	Treat uncontrolled flow from subdivision
41	LR-LR-0003	New SWM	Bioretention/Grassed swale for uncontrolled area - on private property
42	LR-LR-0004	New SWM	Inlet treatment for uncontrolled area
43	LR-LR-0004	New SWM	Inlet/Outlet treatment for uncontrolled area
44	LR-LR-0008	New SWM	Inlet treatment for uncontrolled area
45	LR-LR-0006	New SWM	Inlet/outlet treatment for uncontrolled area
46	LR-LR-0008	Outfall Improvement	Erosion at transition from concrete ditch from field investigation - remove concrete ditch?
47	LR-LR-0008	Pond Retrofit	Remove trickle ditches, plantings, enlarge to improve downstream conditions
48	LR-LR-0008	Outfall Improvement	Erosion downstream of trail - WAG comment
49	LR-LR-0008	Stream Restoration	Erosion area with headcut
50	LR-LR-0008	Buffer/Stream Restoration	Restore buffer, remove paved and trickle ditches, add plantings to ponds
51	LR-LR-0011	Outfall Improvement	Stabilize outfall to reduce erosion
52	LR-LR-0011	Stream Stabilization	Erosion in area from issues forum
53	LR-LR-0011	Pond Retrofit	Remove trickle ditches, add micropools/plantings
54	LR-LR-0011	New SWM	Inlet/outlet treatment for uncontrolled area
55	LR-LR-0011	New SWM	Union Mill ES drains to dry pond, opportunities for LID onsite
56	LR-LR-0012	New SWM	Centreville HS drains to dry pond, opportunities for LID onsite
58	LR-LR-0011	Pond Retrofit	Remove trickle ditches, add micropools/plantings

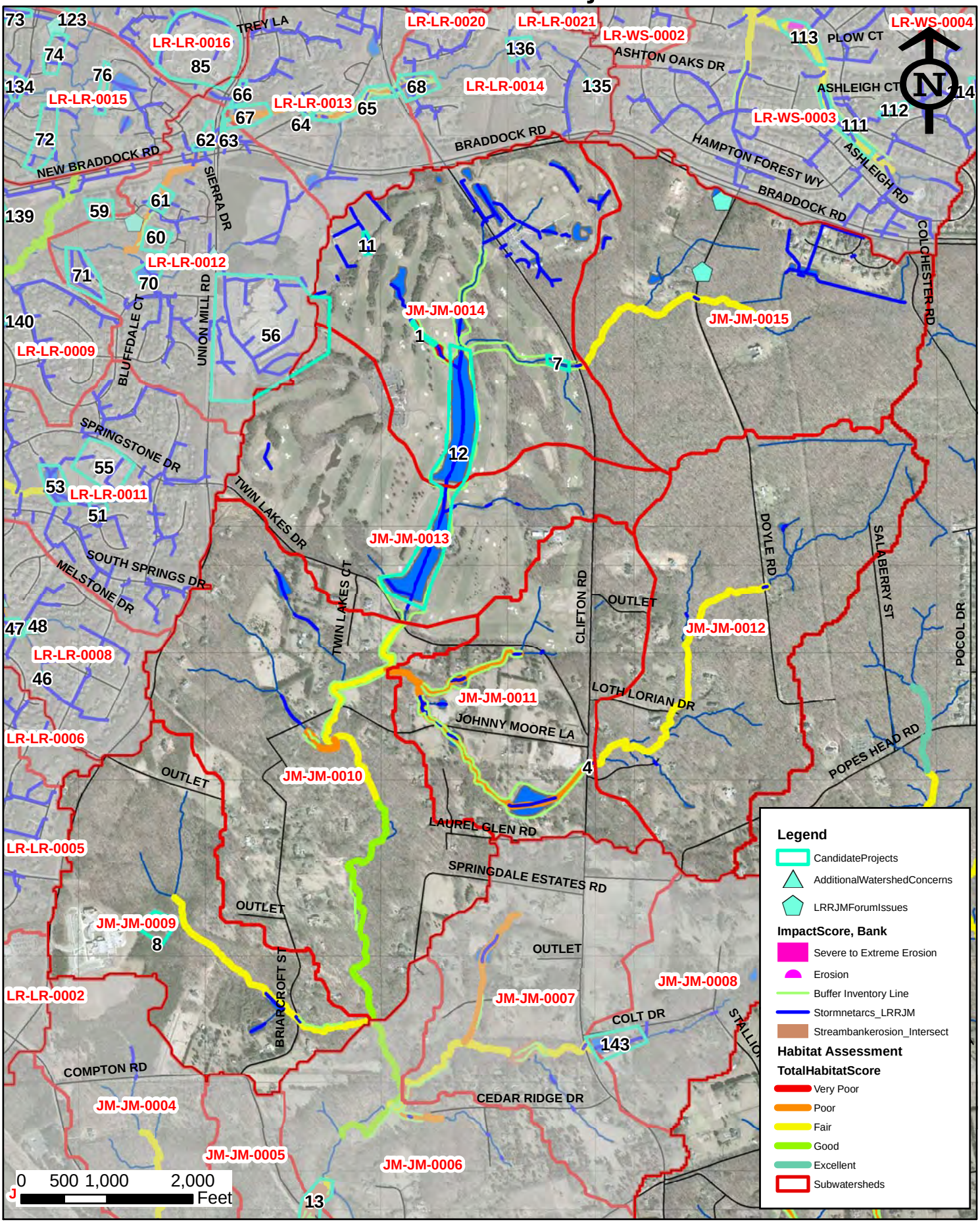
Id	Subwatershed	Type	Comments
59	LR-LR-0009	New SWM	Inlet/outlet treatment for uncontrolled area
60	LR-LR-0012	New SWM	Inlet/outlet treatment for uncontrolled area - WAG look at opportunities for porous paving/LID
61	LR-LR-0012	Pond Retrofit	Enlarge pond to provide more treatment in replacement of Regional R-13
62	LR-LR-0012	New SWM	New pond to provide treatment in replacement of Regional R-13
63	LR-LR-0012	New SWM/Stream Restoration	Culvert retrofit/grassed swale/stream restoration in replacement of Regional R-13
64	LR-LR-0013	Stream Restoration	Address erosion d/s of culvert - possible culvert resize needed
65	LR-LR-0013	Buffer Restoration	Restore buffer along stream - private property, houses close to stream issues
66	LR-LR-0013	Pond Retrofit	Remove trickle ditches, add micropools/plantings - stabilize upstream sinkhole (complaint)
67	LR-LR-0013	Alternatives to Regional Pond	R-13 - feasibility issues with grading, private property, house in pond area
68	LR-LR-0014	Pond Retrofit	Remove trickle ditches, add micropools/plantings - stabilize eroded areas
70	LR-LR-0012	Pond Retrofit	Remove trickle ditches, add micropools/plantings
71	LR-LR-0012	New SWM	Inlet/outlet treatment for uncontrolled area
72	LR-LR-0015	New SWM	Inlet/outlet treatment for uncontrolled area - WAG look at opportunities for porous paving/LID
73	LR-LR-0015	New SWM	Bioretention/LID for uncontrolled area - WAG look at opportunities for porous paving/LID
74	LR-LR-0015	New SWM	Inlet/outlet treatment for uncontrolled area - WAG look at opportunities for porous paving/LID
75	LR-LR-0016	Non-Structural	Sweeping, trash pickup in commercial shopping center - drains to wet pond d/s
76	LR-LR-0015	New SWM	Inlet/outlet treatment for uncontrolled area
77	LR-LR-0016	New SWM?	Confirm treatment by R-16 - if not incorporate LID
78	LR-LR-0016	Flooding	Structures in Floodplain
79	LR-LR-0018	Flooding	Structures in Floodplain

Id	Subwatershed	Type	Comments
80	LR-LR-0015	Pond Retrofit	Remove trickle ditches, add micropools/plantings
81	LR-LR-0016	New SWM	Inlet/outlet treatment for uncontrolled area
82	LR-LR-0016	New SWM	Inlet/outlet treatment for uncontrolled area
83	LR-LR-0016	Pond Retrofit	Remove trickle ditches, add micropools/plantings
84	LR-LR-0016	Pond Retrofit	Remove trickle ditches, add micropools/plantings
85	LR-LR-0016	Non-Structural	Illicit discharge education (noted in NSA) - sweeping/trash in commercial shopping center
86		Road Flooding	From Pro-rata
87	LR-LR-0017	Pond Retrofit	Pond had eroded areas - stabilize - add wetland plantings - adjust subarea to include Sully Manor - area still in construction
88	LR-LR-0016	Culvert Replacement	From Pro-rata - drainage divides in area have changed significantly - no longer needed?
89	LR-LR-0018	Flooding/Buffer	Structures in floodplain, buffer restoration
90	LR-LR-0018	New SWM	LID for uncontrolled area
91	LR-LR-0016	Pond Retrofit	Remove trickle ditches, add micropools/plantings
92	LR-LR-0018	Pond Retrofit	Remove trickle ditches, add micropools/plantings
93	LR-LR-0018	Stream Restoration/Road Flooding	Stabilize stream, Pro rata culvert project - confirm overtopping from RAS - WAG comment that culvert was replaced
94	LR-LR-0019	Pond Retrofit	Regional Pond R-161 - wetland plantings needed - at time of visit growth was sparse
95	LR-LR-0019	New SWM	Colin Powell ES drains to R-161 - opportunities for onsite LID
96	LR-LR-0019	Stream Restoration	Erosion noted during field visit
97	LR-LR-0020	Pond Retrofit	Trickle ditches, dry pond holding water during field visit, clogging and smell
98	LR-LR-0020	Stream Restoration	Erosion at pond outfalls
99	LR-LR-0021	Pond Retrofit	Regional R-7 - opportunity to regrade/plant/direct more flow to pond - clogged during field visit
100	LR-LR-0022	Stream Restoration	Erosion, head cut, oily sheen noted during field visit
101	LR-LR-0022	Pond Retrofit	Regional Pond R-17 Wetland areas, grassed spillways not stable during field visit - replanting and grading

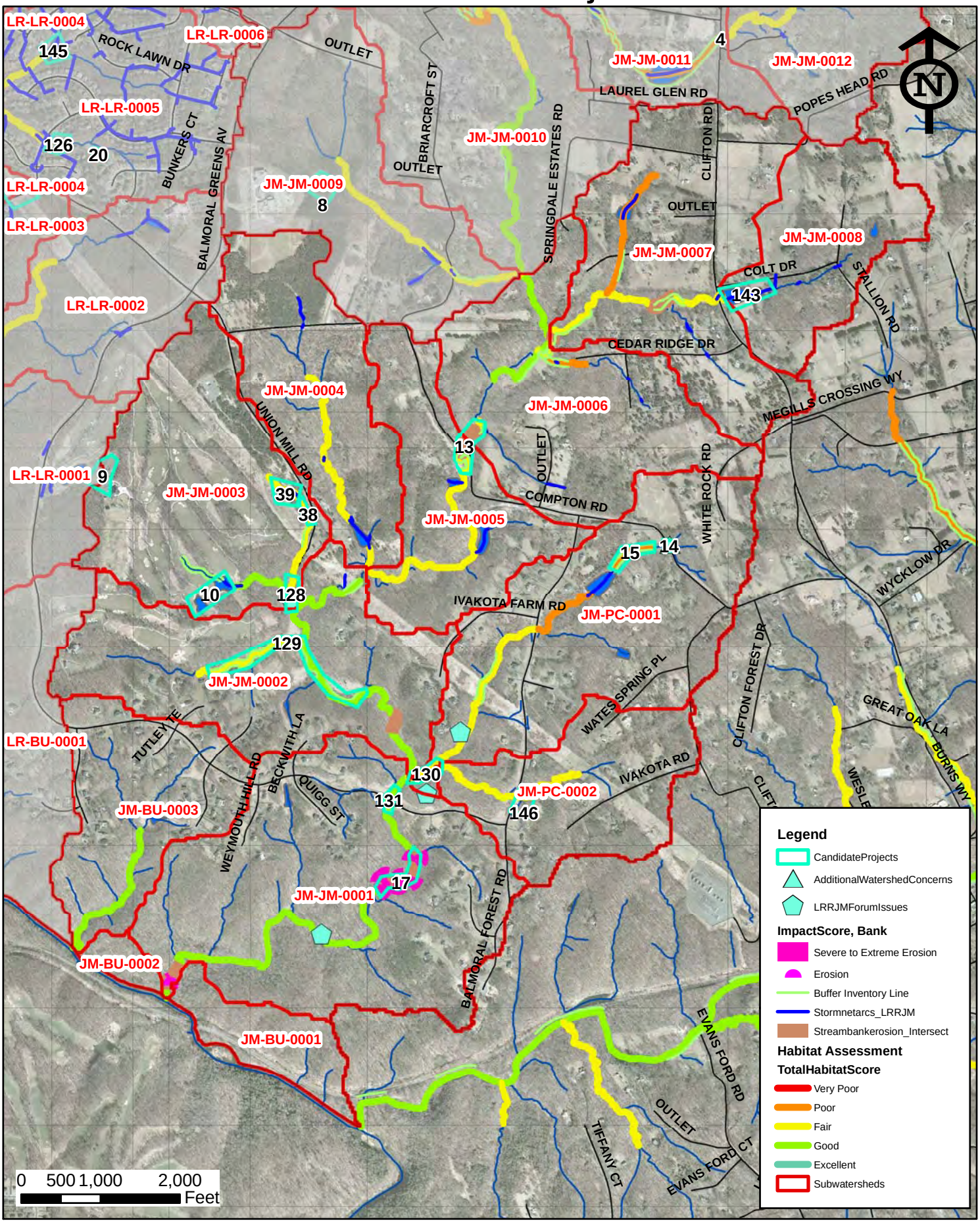
Id	Subwatershed	Type	Comments
102	LR-LR-0024	Non-Structural	Landfill - ensure required monitoring, on site practices are followed
104	LR-LR-0024	New SWM	New outfall treatment for Regional Pond R-12
105	LR-LR-0025	Non-Structural	Betty's Azalea Ranch - education about proper storage practices, investigate leaking fuel tanks
106	LR-LR-0025	New SWM	Missed facility? - opportunity for LID
107	LR-LR-0020	Pond Retrofit	Remove trickle ditches, add micropools/plantings
108	LR-WS-0002	Pond Retrofit	Existing dry pond not in StormNet - Remove trickle ditches, add micropools/plantings
109	LR-WS-0002	New SWM	Outlet treatment for uncontrolled area
110	LR-WS-0002	New SWM	Outlet treatment for uncontrolled area - culvert retrofit u/s of Tractor Lane?
111	LR-WS-0003	Stream Restoration	Stream in concrete channel being undermined - restore buffer and natural channel
112	LR-WS-0003	Stream Restoration/Road Flooding	Concrete channel - restore to natural channel - stabilize downstream erosion - address pipestem flooding
113	LR-WS-0003	Stream Restoration	Erosion from SPA and field visit
114	LR-WS-0003	New SWM	Willow Springs ES drains to dry pond - onsite LID opportunities
115	LR-WS-0004	Pond Retrofit	Remove trickle ditches, add micropools/plantings - enlarge in replacement of R-10?
116	LR-WS-0005	Buffer Restoration	Alternative to R-10?
117	LR-WS-0005	New SWM	Regional Pond R-10 - on private property - feasibility low - buffer restoration and culvert retrofits instead
118	LR-LR-0016	Non-Structural	Educate property owner about storage/junk on property - WAG comment
119	LR-LR-0009	Stream Restoration	WAG Comment - 100 yds of Creek severely degraded in this area - access issues
120	LR-LR-0003 LR-LR-0004	Non-Structural	Cable barriers at power cuts - deter dumping and ATV use - WAG comment
121	LR-LR-0004	Non-Structural	Cable barriers at power cuts - deter dumping and ATV use - WAG comment
123	LR-LR-0016	Debris	WAG Comment - Clean debris in woods at Bent Tree Apt Complex
124	LR-LR-0016	Non-Structural	WAG Comment - Keep parking lot clean - educate property owner - install trash diverters
125		Non-Structural	WAG Comment - Encourage participation in Adopt-a-Highway and stream cleanups
126	LR-LR-0005	Culvert Retrofit	Possible site for culvert retrofit

Id	Subwatershed	Type	Comments
128	JM-JM-0003	Stream Restoration	Issues Scoping Forum Comment - flooding and erosion
129	JM-JM-0002	Buffer Restoration	Buffer issue identified in SPA - unnecesary culverts? for removal - FCPA & HOA
130	JM-PC-0001	Stream Restoration	Issues Scoping Forum Comment - erosion, verified in field investigation
131	JM-JM-0001	Buffer Restoration	Buffer issue identified in SPA
132	LR-LR-0007	Stream Restoration	Erosion/poor flow in channel - comment from Kevin Morley - Green Trails HOA - phone conversation
133	LR-LR-0023	Buffer Restoration	SPA Identified buffer issue along and upstream of Regional Pond R-9
134	LR-LR-0015	Pond Retrofit	Space for modification, need for more plantings - WAG - pond in good shape what is achieved if enlarged or improved?
135	LR-LR-0014	Stream Restoration	Relace paved ditch with natural stream
136	LR-LR-0014	Pond Retrofit	Dry pond retrofit with wetland plantings, micropool
137	LR-LR-0010	Pond Retrofit	Modify pond to provide additional capacity, pollutant removal in replacement of Regional Pond R-5
138	LR-LR-0010	Stream Restoration	Remove paved ditch
139	LR-LR-0009	Pond Retrofit	Good access, space for modifications for wetland plantings, micropools to improve water quality treatment
140	LR-LR-0009	New SWM	Inlet/outlet controls for uncontrolled area
143	JM-JM-0008	Pond Retrofit	Retrofit pond to provide flow reductions, water quality benefit
144	LR-LR-0006	Pond Retrofit	Retrofit ponds to include wetland plantings
145	LR-LR-0005	Pond Retrofit	Retrofit to include wetland plantings
146	JM-PC-0002	Culvert Retrofit	Detention upstream of road - created wetland

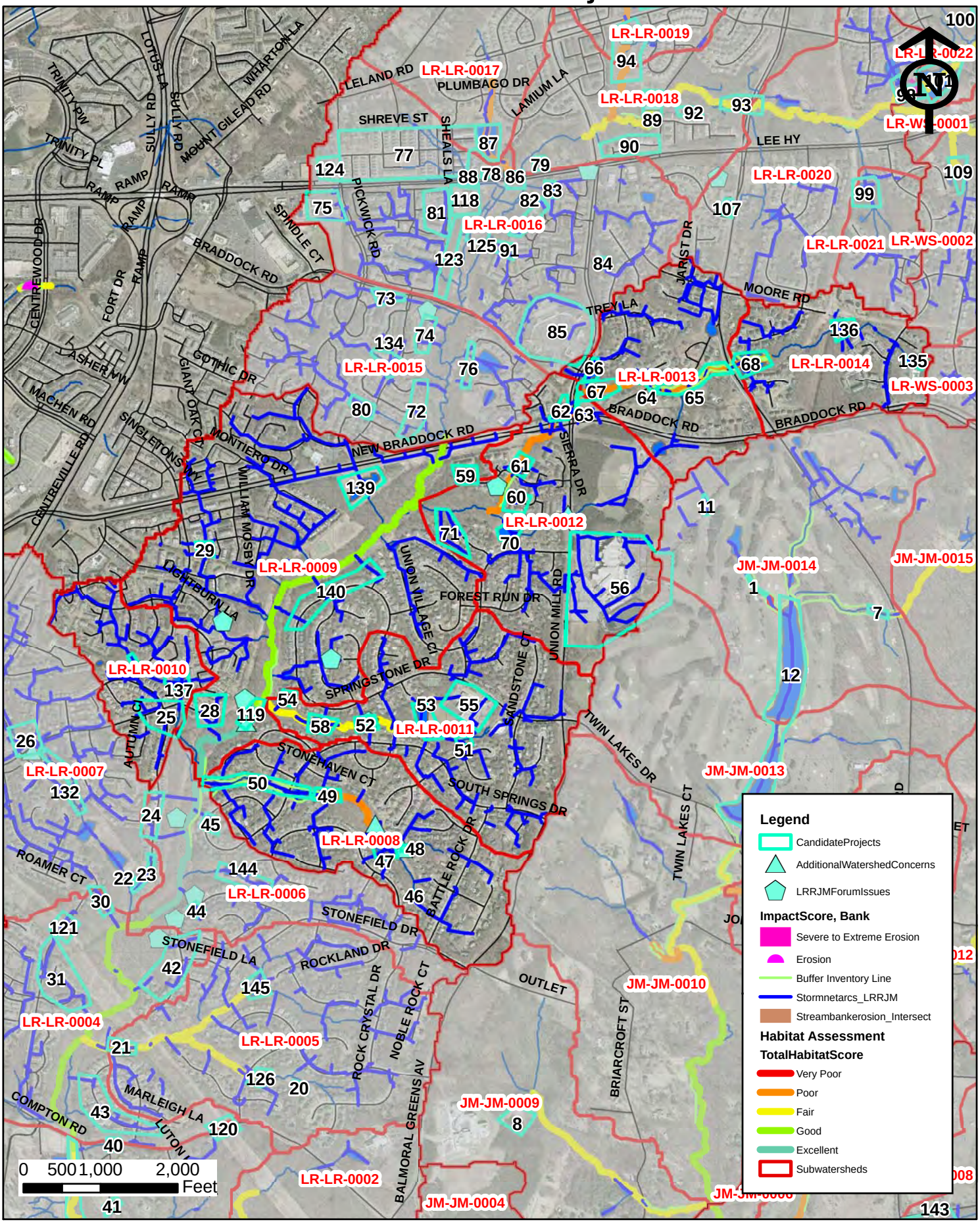
Johnny Moore Creek (1/2)
Candidate Projects



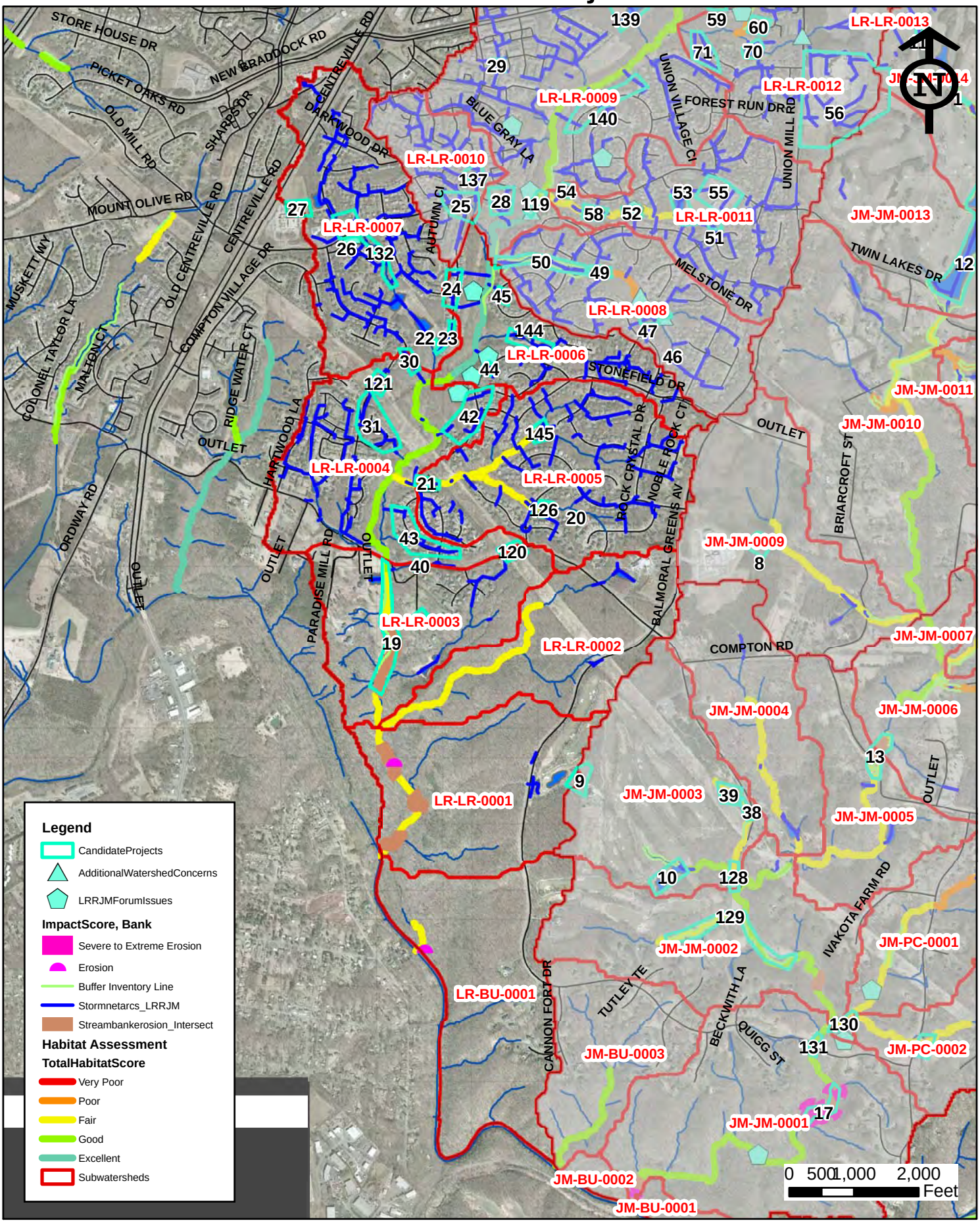
Johnny Moore Creek (2/2)
Candidate Projects



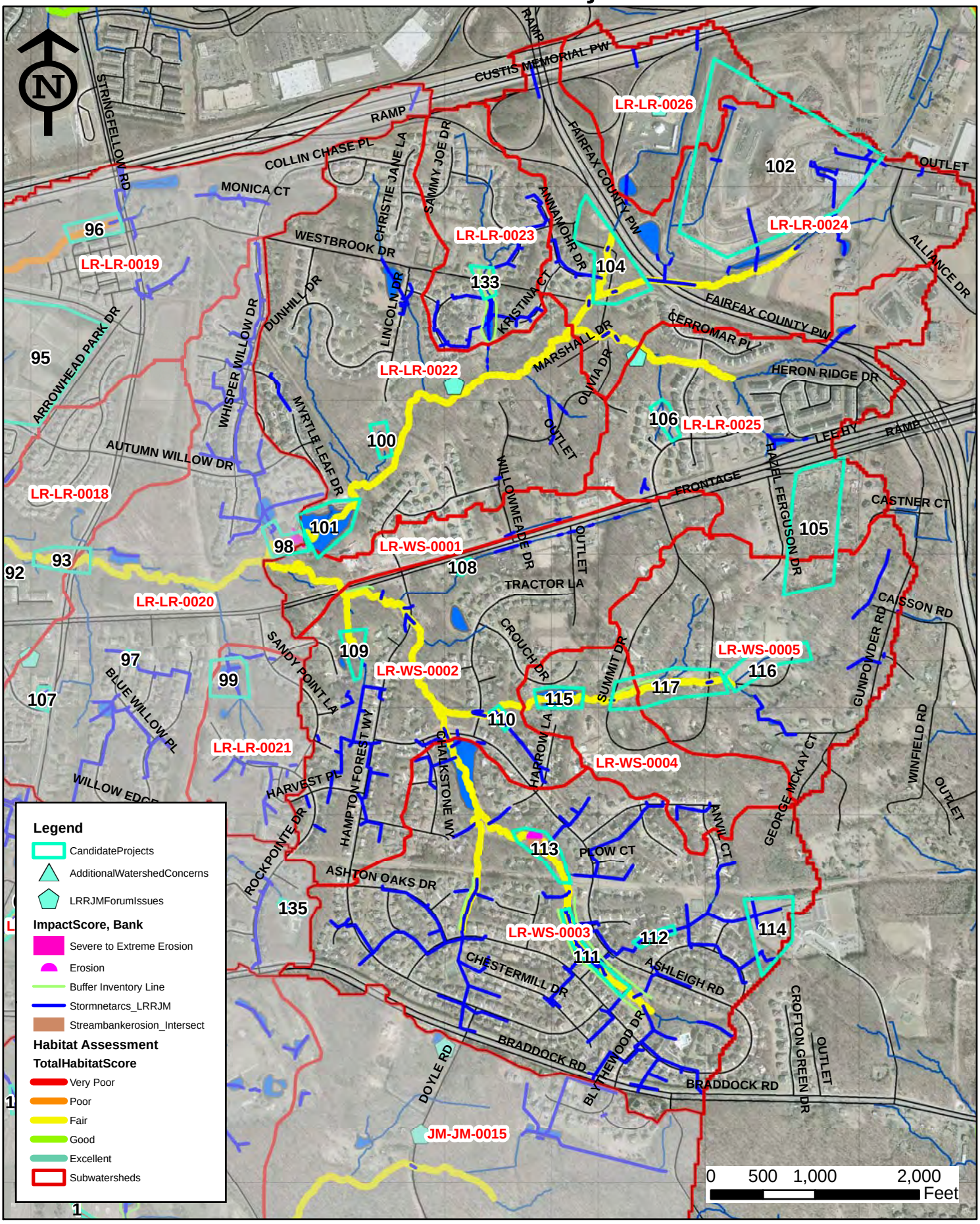
Little Rocky Run Lower (1/2)
Candidate Projects



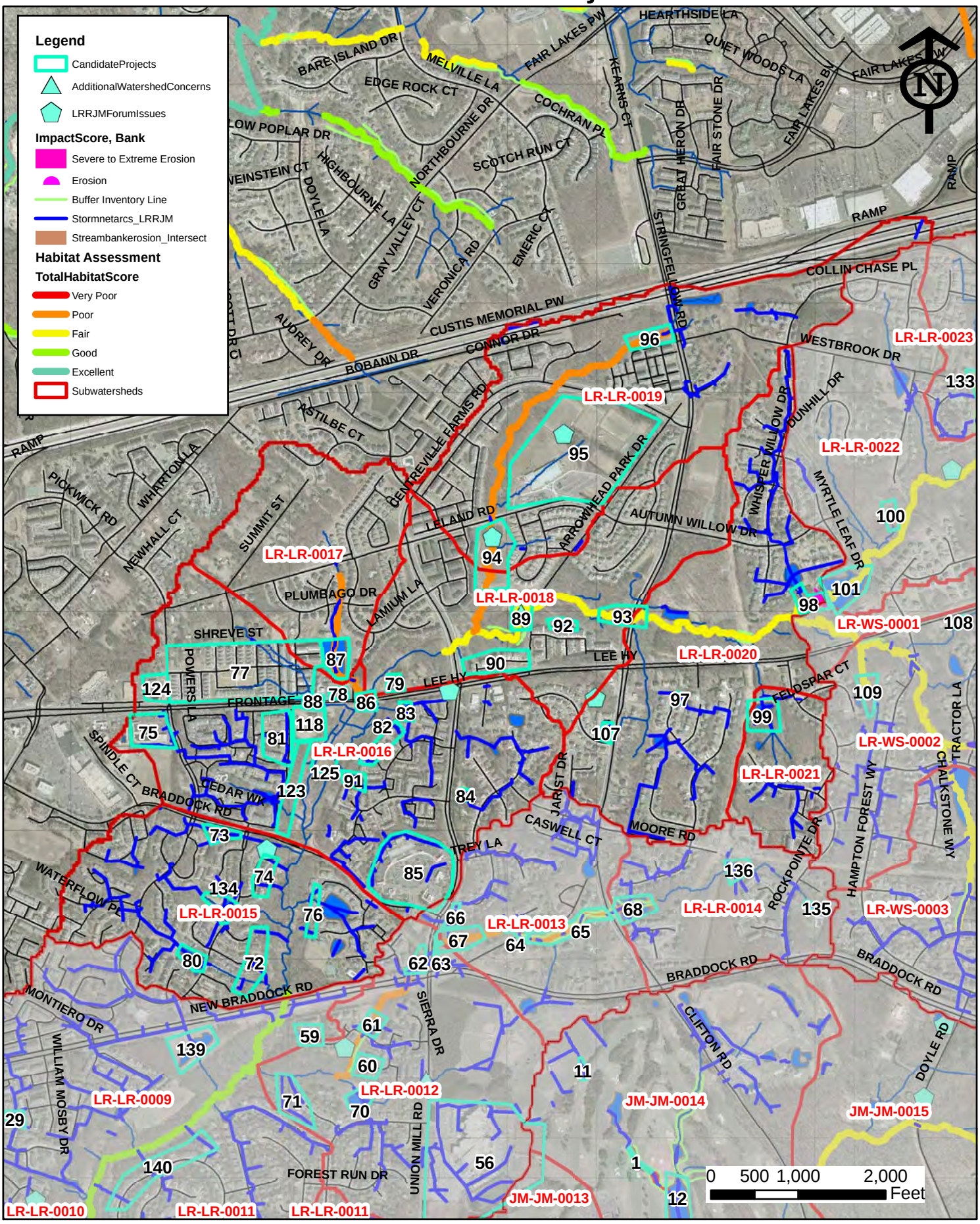
Little Rocky Run Lower (2/2)
Candidate Projects



Little Rocky Run Upper (1/2)
Candidate Projects



Little Rocky Run Upper (2/2)
Candidate Projects



Memo

To	**LeAnne Astin, Fairfax County, SWPD**	File no	
From	**Lynne Mowery, PE, AMEC Earth and Environmental, Inc.**	cc	
Tel	**703-488-3773**		
Fax	**703-488-3701**		
Date	**January 7, 2011**		

Subject **Little Rocky Run/Johnny Moore Creek Project Prioritization Technical Memorandum – FINAL**

SECTION 1.0 – Introduction

This memo bridges the gap between Technical Memorandum 3.2 and the selection of 40 projects to be included as part of the 10-yr implementation plan and the remaining projects to be included as part of the 25-year plan (the process covered in detail by this memorandum).

Watershed Advisory Group Input

The issues scoping forum and the watershed advisory group (WAG) provided valuable input about problem areas in the watershed. The WAG also reviewed the projects identified during the initial subwatershed strategies and provided feedback on project locations and feasibility. All comments from the scoping forum and the WAG were investigated and considered for project selection. Some of the issues identified were not feasible project sites or would have minimal impact on the flooding or water quality issues. Some comments were also more general and did not generate a specific project. The projects generated from the issues scoping forum and WAG are summarized below:

Comment	Project ID
Structural Projects	
Issues Scoping Forum – Erosion at Polecat Branch	JM9201
Issues Scoping Forum – Erosion at South Springs Drive	LR9103B
Issues Scoping Forum – Culverts eroding stream bed	LR9518, LR9519
Issues Scoping Forum – Erosion at Johnny Moore/Union Mill Road	JM9202
WAG #1 Comment – Erosion downstream of trail near Melstone Court	LR9102
WAG #2 Comment – Road Flooding	JM9400
Green Trails WAG Comment – Flooding, erosion	LR9509, LR9201
Non-Structural Projects	
WAG Comment – Trash in commercial shopping centers	LR9802, LR9803

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Comment	Project ID
WAG Comment – Junk removal, debris cleanup	LR9801
WAG Comment – Litter control	LR9800

Investigation of Candidate Projects

The projects identified during the initial subwatershed strategies were investigated in the field to evaluate the project feasibility and to gather other data such as site conditions, site constraints and potential construction considerations. Field staff noted any recommendations for the project and evaluated the feasibility of the project. Factors affecting the feasibility of a project included construction access, permitting issues, land ownership, utility conflicts, the topography of the site and other impacts on the stream, wetlands, trees or floodplain. A database summarizing the field information was developed (*CandidateProjectInvestigation Database_23June09.mdb*). A GIS file of the candidate project sites was also submitted (*CandidateProjects.shp*).

In order to develop a list of 80 projects for evaluation and prioritization, projects that were determined to be unfeasible or that would have minimal impact on the watershed were removed from the candidate project list. A table of the removed projects is shown below.

Removed Projects

Project ID	Description	Reason for Removal
1	Very Poor SPA Habitat Score, issues with golf course, engineered channel	Field investigation found no major issues with channel
7	Headcut from SPA	Identified in SPA - no evidence of head cut in field investigation
9	Golf Course clubhouse, parking lot, etc. confirm treatment	Field investigation verified that some treatment is provided in filters - feasibility of additions in private golf course low
10	Golf Course Ponds	Feasibility of modifications to private golf course ponds is low
12	Plant trees along stream and ponds where possible	Feasibility of planting buffer along golf course fairways is low
21	Clogging problem - review design to address problem - erosion issues north of pond. Recently retrofitted - sedimentation issues	Pond recently retrofitted - recent pond visit found no major problems
41	Bioretention/Grassed swale for uncontrolled area - on private property	Feasibility on private property low
51	Stabilize outfall to reduce erosion	Not viable from field investigation
53	Remove trickle ditches, add micropools/plantings	From field investigation - no trickle ditch, good plantings
66	Remove trickle ditches, add micropools/plantings - stabilize upstream sinkhole (complaint)	Field investigation - no trickle ditch, good plantings
87	Pond had eroded areas - stabilize - add wetland plantings - adjust subarea to include Sully Manor - area still in construction	Pond plantings have stabilized since previous field visit - pond recently constructed

Project ID	Description	Reason for Removal
88	From Pro-rata - drainage divides in area have changed significantly - no longer needed?	From pro rata - no longer an issue from field investigation
93	Stabilize stream, Pro rata culvert project - confirm overtopping from RAS - WAG comment that culvert was replaced	From field investigation - area is stable and has good habitat diversity
96	Erosion noted during field visit	2nd field visit found no major issues
119	WAG Comment - 100 yds of Creek severely degraded in this area - access issues	No major issues identified in field investigation
120	Cable barriers at power cuts - deter dumping and ATV use - WAG comment	Projects generated from WAG comment - will provide minimal benefit - add as general recommendation in WMP
121	Cable barriers at power cuts - deter dumping and ATV use - WAG comment	Projects generated from WAG comment - will provide minimal benefit - add as general recommendation in WMP
143	Retrofit pond to provide flow reductions, water quality benefit	Feasibility of modifications to pond on private property is low

Projects that were estimated to cost less than $80,000 were combined with other nearby projects. In addition, projects that were very close in proximity were combined for cost efficiency. A table reflecting these combined projects is shown below.

Combined Projects

Project Numbers	New Project ID	Project Types
14, 15	JM9400	Culvert Retrofit
22,23	LR9508	New BMP/LID
38, 39	JM9100	Pond Retrofit / Dump Site
47, 48	LR9102L	Pond Retrofit / Outfall Improvement
49, 50	LR9202	Stream Restorations / Buffer Restoration
52, 58	LR9104	Pond Retrofit / Stream Stabilization
64, 65	LR9013A	Stream Restoration / Buffer Restoration
72, 74, 76	LR9518	New BMP/LID
75, 77, 124	LR9802	New SWM / Non-structural
82, 83, 91	LR9521	Pond Retrofit / BMP/LID
84, 85	LR9112L	Pond Retrofit / Non-structural
118, 123	LR9801L	Debris Removal / Non-structural
90, 92	LR9112	Pond Retrofit / BMP/LID
97, 107	LR9114	Pond Retrofits

Prioritization

As noted in the Watershed Management Plan Development Standards, Version 3.2, previously identified structural/non-structural projects identified under Subtask 3.2 were to be evaluated and prioritized based on their overall benefit and feasibility in meeting the watershed goals and objectives. For the Little Rocky

Run/Johnny Moore Creek watersheds, AMEC followed County-provided guidance to set a baseline ranking. The baseline ranking process consisted of setting values in five categories that, when scored according to the provided weighted system, resulted in a preliminary project score. The five categories are described as:

1. Effect on Watershed Impact Indicators (30 percent)
2. Effect on Source Indicators (30 percent)
3. Location within Priority Subwatersheds (10 percent)
4. Sequencing (20 percent)
5. Implementability (10 percent)

Categories 3 (Location within Priority Subwatersheds) and 4 (Sequencing) are static. The provided guidance was followed and remains unchanged. Assumptions used to assign values to Category 5 are summarized separately in this memorandum and were based on input from the Watershed Advisory Group (WAG) and from the County. The two remaining categories required adjustments be made to the baseline conditions based on a consideration of the data collected to this point in the process, including but not limited to: field reconnaissance, professional experience in design, effectiveness, and implementability of the various project types, as well as WAG input. Justification is provided in this memorandum for adjustments that went beyond the scope of the provided prioritization scheme or accommodated specific project sites. The following section defines the baseline condition for Categories 1 and 2.

In order to determine individual project impacts to a subwatershed, 'scenarios' were developed pairing no more than one proposed project per subwatershed at one time. There were two scenarios run for the Johnny Moore Creek watershed and seven for Little Rocky Run watershed. Once project selection was complete, a revised *future with project* profile was created that may include multiple projects in a single subwatershed.

SECTION 2.0 – Establishing a Baseline for Structural Projects

Impact Indicators

Attachment 1 defines which watershed impact indicators were evaluated for each project type. There are two kinds of impact indicators - those that are predictive and those that are not. The predictive impact indicators were evaluated with direct metric values assigned to the *future with project* watershed condition. These impact indicators have metric values for the existing condition, the *future without project condition* and the *future with project condition*. Therefore, they are quantifiable. Predictive indicators were scored according to the procedure outlined in the Watershed Management Development Standards and described below:

> *For predictive indicators, preliminary scores should be based on the percent change in impact score between future without and future with project conditions. Thresholds for project scoring should be based on quintiles (5 statistical percentiles) of the percent change values. The greatest positive percent change should receive a score of 5, and the lowest positive (or greatest negative) percent change should receive a score of 1. The percent change from existing to future should be reviewed to ensure that the preliminary project scores reflect benefits to existing as well as future conditions.*

The predictive impact indicators are Total Suspended Sediment (TSS), Total Nitrogen (TN) and Total Phosphorus (TP). A proposed project has a measurable effect on each of these indicators and quintiles were developed for each indicator regardless of project type. A table of loading rates and percent change for these indicators is shown in Attachment 2.

Benthic Communities, Fish Communities, Aquatic Habitat, Channel Morphology, Instream Sediment, Flood Complaints and E. coli are non-predictive. Scores for these indicators were assigned based on subwatershed need rather than a quantifiable impact a proposed project has on the impact indicator. Need in the subwatershed was assessed using existing conditions impact indicator scores, as determined by the subwatershed ranking protocol.

The remaining impact indicators fall into two groups: those that will become predictive when more data are available, and those that are predictive with an inadequate sample size. Indicators that will become predictive include Hydrology, Number of Road Hazards, Residential Building Hazards and Non-residential Building Hazards. At this stage, a *future with project* value is unavailable for these indicators. Best professional judgment was employed to assign project scores based on how well a particular type of project affected the presence of a watershed impact indicator.

For example, a project that increased the capacity of a culvert crossing would have a positive effect if upstream flooding hazards exist. It's also possible a project of this type could exacerbate flooding downstream. These details were addressed in Subtask 3.6 utilizing HEC-RAS and SWMM modeling data. If a project was proposed specifically to address flooding issues, it was assigned a score of '5' for that impact indicator. These project/score associations were termed 'score overrides' and are summarized in Attachment 3. They were applied generally and then revisited at the project level to determine whether the override accurately described the project impact for the linked indicator.

Best professional judgment was also employed for predictive indicators lacking sufficient data to support assigning project scores based on the percentile methodology. RPA Riparian Habitat, Headwater Riparian Habitat, Wetland Habitat and Terrestrial Forested Habitat are the impact indicators that fall into this category. Only a handful of projects impact these indicators, rendering the percentile methodology ineffective. Any project influencing these impact indicators was assigned a 5 (for the specific impact indicator affected). For example, a Buffer Restoration project received a project score of 5 where proposed planting efforts would have a positive effect on the Habitat indicators (Riparian, Headwater, Wetlands, and Terrestrial Forested). Actual computations were submitted for future analysis on a countywide basis but were not helpful at the watershed scale.

The overrides are summarized in Attachment 3. A score of 3 is best described as neutral. Some projects of a particular project type will have an impact on that indicator, but not necessarily all of them. They remain linked, but were assessed individually. Deviations from the provided overrides are explained separately in this memorandum. An impact indicator score was computed by averaging the scores of all the impact indicators affected by a specific project type.

A table showing the individual scores for each impact indicator is included as Attachment 4.

Source Indicators

Attachment 5 defines which watershed source indicators were evaluated for each project type. The procedure for predictive source indicators is identical to that of predictive impact indicators. The predictive source indicators are TSS, TN, and TP (detailed loading results are the same for Impact and

Source Indicators for TSS, TN, and TP, all of which is summarized in Attachment 2). It is noted that Stream Restoration projects were not linked to anything but the predictive source indicators. There is a clear disconnect between the location of the source and the proposed project location for stream restoration projects. Many of these projects are proposed along Little Rocky Run or Johnny Moore Creek, within in-line subwatersheds that mostly score well for several source indicators. This is attributed to the fact that many of the in-line subwatersheds contain a significant stream buffer and therefore do not contain as many source indicators (impervious areas, channelized/piped streams, outfalls, etc.) as the headwater subwatersheds. Otherwise, the matrix is the same as what was provided by the County.

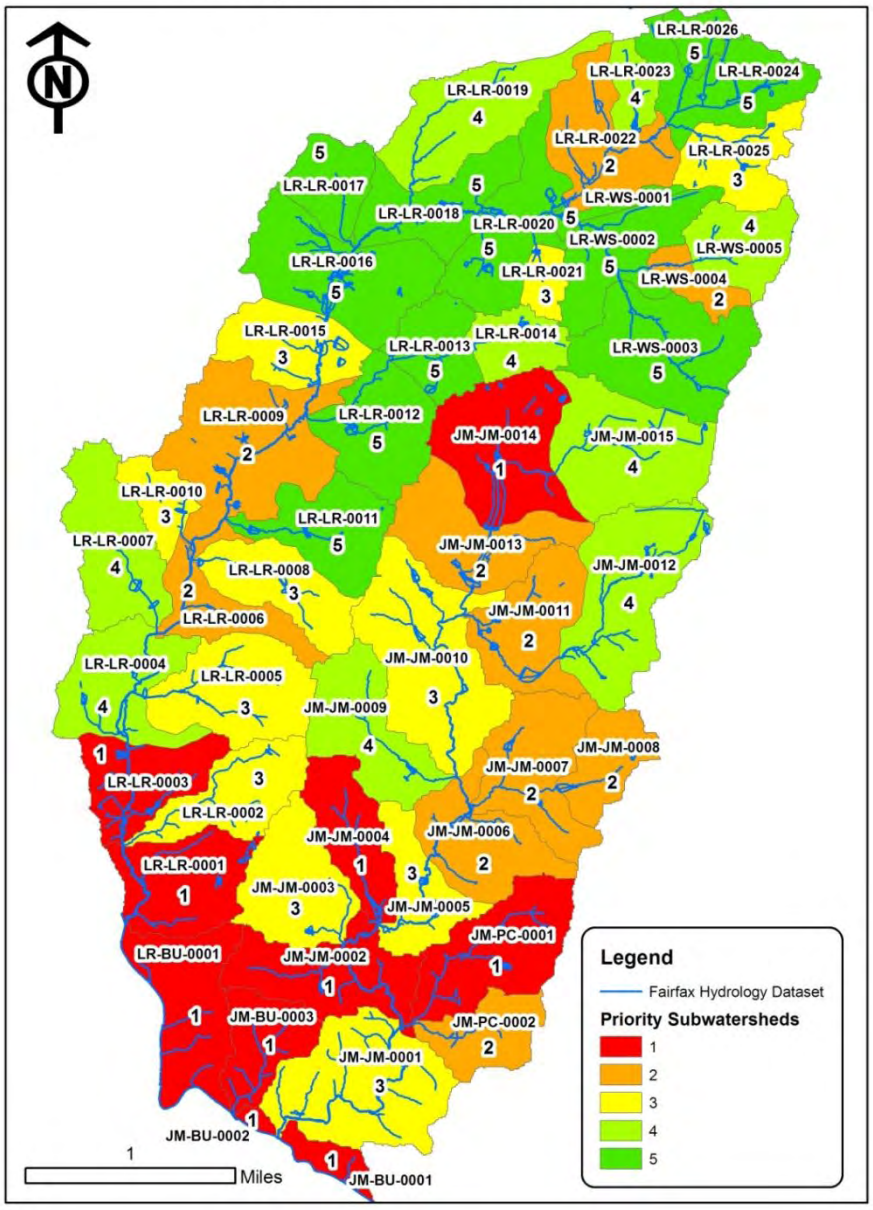
Channelized/Piped Streams, Directly Connected Impervious Area (DCIA), Impervious Surface and Stormwater Outfalls are non-predictive and were scored in the same fashion as non-predictive impact indicators. With few land use changes expected in either watershed, applying the percentile methodology on the difference between the *future without project condition* and the *existing condition* did not yield meaningful results. Therefore, existing conditions scores for source indicators were used to determine subwatersheds that contain more source indicators. A source indicator score was computed by averaging the scores of all the source indicators affected by a specific project type.

Attachment 6 shows the individual scores for each source indicator.

Location within Priority Subwatersheds

Priority subwatersheds were based on the impact indicator composite scores of the *future without project scenario*. Impact indicator composite scores represent an average score for every impact indicator per subwatershed. Quintiles were developed and scores were assessed based on need. In other words, the subwatersheds with the lowest impact composite score received the highest priority (5) score.

Priority Subwatersheds (10%)

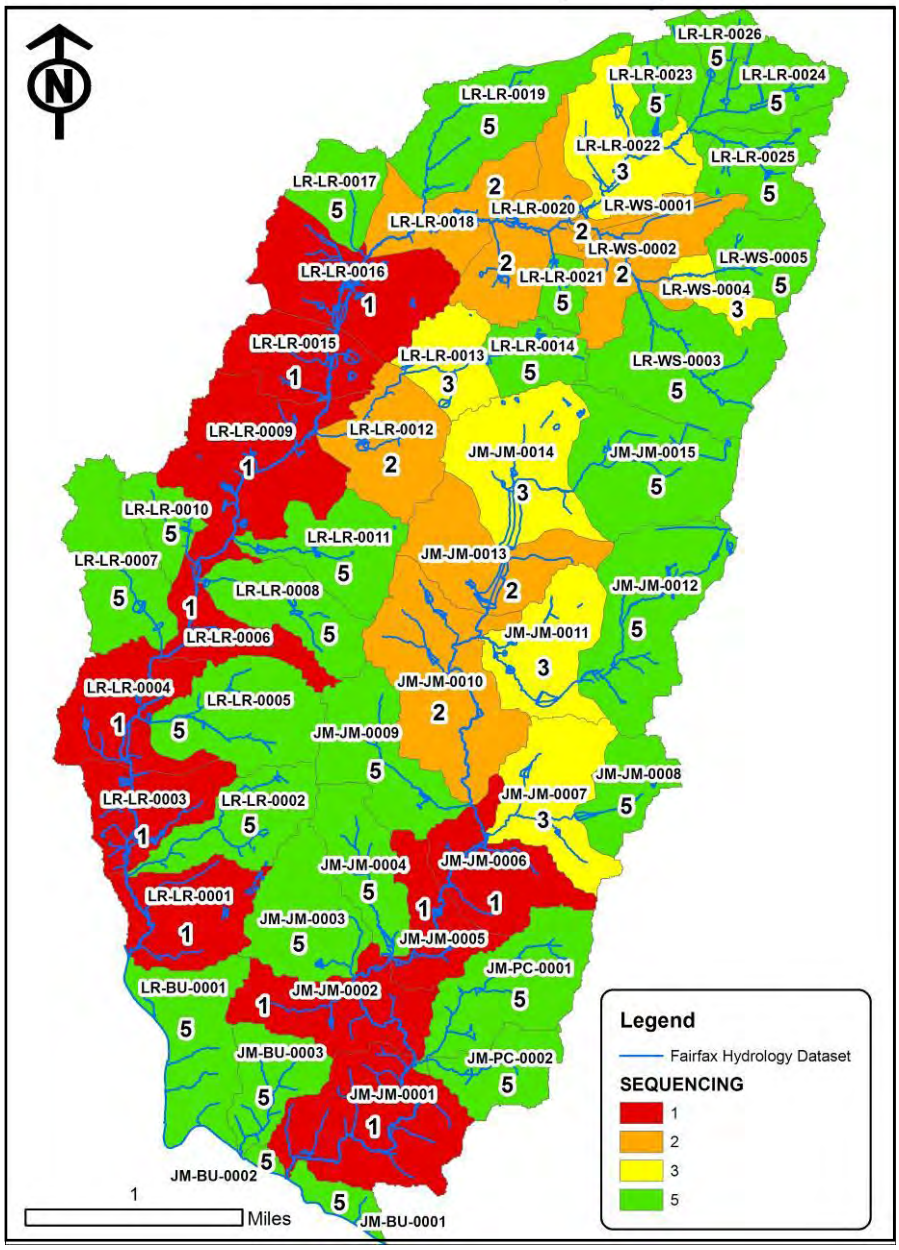


Sequencing

Sequencing scores were developed by first recording the upstream-downstream order of the subwatersheds. Headwater subwatersheds (any subwatershed where a stream originates) were given an order of 1. Subwatersheds just downstream of headwater subwatersheds were given an order of 2. This process continued until all subwatersheds are assigned an order, with the most downstream subwatersheds receiving the highest value. Where subwatersheds of different orders were upstream of a single subwatershed, that subwatershed received the next sequentially highest order.

Once the subwatershed order was established, quintiles were used to assign a project score to each subwatershed order. Those with the lowest subwatershed order were given the highest project score (5). A map showing the scores is below.

SEQUENCING (20%)



Implementability

Guidance from the Watershed Management Plan Development Standards Version 3.2 was used to assign scores for this rating component. This guidance is summarized below:

- High Implementability (5 points)
    - Tree buffer restoration
    - Debris/trash removal
    - SWM retrofits in County maintained facilities where no additional land rights are required
    - Stream restorations that do not require upstream runoff quantity reductions and are proposed on sites with significant land owner support
    - LID retrofits at schools and other County facilities
    - Other priority projects that have significant land owner support
- Moderate Implementability (3 points)
    - Other pond and LID retrofits and other stream restorations that do not require upstream runoff quantity reductions
- Low Implementability (1 point)
    - Projects that do not fit into the above categories and are likely to be less feasible than the majority of recommended projects

Projects with significant site constraints generally have an adjusted score to the next lower category. Projects that were given a 5 for implementability include: pond retrofits on HOA property, new SWM projects on school properties, buffer restorations and non-structural projects such as litter control and education projects. Most stream restoration projects were given a 3 because they are located in areas not owned by the County, would require tree removal and landowner support is unknown at this time. New SWM and culvert retrofits were also given a 3 as they are generally located in HOA areas or private property where landowner support is unknown. Projects given a 1 include: regional ponds, flooding mitigation projects, culvert projects to address road flooding and other projects located on private property where feasibility and access were identified as issues during the field investigations.

For example, for New BMP/LID projects, project LR9512 was given a 3 for implementability because the project is located on HOA property and the landowner issues are unknown, while project LR9516 was given a 5 for implementability because it is an LID retrofit at a school. All pond retrofits were given a 5 for implementability because they are County maintained facilities except for JM9100, which is a breached private facility, and LR9116, which is an existing regional facility that was stabilizing during the field inspection. Additional observance of this pond is needed to determine if this project is necessary at this time.

Assessing potential constraints was a large component of the field work conducted for the candidate projects: the data are available in the database and detailed in the final plan project fact sheets.

Project Scores

Using the weights described in the introduction of this memorandum, a final project score was computed. Attachment 7 includes the final scores for each of the five components that make up the project score. Overrides and project specifics were established using an iterative process and best professional judgment afforded AMEC's team from WAG input and knowledge of the watershed. Where baseline scores were adjusted, documentation is provided in Section 3.0.

SECTION 3.0 - Project Specifics and Assumptions

A map of proposed project locations is included as Map 1.

Stream Restoration

Projects were scored based on the baseline scores shown above with a few exceptions. Most of the stream restoration projects are located in areas with erosion problems identified in the County's Stream Physical Assessment (SPA). For these projects, the STEPL pollutants (TSS, TN and TP) calculated for the subwatershed were increased using the streambank erosion equation to account for this erosion. This erosion increase was removed in the *future with project condition* to account for the change in pollutant loads these projects would have.

Some projects were not located in previously identified erosion areas and were either identified by the WAG or during the field investigation process. These projects could not have the streambank erosion adjustment removed from the STEPL to determine the project's impacts on the STEPL pollutants. Therefore, for these projects the scores for TSS, TN and TP were manually adjusted to reflect an improvement. Adjustments were made for two different types of projects: removal of concrete channels, and stream restoration projects in newly identified eroded areas. For the removal of concrete channels, the scores for TSS, TN and TP were changed to 3. For stream restoration projects in eroded areas these scores were adjusted to 4. The projects for which these adjustments were made are identified below.

Stream Restoration Projects with Adjustments to TSS, TN, and TP Scores

Project ID	Project Type	Adjustment to TSS, TN and TP Scores
LR9208	Concrete channel removal	3
LR9203		
LR9209		
LR9204		
JM9202	Stream restoration in newly identified erosion area	4
LR9201		
JM9201		

Outfall Improvements

There were only two outfall improvement projects identified in the watersheds – no change was made to the baseline scores.

Culvert Retrofits

Only culvert projects that address road flooding were treated as a culvert retrofit - culvert projects that provide water quality improvements upstream of the project were treated as new stormwater management facilities. For this watershed plan, only one road crossing improvement was identified due to a WAG comment. There were no buildings upstream of this crossing, so the impacts on residential and non-residential hazards were removed for this project or it would have been incorrectly elevated in rank.

Flood Protection/Mitigation Projects

There was only one flood protection mitigation identified in the watershed. A residential structure is located in the floodplain of Little Rocky Run downstream of Arrowhead Park Drive. No change was made to the baseline scores for this project.

New BMP/LID and BMP/LID Retrofits

No BMP/LID retrofits were proposed. AMEC evaluated new BMP/LID projects by adjusting the subareas as appropriate and calculating new nutrient loadings. BMP/LID type was not considered in the revised calculations. Instead, subareas were converted where applicable to subarea 'C', which represents average removal efficiencies for several different BMP/LID options. While in some cases the specific proposed BMP/LID is known, there were many site constraints and other unknowns that made it impossible to be specific in every case. In order to avoid introducing a bias, the subarea C removal efficiencies were used for all new BMP/LID projects.

The wetland habitat scores for the new stormwater management projects that are proposed to be tree box filters were reduced from the override value of 5 to 3 since these projects would not impact wetland habitat. The projects for which this adjustment was made are summarized below.

Projects with Adjustment to Wetland Habitat Override Values

LR9505B	LR9507	LR9515
LR9503	LR9103C	LR9518
LR9501	LR9513	LR9520
LR9502	LR9517	LR9512
LR9505		

New Stormwater Ponds and Stormwater Pond Retrofits

New stormwater ponds and stormwater pond retrofits were grouped together because they are linked to the same impact and source indicators. Only one new stormwater pond was considered.

Initially, retrofits to existing dry ponds were evaluated by adjusting removal efficiencies from standard 'B2' values to removal efficiencies obtained from Table 7 of 'Stormwater Loading Factors and BMP Efficiencies for Countywide SWMM Model Applications'. The adjustments to the loadings are summarized below.

Retrofit Removal Efficiencies

	TN	TP	TSS
Original efficiency for B2 areas	0.30	0.40	0.80
Recommended efficiency for retrofitted B2 areas*	0.45	0.55	0.80
Efficiency used in ranking**	0.38	0.53	0.80

**From "Stormwater Loading Factors and BMP Effiencies for Countywide SWMM Model Applications," Table 7, Extended Dry Detention Basin with Stormwater Wetlands Bottom*
***Same as efficiency for C areas*

AMEC was not satisfied with the results of this adjustment as pond retrofit projects were heavily weighted. The main reason for this is that new SWM/BMP removal efficiencies were not customized to a specific treatment type. They were categorized using the removal efficiencies assigned to subarea type 'C' as previously described. The removal efficiencies from Table 7 were higher across the board than subarea C efficiencies, causing many proposed new BMP/LID facilities to fall out of the proposed top 40 projects. To be consistent, pond retrofits were adjusted to subarea C removal efficiencies for TN and TP. TSS removal efficiency remained at 80 percent since the reviewed literature supports that figure for stormwater ponds.

Regional Ponds

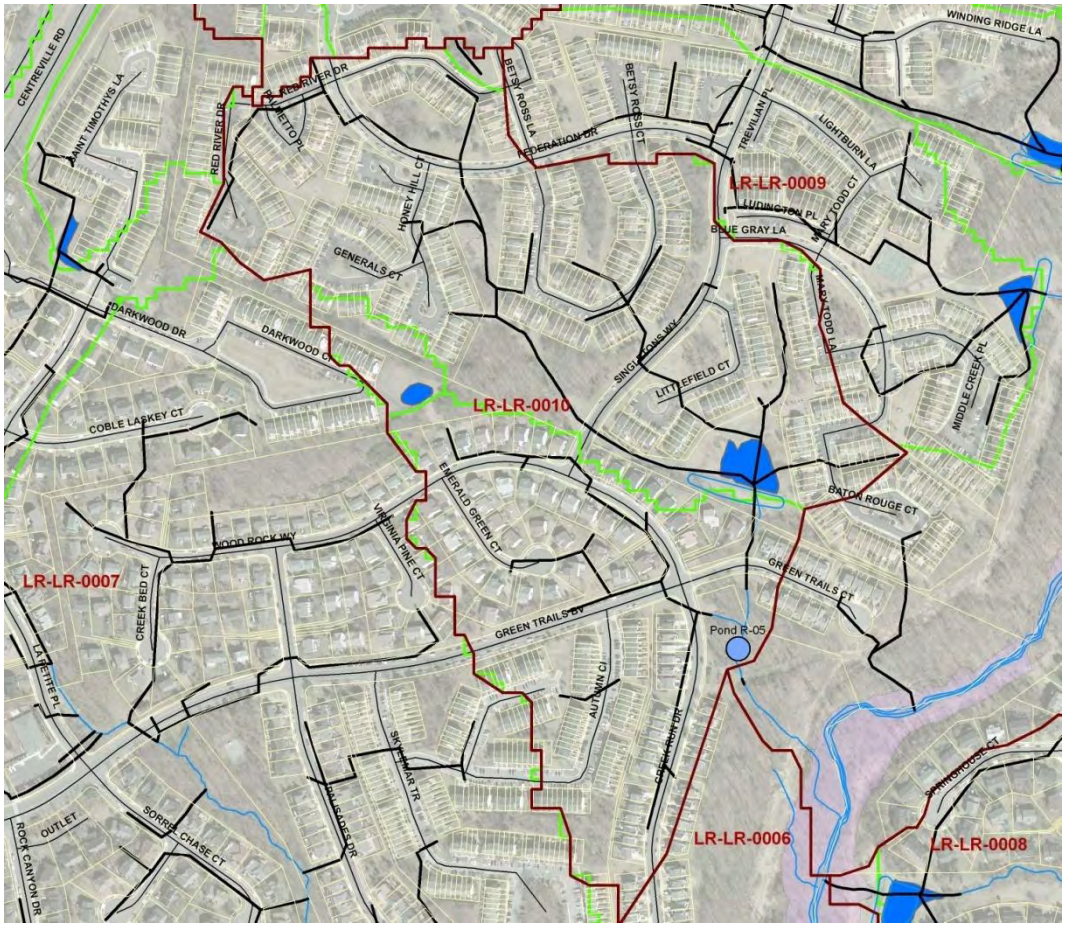
There are four inactive regional pond projects in the Little Rocky Run watershed. All of these have low feasibility because of their location on private property or other issues. The regional ponds were included as projects in the ranking and prioritization process to provide a comparison point for the impact and source scores. These ponds rank higher than they should, even with a low score for implementability, due to their positive scores for pollutant removal and their locations in headwater subwatersheds which gives them a high sequencing score. Although each regional pond was ranked, they are not shown in the final ranking table (Attachment 7) to avoid confusion with other projects that are more feasible. Each regional pond is summarized below along with the project alternatives. The table below links proposed projects and the associated Regional facility.

Project ID	Regional Pond Number
LR9005S*	R-05
LR9005A	R-05
LR9005B	R-05
LR9005C	R-05
LR9010S*	R-10
LR9010A	R-10
LR9010B	R-10
LR9013S*	R-13
LR9013A	R-13
LR9013B	R-13
LR9013C	R-13
LR9013D	R-13

** Hypothetical new regional ponds*

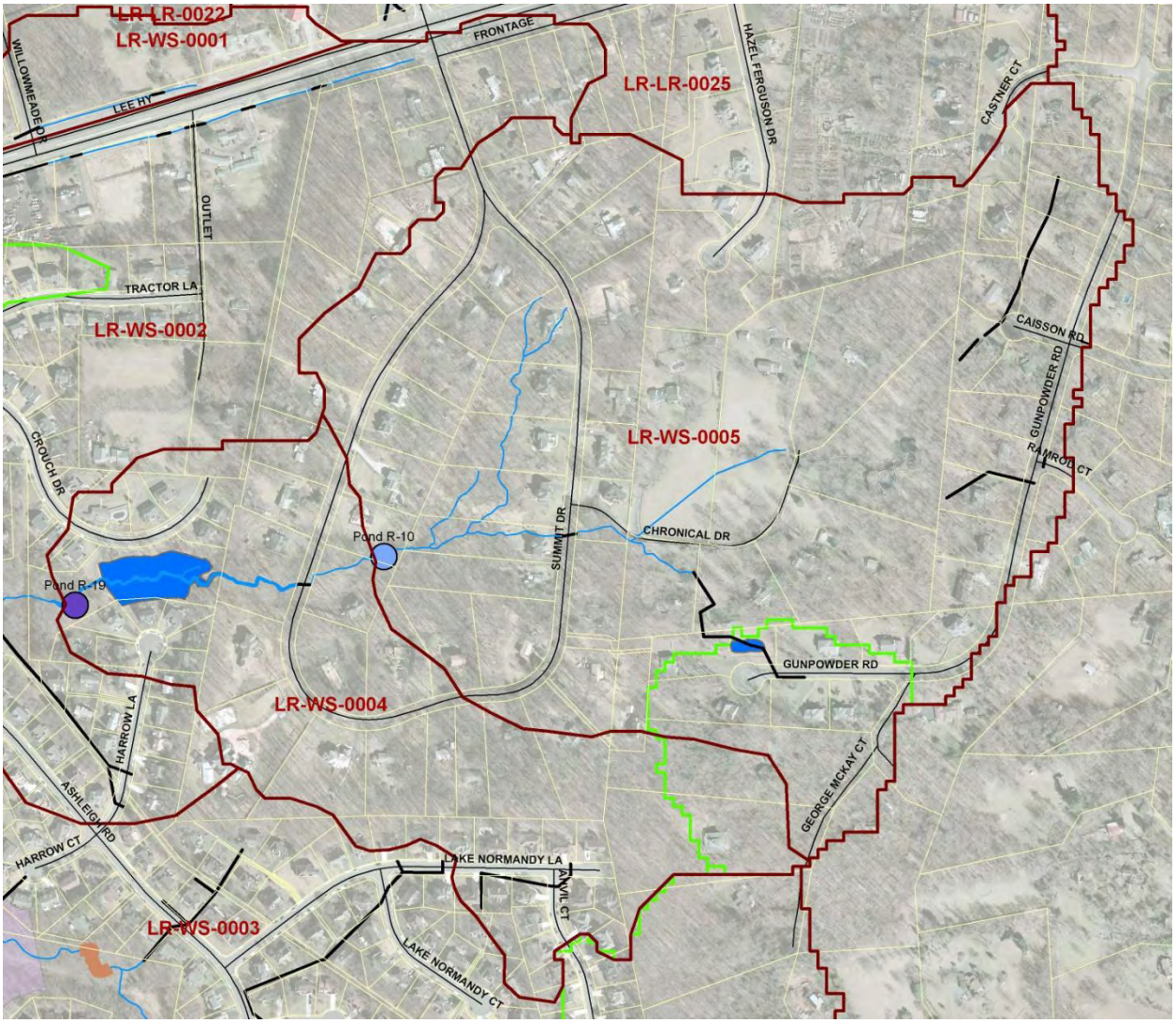
Regional Pond R-05

This pond is located in an area owned by the Green Trails Homeowner's Association (HOA) in subwatershed LR-LR-0010. From discussions with the WAG, the HOA is not supportive of a pond in this location. The drainage area to the proposed pond site is 64 acres. Two dry ponds have been constructed upstream of the pond site, 0829DP and 1312DP, with subareas of 39 acres and two acres respectively. Because of these ponds, 64 percent of the regional pond area is controlled by stormwater management facilities. The proposed alternatives include providing treatment of the untreated storm sewer system to the west of the pond site, which would treat approximately 20 acres; providing treatment of the untreated storm sewer system to the east of the pond site, which would treat approximately seven acres; and retrofitting pond 0829DP to enhance the pond removal efficiency. A map of the pond area is below.



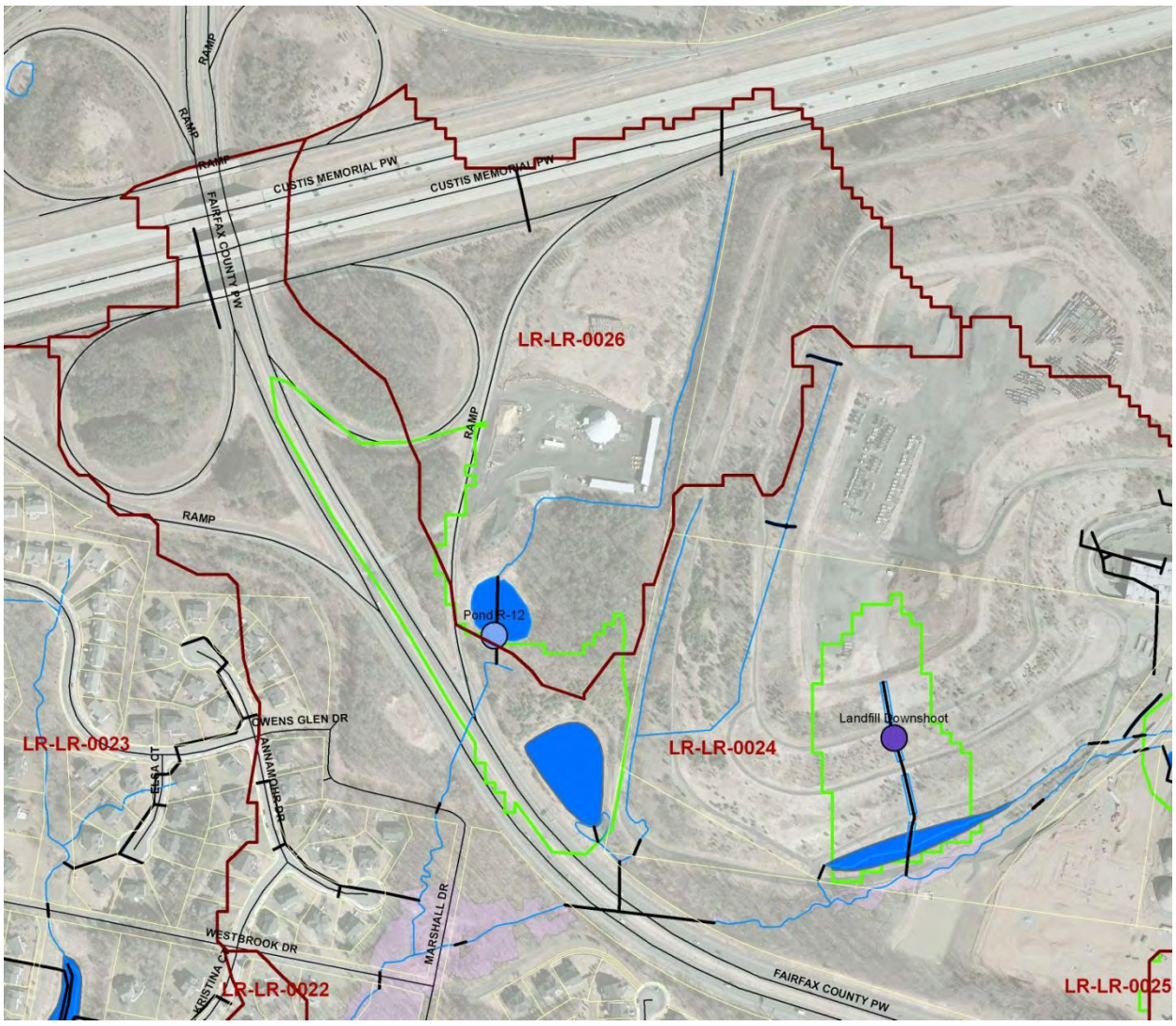
Regional Pond R-10

This pond is located on a number of large residential properties in subwatershed LR-WS-0005. The drainage area to the pond is 114 acres. Regional pond R-19 is located just downstream of the Pond R-10 site – the Regional Pond Plan included both of these ponds in series. There is a wet pond upstream of R-10 that treats approximately 14 acres. The feasibility of constructing pond R-10 is low because of the property issues involved. Another factor is that the low density of the development upstream of the pond site does not appear to warrant two regional ponds in series. The proposed alternatives include buffer restoration upstream of the pond site and retrofitting Pond R-19 to enhance the pond removal efficiency. A map of the pond area is below.



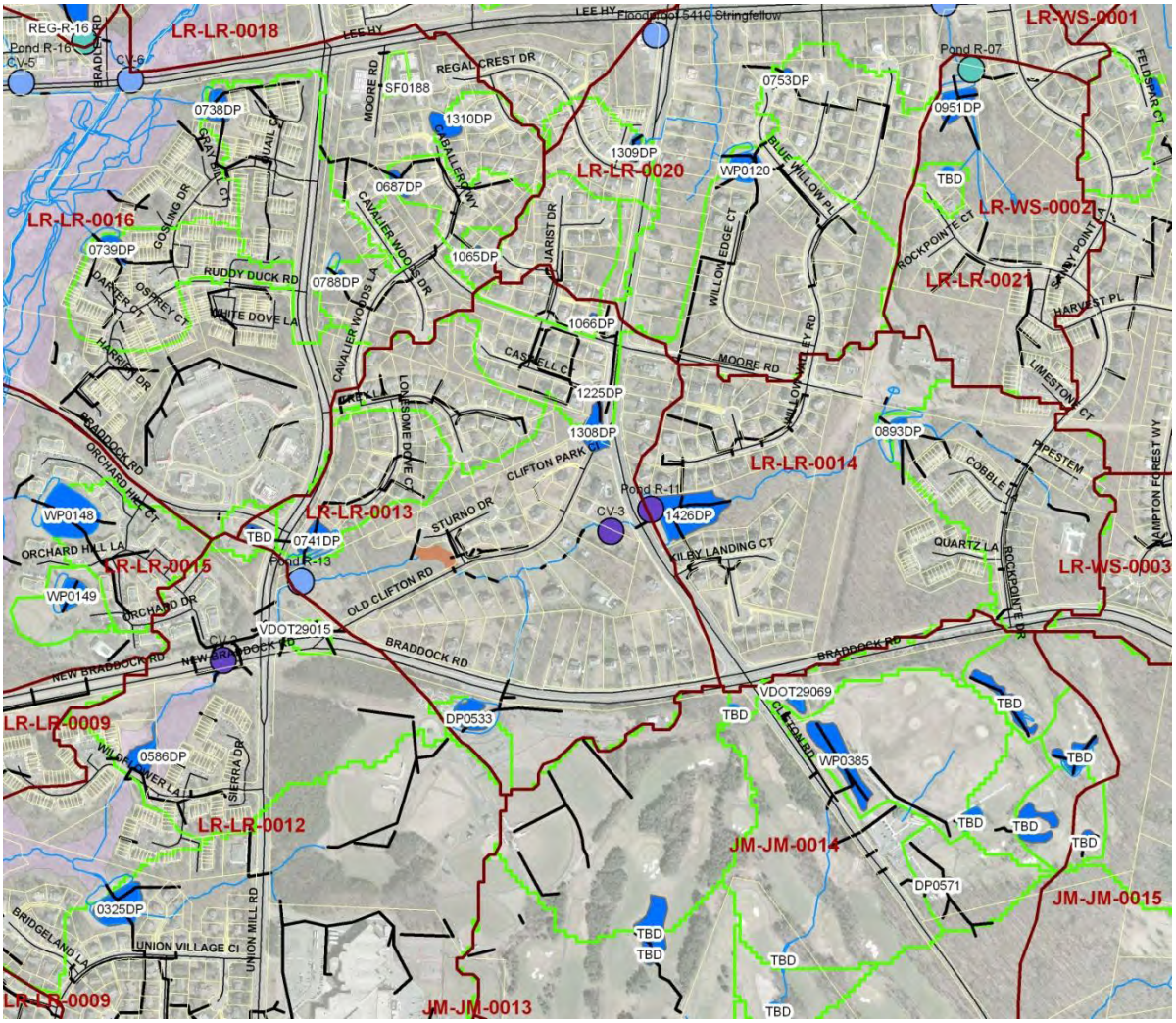
Regional Pond R-12

This pond is located on VDOT property at the intersection of the Fairfax County Parkway and Interstate 66. Although the regional pond was not constructed by the County, there is a VDOT pond (VDOT29016) at the site of the proposed regional pond that is treating all 46 acres draining to it. There is another VDOT pond (VDOT29017) just south of that is treating additional road drainage. These ponds provide the treatment originally proposed in Pond R-12. Additional treatment of the areas is proposed downstream of the Fairfax County Parkway. A map of the pond area is below.



Regional Pond R-13

This pond is located on private residential property in subwatershed LR-LR-0013. The drainage area to the proposed pond site is 183 acres. This includes the 82 acres upstream that are treated by Regional Pond R-11. The Regional Pond Plan includes these two ponds in series. The feasibility of this pond is low because of its location on private property and space and topography constraints. Four dry ponds have been constructed in the drainage area of Pond R-13 downstream of R-11: 1308DP (11 acres), 0741DP (21 acres); VDOT Pond (two acres) and DP0533 (eight acres). Because of these ponds, 42 percent of the regional pond area is controlled by stormwater management facilities. There is also an inline pond (0586DP) downstream of the R-13 site that treats 105 acres – including the R-13 area. The proposed alternatives include stream restoration of an eroded area downstream of Old Clifton Road; buffer restoration; new stormwater management of untreated system at the intersection of Braddock Road and Union Mill Road; storage upstream of the culvert at Union Mill Road; and retrofitting pond 0586DP to enhance the pond removal efficiency. A map of the pond area is below.



SECTION 4.0 – Non-structural Prioritization Criteria

In this watershed, there were two types of non-structural projects assessed: buffer restoration and other non-structural projects. Buffer restoration projects were identified through the SPA data that identified areas with insufficient buffer width. Buffer restoration projects were assessed using the baseline scoring for stream restoration, adjusted to remove channel morphology (CEM): hydrology, TSS, TN and TP from the Individual Impact Indicators and channelized/piped streams, stormwater outfalls, SS crossings, E. coli, TSS, TN and TP from the Source Indicators. Terrestrial forested habitat was added to the scoring for the Individual Impact Indicators. Thus the scoring indicators for buffer restoration include:

Individual Impact Indicators:

- Benthic Communities
- Fish Communities
- Aquatic Habitat
- Instream Sediment
- RPA Riparian Habitat
- Headwater Riparian Habitat
- Wetland Habitat
- Terrestrial Forested Habitat

Source Indicators

- Streambank Buffer Deficiency

Ranking Scores for Buffer Restoration Projects

Buffer Restoration Projects						
Project ID	**Impact 30%**	**Source 30%**	**Location within Priority Subwatershed 10%**	**Sequencing 20%**	**Implementability 10%**	**Project Weighted Score**
LR9010A	**5**	**1**	**4**	**5**	**5**	**3.625**
JM8801	**4**	**1**	**3**	**2**	**5**	**2.7375**
JM8800	**5**	**1**	**5**	**2**	**5**	**3.0125**
LR8800	**5**	**5**	**3**	**5**	**5**	**4.7625**

Three non-structural projects were identified through the Issues Scoping Forum and from WAG input. The WAG identified several areas that are usual sources of litter that would benefit from a targeted litter control education programs and cleanups to reduce floatables in the watershed. Project LR9800 is the result of WAG comments about litter in Compton Valley Estates. Project LR9801 is the result of WAG comments about debris at the Bent Tree Apartment complex. Project LR9802 resulted from WAG complaints about trash at two commercial shopping centers. Each of these projects would involve educating the property owners about trash removal and litter control requirements. Each would also be involved with targeted litter control projects such as installation of gutter guards and stream cleanups.

The WAG also identified other areas of concern that did not generate projects in the watershed plan. These include trails along Little Rocky Run to increase citizen access, monitoring of the landfill in the

headwaters of the watershed, development in the watershed, access along the power line easement and encroachment into the RPA.

These non-structural projects were scored using a modified version of the system used for the structural projects. Instead of the five factors used in the structural scoring, four factors were used. Three of the factors are the same as those used in the structural scoring: location within priority subwatersheds, sequencing and implementability. The other indicator used to rank non-structural projects was a score based on the impact the projects would have on watershed health. Since these projects were similar, each was given a score of 4 for impact. The projects would address citizen concerns and help reduce the litter problem in the Little Rocky Run watershed. The weights and scores for the non-structural projects in the plan are shown below.

Ranking Scores for Non-Structural Projects

Non-Structural Projects					
Project ID	**Impact 40%**	**Location within Priority Subwatershed 15%**	**Sequencing 30%**	**Implementability 15%**	**Project Weighted Score**
LR9801	4	5	2	4	3.6
LR9802	4	5	2	4	3.6
LR9800	4	5	1	4	3.3

SECTION 5.0 – Project Modeling

The benefits of plan implementation were analyzed through the modeling. Projects in the 10-year implementation plan that could impact stormwater discharge rates through new or increased detention storage were modeled in the SWMM hydrologic model to determine the magnitude of this new or increased storage on discharge rates. These changes included some modifications to subareas draining to facilities.

These discharge changes were then input into the HEC-RAS hydraulic model to assess any changes to flooding elevations. The changes to flood elevations as a result of the projects were minimal.

The pollutant removal provided by each project was analyzed using the STEPL spreadsheet.

These changes were then incorporated into the project impact composite score to reassess the project ranking based on the SWMM results. The addition of the modeling output to project ranking resulted in an increase in rank for projects providing water quantity improvements. The ranking adjustments generated by the changes to the SWMM and HEC-RAS along with modified project IDs are shown in Attachment 8.

5.1 Design Storms

Storm events are classified by the amount of rainfall, in inches, that occurs over the duration of a storm. The amount of rainfall depends on how frequently the storm will statistically occur and how long the storm lasts. Based on many years of rainfall data collected, storms of varying strength have been established based on the duration and probability of that event occurring within any given year. In general, smaller storms occur more frequently than larger storms of equal duration. Hence, a 2-year, 24hr storm (having a 50 percent chance of happening in a given year) has less rainfall than a 10-year, 24hr storm (having a 10

percent chance of happening in a given year). Stormwater runoff (which is related to the strength of the storm) is surplus rainfall that does not soak into the ground. This surplus rainfall flows (or 'runs off') from roof tops, parking lots and other impervious surfaces and is ultimately received by storm drainage systems, culverts and streams.

Modeling is a way to mathematically predict and spatially represent what will occur with a given rainfall event. There are two primary types of models that are used to achieve this goal; hydrologic and hydraulic:

- *Hydrologic models* take into account several factors: the particular rainfall event of interest; the physical nature of the land area where the rainfall occurs and how quickly the resulting stormwater runoff drains this given land area. Hydrologic models can describe both the quantity of stormwater runoff and resulting pollution, such as nutrients (nitrogen and phosphorus) and sediment that are transported by the runoff.

- *Hydraulic models* represent the effect the stormwater runoff from a particular rainfall event has on both man-made and natural systems. These models can predict both the ability of man-made culverts/channels to convey stormwater runoff and the spatial extent of potential flooding.

The table below shows three storm events and the rationale for being modeling:

Modeling Rationale

Storm Event	Modeling Rationale
2-year, 24hr	Represents the amount of runoff that defines the shape of the receiving streams.
10-year, 24hr	Used to determine which road culverts will have adequate capacity to convey this storm without overtopping the road.
100-year, 24hr	Used to define the limits of flood inundation zones

5.2 Selection of Projects

Ten projects from the 10-year implementation plan were selected for SWMM modeling. The projects analyzed in the SWMM were: JM9100, JM9500, LR9005A, LR9005C, LR9010B, LR9013D, LR9102, LR9110, LR9115, and LR9509.

Projects were selected based on the criteria established at the Technical Team Meeting #6 and in accordance with the guidance document entitled, Clarification of language from March 2009 WMP Standards Version 3.2 (Subtasks 3.4 & 3.6). Based on these criteria, projects that were capable of providing meaningful increased quantity control or reduced flooding were selected for additional modeling in subtask 3.6.

Seven of the projects selected for SWMM modeling are pond retrofits that include an increase in storage. The other three projects modeled in SWMM include new facilities and a culvert retrofit that will provide increased storage.

To be consistent with this guidance, the modeling effort in subtask 3.6 did not include modeling subarea type C facilities in the SWMM model. Projects of this type include rain gardens, water quality filters and infiltration basins. Projects of this class were generally smaller scale improvements to the local area, and although these projects have high water quality benefits, they provide no meaningful quantity control and have little to no impact on reducing flooding conditions.

Pond retrofits that did not include significant modifications in storage or changes to the riser configuration were not modeled in the SWMM. These projects will provide improved water quality benefits through the removal of trickle ditches and addition of plantings.

The HEC-RAS models for Little Rocky Run and Johnny Moore Creek contain only the main stem and major tributaries of the two watersheds. There are no proposed projects reflected in the HEC-RAS models due to project locations outside of the modeling area, the extent of the proposed changes to the stream channel, or other factors. Culvert retrofits, in-line ponds and stream restoration projects that are not located on a modeled channel could not be incorporated into the model. Stream restoration projects that did not propose alterations to the channel cross sections or significant changes to the morphology and planform of the stream were also excluded from the HEC-RAS modeling effort. Minor stream restoration projects, such as stream bank stabilization, do not significantly change the conveyance capability of the stream channel nor do they generally have a significant impact on channel velocities.

5.3 Setup and Calibration of Stormwater Models

As discussed in the previous section, modeling is a way to mathematically predict and spatially represent what will occur during a given rainfall event. Hydrologic and hydraulic models are the two types of models that are used to achieve this.

Hydrologic and hydraulic models were created for three distinct scenarios as listed below:

- Existing conditions
- Future conditions without projects
- Future conditions with projects

For *existing conditions*, the models simulated the condition of the watersheds at the time the models were created by incorporating information on land use, soils, existing stormwater management and best management practice facilities, previous stream and watershed assessments, and actual field reconnaissance and site visits. The *future conditions without projects* scenario simulated future conditions based on countywide future land use and development, derived from the County's comprehensive plan and build-out predictions. As the name implies, the *future conditions without projects* models do not contain any of the watershed restoration strategies or projects identified in this plan. The *future conditions with projects* scenario simulates the implementation of the projects discussed in the previous sections.

The *future conditions with projects* scenario uses the *future conditions without projects* models as a base on which proposed restoration strategies are added and evaluated. Comparison of modeling results from these three scenarios yielded pollutant loading and stormwater runoff reductions which are discussed below.

5.4 GIS Processing

A sequence of Geographical Information System (GIS) processing was required in preparation for pollution modeling with STEPL and hydrologic modeling with SWMM. The *future conditions with projects* scenario was evaluated in the STEPL. Each project was evaluated individually in order to assess the benefits of each individual project. In order to isolate project benefits, the projects were divided into multiple 'runs' for modeling purposes. Each run contained no more than one project per subwatershed; projects with multiple subprojects were processed together in order to model the benefits of the entire group of projects. These results were used in the report to summarize plan benefits. A final composite subarea layer reflecting all projects and associated STEPL models were provided for future use (See Section 6).

For each run, drainage areas to each modeled project were delineated in GIS. Processing was conducted in GIS to break each subwatershed into subareas based on the existing and/or proposed stormwater controls. There are five distinct subareas, each representing a type of stormwater facility:

- Peak-shaving only (subarea A)
- Peak-shaving and water quality, wet pond (subarea B1)
- Peak-shaving and water quality, dry pond (subarea B2)
- Peak-shaving only (subarea C)
- No stormwater treatment (subarea D)

Subareas were delineated from subwatersheds to adequately characterize all of the stormwater treatment that was occurring in the subwatershed. In some cases, the *existing conditions* and *future conditions without projects* subareas were calculated incorrectly. The treatment by some ponds was not included in the appropriate subarea because the pond was not included in the County's stormwater network and not identified until candidate project field reconnaissance, or because the drainage area to the pond did not contain any parcels included in the County's controlled parcels GIS layer. The treatment of some other areas was overestimated, usually because the parcels were included in the County's controlled parcels GIS layer but not located within the drainage area of an existing stormwater management facility. These inaccuracies inherent in the GIS processing methodology are minimal at the watershed scale; however, they are problematic at an individual project scale. For areas where the individual projects did not show a water quality benefit because of these discrepancies, the process described in Section 6.0 was used to quantify the project benefit.

5.5 Pollution Model

The Spreadsheet Tool for the Estimation of Pollutant Load (STEPL) model developed for the U.S. EPA was used to quantify the nutrient and sediment loads generated by stormwater runoff. The STEPL model calculates nutrient and sediment loads using simple algorithms based on the runoff volume and the pollutant concentrations in the runoff water as influenced by factors such as the land use distribution and management practices. The annual sediment load is calculated based on the Universal Soil Loss Equation (USLE) and the sediment delivery ratio. Sediment and pollutant load reductions that result from the implementation of existing and/or proposed stormwater management facilities or best management practices (BMPs) are computed using known pollutant removal efficiencies.

5.5.1 Pollutant Model Setup

A STEPL model was developed for each of three conditions as described above. The model for each scenario was generally set up in the same manner. Local data such as state name, County name, precipitation information, Universal Soil Loss Equation (USLE) parameters and nutrient concentration in runoff were entered into the model.

Land use and soils tables were developed and imported into the STEPL model based on the distribution of each land use type or soil hydrologic group within each subarea. Pollutant loads and load reductions were automatically calculated for total nitrogen, total phosphorus, and sediment.

Because pollutant loads and load reductions were calculated at a subwatershed scale, each proposed project was modeled individually in order to show the water quality benefits for each specific project, and as a group to show the water quality benefits of watershed management plan as a whole.

Regional ponds were not modeled using the subarea classifications like smaller stormwater facilities because these facilities often drain larger areas that may include several subareas with additional stormwater controls. Therefore, regional facilities that were proposed for retrofit or construction were modeled by revising the regional pond pollutant removal efficiencies.

5.5.2 Streambank Erosion

The erosion areas were primarily identified through the County's SPA data with some areas added based on comments from the public or identified during the field reconnaissance conducted in June 2008.

Per the guidance document "Guidance for Representing Streambank Erosion and Regional Pond Efficiencies," dated 2/5/2009, the empirical equation was used to characterize the streambank erosion:

Annual Sediment Load from Streambank, ton = L*H*RR*DW* NCF

Where:

L = Streambank Length, ft

H = Streambank Height, ft

RR = Lateral Recession Rate, ft/year

DW = Soil Dry Weight, ton/ft^3, based on the soil texture (Values from February 2009 guidance document based on soil texture)

NCF = Nutrient correction faction, based on the soil texture (optional) (Values from February 2009 guidance document based on soil texture)

Load Reduction = Load * BMP Efficiency

Nutrient Load, lbs = Sediment Load * NC/100 (Sediment load based on the equation in the February 2009 guidance document)

Where NC = Nutrient concentration percentage (Calculation of loads based on percentages from STEPL)

Bank length was based on the eroded stream length from the SPA layers and reflects actual measurements performed in the field during the SPA analysis. AMEC visited most of the erosion areas and identified some new ones, so rough field measurements for bank height were used. In

the event that a site wasn't visited (e.g., there was an erosion site in the middle of the FCPA that was considered inaccessible during the field reconnaissance), a judgment of height was made using the SPA data.

The lateral recession rate was based on SPA data and/or field reconnaissance data using the categories and descriptions from the Streambank Lateral Recession Rate table in the STEPL spreadsheet. The values for the recession rate are based on the default values recommended in the February 2009 posting from Tetra Tech. The posting was in the technical discussion STEPL template/Streambank Erosion thread.

A Microsoft Excel spreadsheet was used to calculate stream loadings in lieu of creating a separate STEPL model. The calculated loads were aggregated to the subwatershed level and incorporated with the land-based loadings generated in the previously loaded STEPL models to determine total loadings used in the project prioritization task.

5.5.3 Pollutant Model Results

The results of the STEPL model by WMA are summarized in the following table. It is estimated that the 10-year implementation plan would remove 283 tons per year (33 percent) of sediment, 1,583 pounds per year (5 percent) of nitrogen and 317 pounds per year (8 percent) of phosphorus. The pollutant removal of the entire plan is estimated at 348 tons per year (40 percent) of sediment, 2,374 pounds per year (8 percent) of nitrogen and 474 pounds per year (11 percent) of phosphorus.

Pollutant Loading and Flow Reductions by WMA

WMA	Area (ac)	Scenario[3]	Runoff Volume (in)[1]		Peak Flow (cfs/ac)[1]		TSS	TN	TP
			2 Year	10 Year	2 Year	10 Year	(lb/ac/yr)[2]	(lb/ac/yr)[2]	(lb/ac/yr)[2]
Johnny Moore Creek	3373.7	Existing Condition	1.23	2.93	0.15	0.43	236.16	1.91	0.35
		Future Without Projects	1.26	2.97	0.16	0.45	246.04	2.42	0.42
		Future With 10-year Projects	1.22	2.90	0.15	0.44	120.89	2.28	0.37
		Reduction (10-year Plan)	0.04 (3%)	0.07 (2%)	0.01 (3%)	0.01 (2%)	125.15 (51%)	0.14 (6%)	0.05 (11%)
		Future With 25-year Projects	N/A	N/A	N/A	N/A	120.87	2.28	0.37
		Reduction (25-year Plan)	N/A	N/A	N/A	N/A	125.17 (51%)	0.14 (6%)	0.05 (11%)
Little Rocky Run - Lower	2211.74	Existing Condition	1.69	3.60	0.30	0.84	157.56	5.34	0.67
		Future Without Projects	1.70	3.62	0.31	0.86	159.98	5.50	0.68
		Future With 10-year Projects	1.70	3.61	0.30	0.85	139.99	5.27	0.64
		Reduction (10-year Plan)	0.00 (0%)	0.01 (0%)	0.01 (1%)	0.01 (1%)	19.99 (12%)	0.23 (4%)	0.04 (6%)
		Future With 25-year Projects	N/A	N/A	N/A	N/A	97.03	5.12	0.61
		Reduction (25-year Plan)	N/A	N/A	N/A	N/A	62.95 (39%)	0.38 (7%)	0.07 (11%)
Little Rocky Run - Upper	2329.46	Existing Condition	1.37	3.04	0.14	0.41	229.23	4.59	0.66
		Future Without Projects	1.41	3.09	0.15	0.43	230.47	4.71	0.67
		Future With 10-year Projects	1.40	3.08	0.14	0.41	187.42	4.44	0.63
		Reduction (10-year Plan)	0.01 (0%)	0.01 (0%)	0.01 (2%)	0.02 (3%)	43.05 (19%)	0.27 (6%)	0.04 (7%)
		Future With 25-year Projects	N/A	N/A	N/A	N/A	172.79	4.26	0.61
		Reduction (25-year Plan)	N/A	N/A	N/A	N/A	57.68 (25%)	0.45 (10%)	0.06 (10%)

[1] Flow is cumulative
[2] Loads are representative of individual land area contributions
[3] 25-year projects were not evaluated in the hydrologic model

5.6 Hydrologic Model

The SWMM model was developed by the U. S. Environmental Protection Agency and was used to model rainfall runoff relationships in the Little Rocky Run and Johnny Moore Creek watersheds. Peak rate of runoff and total runoff volume values were generated from the SWMM models and describe the magnitude of stormwater runoff that results from each of the design storms.

5.6.1 Hydrologic Model Setup

SWMM models were generally created in the same manner for all three scenarios. Delineated subwatersheds were imported into the model and subareas were added depending on the type of stormwater facility/restoration strategy. Subwatershed and subarea parameters were input into the model from existing data, updated with field reconnaissance data and calibrated against real world flow and runoff information.

Subareas were delineated from subwatersheds to adequately characterize all of the stormwater treatment that was occurring in the subwatershed. Subareas were representative of all stormwater facilities or restoration strategies of a single type within a subwatershed. Therefore, the area draining to the facilities of each type were summed up and modeled as a single subarea (i.e. sum of all areas draining to C type facilities are represented by a single C type subarea within the model).

Regional ponds listed in the 1989 County Regional Stormwater Management Plan have both the stage-area relationship and the orifice elevation and size available. These regional ponds were represented within the model separately from the subarea delineation described above. The stage-area table from the report was specified for the storage unit, and the sizes and crest heights were specified for the orifices.

SWMM models for the *existing conditions* and the *future conditions without project* scenarios were prepared by Tetra Tech, updated with field reconnaissance data and calibrated using discharge relationships developed in D. G. Anderson's 1970 Water Supply Paper and/or flood frequency methods detailed in U.S.G.S. Fact Sheet 023- 01.

The SWMM models for the *future conditions with projects* scenario were developed using the *future conditions without projects* as the base models into which the proposed 10-year structural projects would be added. The SWMM Updating Tool developed by Tetra Tech and the methodology outlined in the "Tutorial for using the SWMM Updating Tool" provided by Tetra Tech were used to build these SWMM models.

Subareas delineated in the GIS processing described above were manually entered into the SWMM models and subarea parameters such as subarea width and storage unit surface areas were calculated and adjusted in the models. Orifice sizes for the various stormwater facilities were calculated per the "Tutorial for Orifice Sizing" provided by Tetra Tech.

Calibrated infiltration values in subareas that had no change in area from the *future conditions without projects* models were copied into the *future conditions with projects* models and finalized.

5.6.2 Hydrologic Model Results

The hydrologic model results are summarized in the following table.

SWMM Modeling Results

Subbasin	Project ID	2-yr Total Flow (cfs)			10-yr Total Flow (cfs)		
		Future without Projects	Future with Projects	Difference	Future without Projects	Future with Projects	Difference
JM-JM-0003	JM9100	53.45	38.99	-27%	130	106.15	-18%
JM-PC-0002	JM9500	48.87	33.5	-31%	108.86	79.52	-27%
LR-LR-0007	LR9509	36.07	34.91	-3%	125.91	117.12	-7%
LR-LR-0008	LR9102	77.51	77.58	0%	154.9	155.01	0%
LR-LR-0010	LR9005A & LR9005C	46.58	42.13	-10%	103.12	85.7	-17%
LR-LR-0012	LR9013D	163.69	134.99	-18%	320.81	268.86	-16%
LR-LR-0014	LR9110	17.01	16.57	-3%	51.57	50.42	-2%
LR-LR-0021	LR9115	8.46	8.36	-1%	24.93	24.75	-1%
LR-WS-0004	LR9010B	36.33	36.33	0%	76.81	76.81	0%

5.7 Hydraulic Model

The Hydrologic Engineering Centers River Analysis System (HEC-RAS) hydraulic model was initially developed by the U.S. Army Corps of Engineers (USACE) in the early 1990s as a tool to manage the rivers and harbors in their jurisdiction. HEC-RAS has found wide acceptance as the standard for simulating the hydraulics of water flow through natural and/or manmade channels and rivers. HEC-RAS is commonly used for modeling water flowing through a system of open channels with the objective of computing water surface elevations.

5.7.1 Hydraulic Model Setup

The geographic input data for the HEC-RAS model were extracted using HEC-GeoRAS. HECGeoRAS is a tool that processes the geospatial data within the County's Geographic Information System, specifically as it pertains to physical features such as stream geometry and flow path so that these features can be represented in the model. The HEC-RAS models were limited to the major tributaries and the main stem of Little Rocky Run and Johnny Moore Creek and do not include intermittent streams in headwater areas. Low flows and undefined channels prevent the models from providing beneficial output in these areas. However, the flow contributions from these areas were considered in downstream areas within the model.

Using available County or Virginia Department of Transportation (VDOT) engineering data, bridge and culvert crossings were coded into the model to simulate the effect these facilities have on the water surface elevations or profile. Where data were not available, field reconnaissance was performed to obtain the crossing elevation data. These crossing data were determined relative to a point where the elevation could be estimated accurately from the County's topographic data.

Manning's 'n' values, which represent surface roughness, were assigned to the channel and overbank portions of the studied streams based on field visits and aerial photographs.

The hydrologic flow input data and the locations where the flows change were extracted from SWMM. The 2-yr, 10-yr and 100-yr storm flow outputs were determined at several locations in order to provide a detailed flow profile for input into the HEC-RAS hydraulic model.

As stated previously, the 2-year storm discharge is regarded as the channel-forming or dominant discharge that transports the majority of a stream's sediment load and therefore actively forms and maintains the channel. A comparison of stream dynamics and channel geometry for the 2-year discharge provides insight regarding the relative stability of the system and helps to identify areas in need of restoration.

The 10-year storm discharge was included to analyze the level of service of bridge and culvert stream crossings. Occurring less frequently than the 2-year storm, the flood stage associated with this storm can result in more significant safety hazards to residents. All stream crossings (bridges and culverts) were analyzed against this storm to see if they performed at safe levels.

The 100-year storm discharge is used by the Federal Emergency Management Agency (FEMA) to delineate floodplain inundation zones in order to establish a Flood Insurance Rate Map (FIRM) for a given area. The 100-yr HEC-RAS models were built in compliance with FEMA standards and were included to map the limits of these floodplain inundation zones. This mapping provided a means to assess which properties are at risk to flooding by the 100-yr storm event.

The flow reductions from the *future conditions with projects* SWMM model produced no significant changes in water surface elevations.

SECTION 6.0 – Quantifying a Water Quality Benefit

Following prioritization and cost-benefit analysis, it was discovered that a number of projects did not produce a quantifiable water quality benefit. Primarily, these projects treat parcels that were classified as already having treatment (reflected as a Subarea type C) when in some cases they do not. In general, it is an indication that the watershed developed most significantly when stormwater quality regulations were already in place. As a result, a number of proposed projects are located upstream of other facilities or in areas where treatment was assumed because it was requirement at the time of development. In some cases, a neighborhood can be compliant with stormwater regulations without treating every parcel, essentially by overtreating parcels that drain to a designed facility. With a great deal of the developed parcels already draining to treatment facilities, AMEC favored treating parcels that run off directly to the storm sewer or stream – despite the fact that they were developed in compliance with regulations when considering the community as a whole.

In order to calculate pollutant removal in areas already classified as treated, AMEC reclassified these parcels (Subarea type D) so as not to claim treatment in the *existing conditions* and *future conditions without project* models. In doing so, a water quality benefit could be quantified for the proposed projects. These adjustments were made only within drainage areas to proposed new facilities.

Subareas classified as C located within the drainage areas of proposed retrofits to existing regional ponds were also reclassified as D. Pollutant reductions for proposed retrofits to regional ponds were calculated with the regional pond tool in STEPL. The existing and proposed pollutant removal efficiencies for regional ponds are as follows:

Regional Pond Removal Efficiencies

Existing/Future Without Projects Conditions			Future With Projects Conditions		
TN	TP	TSS	TN	TP	TSS
0.35	0.50	0.80	0.50	0.55	0.80
0.35	0.60	0.80	0.50	0.60	0.80

Project LR9116 (a retrofit of pond R-17) differed from other regional pond retrofit projects in the *future with projects condition* in TN removal efficiency – it was assigned an efficiency of 0.40.

While these subareas were being updated, AMEC also modified the existing conditions subareas in subwatersheds JM-JM-0009, LR-LR-0020, LR-WS-0002 and LR-WS-0003, which were discovered to have errors. SWMM orifice sizing was updated accordingly. These changes were carried through subsequent models as needed (*future with and without project* models).

In some cases (see Section 3.0), a project was proposed to restore an armored channel to a natural state. These projects were classified as stream restorations. Typically, stream restoration projects were assigned a water quality benefit based on restoring eroding banks to a stable state. Where channel banks were actively degrading, sediment and nutrient contributions were computed based on the soil type, lateral recession rate and area of bank eroding. The identified armored channels are stable and therefore not sloughing off sediment and nutrients from their banks. Instead, it was assumed that a measurable benefit would be gained because erosion downstream of the armored channel would be prevented. Low lateral recession rates were applied to the length of the concrete-lined ditch/channel slated to be restored.

Stream segments identified by the WAG that were not classified as erosion areas in the SPA were assumed to have a low recession rate and an average bank height of five feet in the absence of more detailed data.

Proposed projects were not re-prioritized based on these changes. The County wanted to compute the benefit for future analysis, but did not require that the prioritization be updated, due to time and budget constraints. Despite the fact that no pollutant removal was quantified at the time of prioritization for some stream restoration projects, AMEC used score overrides to assess these projects (see Section 3.0) based on their expected impact. It is unlikely that these changes would have significantly impacted the prioritization. AMEC produced revised *existing conditions*, *future without project conditions and future with project conditions* STEPL and SWMM models to account for all of these changes, so that future County efforts would be substantiated by the most up-to-date modeling data.

This process was initiated to target projects where no pollutant loading removal was shown, as previously described. However, it was determined to be much more tedious and costly to isolate only these projects for revised computations. Essentially, the *existing, future without project and future with project* nutrient loads were recomputed for every proposed project. In addition, because stormwater pond retrofits involved the removal of trickle ditches, plantings and internal geometry changes, it was reasoned that sedimentation would be slightly improved. Subarea 'C' removal rates were used for stormwater pond retrofits, except where noted for retrofits to regional facilities – allowing for a slight improvement to TSS removal efficiencies (from 80 percent to 83 percent).

At the County's request, AMEC produced an additional *future with project* STEPL model based on a composite subarea layer. Throughout the process, projects were analyzed for their individual contribution to a subwatershed. In other words, only one project per subwatershed could be analyzed in the STEPL at a time. In some cases there are multiple proposed projects for a given subwatershed with overlapping drainage areas. The combined impact in these instances would not be as great as the sum of the individual projects. Though a final STEPL model was produced that utilizes a composite subarea layer, the results reported are based on the individual project pollutant reductions. A SWMM model was

produced with the same subarea allotment, despite the fact that peak flows are known to increase as a result. This model is also for future considerations and was not used in plan development.

SECTION 7.0 – Cost Benefit Analysis

The cost benefit analysis was performed as a simple ratio of the project benefit divided by a cost factor. The benefit value was the project composite score that was used in the project ranking. The project composite score represents a composite of environmental indicators and other factors such as pollutant removal. The composite score for some projects were adjusted to account for feasibility issues. The cost factor was calculated by scaling the project costs to match the numerical range of the project composite scores. The results of the cost-benefit analysis were compared to the adjusted composite scores. In situations where the cost-benefit rank differed from the adjusted composite rank by more than 25 percent a cost-based modification of +/- 0.25 was applied to the adjusted composite score and the projects were re-ranked. The table below summarizes adjustments made due to best professional judgment as well as due to the cost-benefit analysis.

Cost Benefit Analysis Results – 10-year Implementation Plan

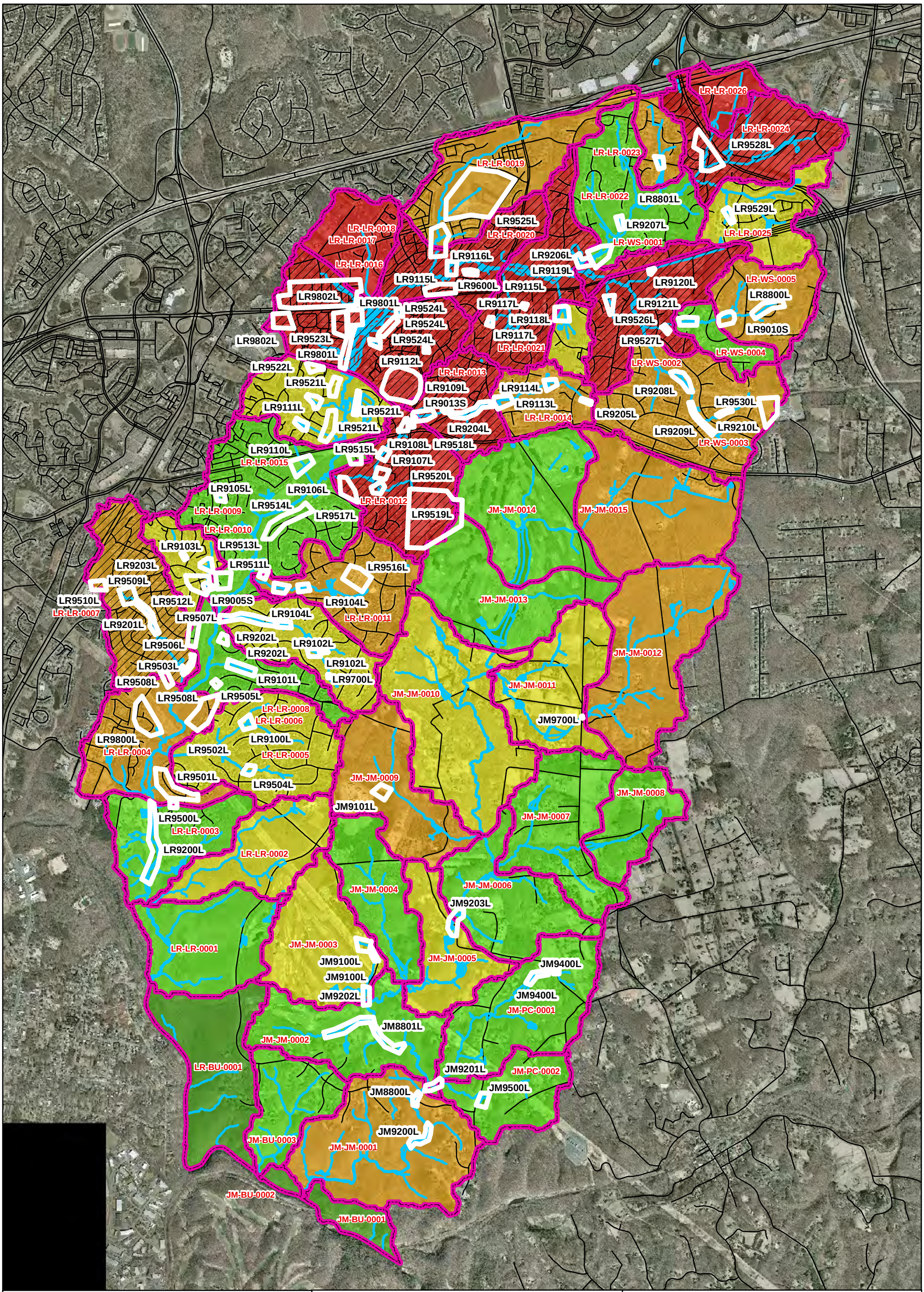
Project	Project Type	Final Adjusted Composite Score (B)	Project Cost	Scaled Cost Factor (C)	CBA: Final Score/ Scaled Cost Factor (B / C)	Rank adjusted for CBA
LR9005C	New BMP/LID	5.34	$350,000.00	2.52	2.118	1
LR9510	New BMP/LID	4.37	$260,000.00	2.45	1.784	2
LR9103	Pond Retrofit, Stream Stabilization	4.28	$560,000.00	2.69	1.590	3
LR9013D	Pond Retrofit	4.22	$180,000.00	2.38	1.770	4
LR9005A	Pond Retrofit	4.16	$230,000.00	2.43	1.717	5
LR9102	Pond Retrofit, Outfall Improvement	4.11	$220,000.00	2.42	1.702	6
LR9100	Pond Retrofit	4.07	$100,000.00	2.32	1.755	7
LR9516	New BMP/LID	3.99	$330,000.00	2.51	1.592	8
JM9202	Stream Restoration	3.97	$320,000.00	2.50	1.591	9
LR9110	Pond Retrofit	3.97	$120,000.00	2.34	1.700	10
LR9514	New BMP/LID	3.90	$100,000.00	2.32	1.681	11
LR9209	Stream Restoration, Flood Protection	3.87	$380,000.00	2.55	1.521	12
LR9115	Pond Retrofit	3.86	$290,000.00	2.47	1.562	13
LR9117	Pond Retrofit	3.83	$40,000.00	2.27	1.575	14
JM9201	Stream Restoration	3.77	$420,000.00	2.58	1.463	15
LR9522	New BMP/LID	3.77	$220,000.00	2.42	1.560	16
LR9508	New BMP/LID	3.76	$90,000.00	2.31	1.626	17
JM9100	Pond Retrofit, Dump Site	3.74	$200,000.00	2.40	1.556	18
LR9111	Pond Retrofit	3.69	$100,000.00	2.32	1.591	19
LR9204	Stream Restoration	3.69	$110,000.00	2.33	1.585	20
LR9527	New BMP/LID	3.69	$130,000.00	2.34	1.574	21
LR9201	Stream Restoration	3.66	$830,000.00	2.91	1.344	22

Project	Project Type	Final Adjusted Composite Score (B)	Project Cost	Scaled Cost Factor (C)	CBA: Final Score/ Scaled Cost Factor (B / C)	Rank adjusted for CBA
LR9010A	Buffer Restoration	3.63	$110,000.00	2.33	1.557	23
LR9208	Stream Restoration	3.62	$800,000.00	2.88	1.343	24
LR9109	Pond Retrofit, Non-Structural	3.62	$40,000.00	2.27	1.484	25
LR9106	Pond Retrofit	3.59	$190,000.00	2.39	1.498	26
LR9114	Pond Retrofit (x2)	3.56	$60,000.00	2.29	1.558	27
LR9205	Stream Restoration	3.53	$510,000.00	2.65	1.427	28
LR9203	Stream Restoration	3.45	$310,000.00	2.49	1.388	29
JM9400	Culvert Retrofit, Buffer Restoration	3.45	$120,000.00	2.34	1.476	30
LR9521	New BMP/LID, Pond Retrofit (x2)	3.44	$180,000.00	2.38	1.442	31
LR9526	New BMP/LID	3.44	$130,000.00	2.34	1.467	32
LR9207	Stream Restoration	3.42	$650,000.00	2.76	1.329	33
LR9010B	Pond Retrofit	3.41	$240,000.00	2.43	1.403	34
LR9202	Stream Restoration, Buffer Restoration	3.38	$820,000.00	2.90	1.166	35
LR9013C	New SWM	3.29	$90,000.00	2.31	1.424	36
LR9013A	Stream Restoration, Buffer Restoration	3.29	$280,000.00	2.47	1.335	37
JM9203	Stream Restoration, Buffer Restoration	3.28	$770,000.00	2.86	1.233	38
JM9200	Stream Restoration	3.25	$770,000.00	2.86	1.224	39
LR9524	New BMP/LID	3.22	$210,000.00	2.41	1.337	40
LR9523	New BMP/LID	3.12	$510,000.00	2.65	1.177	41
LR9013B	New BMP/LID, Stream Restoration	3.11	$210,000.00	2.41	1.291	42
LR9509	New BMP/LID	3.08	$140,000.00	2.35	1.309	43
LR9504	New BMP/LID	2.94	$80,000.00	2.30	1.276	44
JM9500	New BMP/LID	2.56	$120,000.00	2.34	1.096	45
LR9005B	New BMP/LID	2.54	$70,000.00	2.30	1.106	46
			$12,970,000			

The 25-year implementation plan cost benefit results are presented in the table below.

Cost Benefit Analysis Results – 25-year Implementation Plan

Project	Project Type	Final Adjusted Composite Score (B)	Project Cost	Scaled Cost Factor (C)	CBA: Final Score/ Scaled Cost Factor (B / C)	Rank adjusted for CBA
LR9515	New BMP/LID	3.33	$80,000.00	2.30	1.445	47
LR9107	Pond Retrofit	3.29	$80,000.00	2.30	1.426	48
LR9518	New BMP/LID (x3)	3.28	$80,000.00	2.30	1.423	49
LR9517	New BMP/LID	3.25	$80,000.00	2.30	1.410	50
JM9101	Pond Retrofit	3.21	$80,000.00	2.30	1.395	51
LR9108	Pond Retrofit	3.19	$80,000.00	2.30	1.386	52
LR9502	New BMP/LID	3.11	$80,000.00	2.30	1.350	53
LR9206	Stream Restoration	3.10	$80,000.00	2.30	1.345	54
LR9519	New BMP/LID	3.10	$90,000.00	2.31	1.341	55
LR9700	Outfall Improvement	3.10	$80,000.00	2.30	1.345	56
LR9112	Pond Retrofit, New BMP/LID	3.08	$80,000.00	2.30	1.336	57
LR9507	New BMP/LID	3.05	$80,000.00	2.30	1.324	58
LR9501	New BMP/LID	3.03	$80,000.00	2.30	1.315	59
LR9512	New BMP/LID	3.02	$90,000.00	2.31	1.306	60
LR9525	New BMP/LID	2.99	$1,120,000.00	3.14	1.031	61
LR9101	Pond Retrofit	2.95	$110,000.00	2.33	1.267	62
LR9520	New BMP/LID	2.94	$80,000.00	2.30	1.276	63
LR9113	Pond Retrofit	2.91	$400,000.00	2.56	1.235	64
LR9505	New BMP/LID	2.89	$80,000.00	2.30	1.254	65
LR9104	Pond Retrofit	2.86	$80,000.00	2.30	1.240	66
LR9105	Pond Retrofit	2.86	$90,000.00	2.31	1.236	67
LR9600	Flood Protection, Buffer Restoration	2.84	$800,000.00	2.88	0.986	68
LR9506	New BMP/LID	2.79	$80,000.00	2.30	1.211	69
LR9503	New BMP/LID	2.79	$80,000.00	2.30	1.215	70
LR9513	New BMP/LID	2.62	$80,000.00	2.30	1.137	71
JM9700	Outfall Improvement	2.46	$160,000.00	2.37	1.038	72
LR9500	New BMP/LID	2.24	$80,000.00	2.30	0.972	73
			$4,380,000			



N

0 0.25 0.5 1 Miles

Legend

Proposed Projects
Subbasins
Problem Areas
Fairfax Hydrology Dataset
Street Centerlines

Impact Composite Score

4.894737 - 5.657895
5.657896 - 6.184211
6.184212 - 6.552632
6.552633 - 7.184211
7.184212 - 7.973684

Map 1
Proposed Project Location Map

Attachment 1 – Project Type/Impact Indicator Association

	Regional Pond/ Alternatives	New/ Retrofit SWM Pond	Stream Restoration	Culvert Retrofit	New/Retrofit BMP/LID	Flood Protection/Mitigation	Outfall Improvement
Benthic Communities			X				X
Fish Communities			X				X
Aquatic Habitat			X	X			X
Channel Morphology	X	X	X			X	X
Instream Sediment	X	X	X				X
Hydrology	X	X			X	X	X
Number of Road Hazards				X		X	
Magnitude of Road Hazards				X		X	
Residential Building Hazards						X	
Non-residential Building Hazards						X	
Flood Complaints				X	X	X	
RPA Riparian Habitat			X		X		
Headwater Riparian Habitat			X		X		
Wetland Habitat			X		X		
Terrestrial Forested Habitat					X		
E. coli	X	X	X		X		X
TSS Concentration	X	X	X		X		X
TN Concentration	X	X			X		X
TP Concentration	X	X	X		X		X

Attachment 2 - Loading Rates

Loading Rates for Structural Projects

Project Number	Project Type	Subwatershed	TSS (ton/ac/yr)			TN (lb/ac/yr)			TP (lb/ac/yr)		
			Future w/o	Future with	% Reduction	Future w/o	Future with	% Reduction	Future w/o	Future with	% Reduction
JM9100L	1	JM-JM-0003	0.10	0.10	-0.17%	1.40	1.36	-2.84%	0.41	0.39	-4.55%
JM9101L	1	JM-JM-0009	0.07	0.07	0.18%	4.16	4.17	0.17%	0.62	0.62	0.18%
JM9200L	2	JM-JM-0001	0.75	0.06	-91.52%	2.57	1.47	-42.64%	0.67	0.25	-62.97%
JM9201L	2	JM-PC-0001	0.05	0.05	0.28%	2.10	2.11	0.29%	0.32	0.32	0.30%
JM9202L	2	JM-JM-0003	0.10	0.10	-0.17%	1.40	1.40	-0.13%	0.41	0.41	-0.16%
JM9203L	2	JM-JM-0005	0.17	0.08	-52.24%	1.95	1.82	-6.64%	0.37	0.31	-14.30%
JM9400L	4	JM-PC-0001	0.05	0.04	-10.16%	2.10	1.97	-6.54%	0.32	0.29	-8.85%
JM9500L	5	JM-PC-0002	0.06	0.03	-48.94%	2.27	1.66	-26.80%	0.33	0.21	-35.93%
JM9700L	7	JM-JM-0011	0.06	0.06	0.70%	2.31	2.33	0.73%	0.38	0.38	0.74%
LR9005S	0	LR-LR-0010	0.10	0.02	-80.00%	7.13	3.20	-55.15%	1.00	0.40	-60.40%
LR9010S	0	LR-WS-0005	0.07	0.00	-95.99%	3.75	1.18	-68.44%	0.57	0.11	-79.97%
LR9013S	0	LR-LR-0013	0.16	0.04	-75.38%	6.99	3.15	-54.94%	1.08	0.43	-59.87%
LR9100L	1	LR-LR-0005	0.02	0.02	0.08%	3.88	3.76	-3.15%	0.39	0.36	-7.00%
LR9101L	1	LR-LR-0006	0.11	0.11	0.02%	5.25	5.07	-3.45%	0.78	0.74	-5.10%
LR9102L	1	LR-LR-0008	0.11	0.11	0.01%	6.40	6.27	-1.93%	0.92	0.89	-3.02%
LR9103L	1	LR-LR-0010	0.10	0.10	-0.14%	7.13	6.78	-4.88%	1.00	0.92	-8.88%
LR9104L	1	LR-LR-0011	0.10	0.10	0.09%	6.34	6.26	-1.19%	0.91	0.89	-1.85%
LR9105L	1	LR-LR-0009	0.10	0.10	-0.11%	6.20	6.16	-0.68%	0.88	0.87	-1.08%
LR9106L	1	LR-LR-0009	0.10	0.10	-0.11%	6.20	6.14	-0.89%	0.88	0.87	-1.42%
LR9107L	1	LR-LR-0012	0.13	0.13	-0.24%	5.78	5.68	-1.74%	0.90	0.87	-2.37%
LR9108L	1	LR-LR-0012	0.13	0.13	-0.24%	5.78	5.76	-0.38%	0.90	0.89	-0.44%
LR9109L	1	LR-LR-0012	0.13	0.13	-3.71%	5.78	5.63	-2.53%	0.90	0.87	-2.85%
LR9110L	1	LR-LR-0015	0.11	0.11	-0.26%	6.98	6.83	-2.11%	0.95	0.92	-3.38%
LR9111L	1	LR-LR-0015	0.11	0.11	-0.26%	6.98	6.88	-1.40%	0.95	0.94	-1.31%
LR9112L	1	LR-LR-0016	0.15	0.15	-0.33%	8.23	8.20	-0.36%	1.13	1.13	-0.45%
LR9113L	1	LR-LR-0014	0.03	0.03	0.11%	4.12	2.66	-35.43%	0.42	0.38	-9.72%
LR9114L	1	LR-LR-0014	0.03	0.03	0.11%	4.12	4.08	-0.99%	0.42	0.41	-2.40%
LR9115L	1	LR-LR-0018	0.17	0.16	-0.80%	6.68	6.63	-0.72%	1.05	1.04	-0.66%
LR9116L	1	LR-LR-0019	0.04	0.04	0.34%	5.68	5.70	0.33%	0.50	0.50	0.35%
LR9117L	1	LR-LR-0020	0.21	0.21	-0.23%	5.54	5.51	-0.45%	0.90	0.89	-0.49%
LR9118L	1	LR-LR-0021	0.03	0.03	-2.33%	4.19	2.64	-36.97%	0.39	0.35	-11.88%
LR9119L	1	LR-LR-0022	0.02	0.02	0.11%	2.64	2.65	0.06%	0.23	0.23	0.10%
LR9120L	1	LR-WS-0002	0.10	0.10	0.05%	4.81	4.70	-2.30%	0.73	0.70	-4.04%
LR9121L	1	LR-WS-0004	0.01	0.01	0.00%	2.59	1.66	-35.84%	0.27	0.24	-10.11%
LR9200L	2	LR-LR-0003	0.34	0.07	-78.84%	3.55	3.12	-12.16%	0.65	0.48	-25.82%
LR9201L	2	LR-LR-0007	0.04	0.04	0.28%	5.61	5.62	0.23%	0.60	0.60	0.26%
LR9202L	2	LR-LR-0008	0.11	0.11	-1.23%	6.40	6.38	-0.33%	0.92	0.91	-0.76%
LR9203L	2	LR-LR-0010	0.10	0.10	0.00%	7.13	7.14	0.11%	1.00	1.01	0.08%
LR9204L	2	LR-LR-0013	0.16	0.15	-5.97%	6.99	6.99	-0.10%	1.08	1.07	-0.43%
LR9205L	2	LR-LR-0014	0.03	0.03	0.11%	4.12	4.12	0.14%	0.42	0.42	0.09%
LR9206L	2	LR-LR-0020	0.21	0.14	-33.72%	5.54	5.41	-2.38%	0.90	0.85	-5.21%
LR9207L	2	LR-LR-0022	0.02	0.02	-2.41%	2.64	2.64	-0.04%	0.23	0.23	-0.16%
LR9208L	2	LR-WS-0003	0.02	0.02	-4.61%	3.33	3.33	0.02%	0.35	0.35	-0.24%
LR9209L	2	LR-WS-0003	0.02	0.02	0.19%	3.33	3.33	0.18%	0.35	0.35	0.19%
LR9210L	2	LR-WS-0003	0.02	0.02	0.19%	3.33	3.33	0.18%	0.35	0.35	0.19%
LR9500L	5	LR-LR-0003	0.34	0.34	-0.77%	3.55	3.50	-1.34%	0.65	0.64	-1.71%
LR9501L	5	LR-LR-0004	0.12	0.12	-2.75%	5.10	5.05	-1.04%	0.75	0.74	-1.79%
LR9502L	5	LR-LR-0004	0.12	0.12	-3.24%	5.10	5.04	-1.25%	0.75	0.74	-2.12%

Attachment 2 - Loading Rates

Loading Rates for Structural Projects

Project Number	Project Type	Subwatershed	TSS (ton/ac/yr)			TN (lb/ac/yr)			TP (lb/ac/yr)		
			Future w/o	Future with	% Reduction	Future w/o	Future with	% Reduction	Future w/o	Future with	% Reduction
LR9503L	5	LR-LR-0004	0.12	0.12	-0.76%	5.10	5.10	-0.18%	0.75	0.75	-0.43%
LR9504L	5	LR-LR-0005	0.02	0.02	-13.92%	3.88	3.71	-4.35%	0.39	0.36	-7.33%
LR9505L	5	LR-LR-0006	0.11	0.11	-2.64%	5.25	5.19	-1.06%	0.78	0.76	-1.65%
LR9506L	5	LR-LR-0006	0.11	0.11	-3.98%	5.25	5.27	0.46%	0.78	0.77	-1.22%
LR9507L	5	LR-LR-0006	0.11	0.11	-3.59%	5.25	5.17	-1.43%	0.78	0.76	-2.24%
LR9508L	5	LR-LR-0007	0.04	0.04	-1.01%	5.61	5.60	-0.25%	0.60	0.60	-0.49%
LR9509L	5	LR-LR-0007	0.04	0.02	-35.01%	5.61	4.70	-16.17%	0.60	0.46	-23.34%
LR9510L	5	LR-LR-0007	0.04	0.04	-1.14%	5.61	5.58	-0.46%	0.60	0.60	-0.84%
LR9511L	5	LR-LR-0009	0.10	0.10	-0.18%	6.20	6.19	-0.07%	0.88	0.88	-0.09%
LR9512L	5	LR-LR-0010	0.10	0.08	-22.75%	7.13	6.73	-5.68%	1.00	0.91	-9.49%
LR9513L	5	LR-LR-0011	0.10	0.10	-0.81%	6.34	6.32	-0.26%	0.91	0.91	-0.41%
LR9514L	5	LR-LR-0009	0.10	0.10	-4.54%	6.20	6.11	-1.42%	0.88	0.86	-2.30%
LR9515L	5	LR-LR-0009	0.10	0.10	-0.73%	6.20	6.18	-0.31%	0.88	0.88	-0.41%
LR9516L	5	LR-LR-0011	0.10	0.10	-0.10%	6.34	6.32	-0.32%	0.91	0.91	-0.59%
LR9517L	5	LR-LR-0012	0.13	0.13	-1.58%	5.78	5.74	-0.69%	0.90	0.89	-0.94%
LR9518L	5	LR-LR-0012	0.13	0.13	-1.65%	5.78	5.73	-0.89%	0.90	0.89	-1.12%
LR9519L	5	LR-LR-0012	0.13	0.11	-16.19%	5.78	5.32	-7.97%	0.90	0.78	-12.46%
LR9520L	5	LR-LR-0012	0.13	0.13	-0.98%	5.78	5.74	-0.64%	0.90	0.89	-0.69%
LR9521L	5	LR-LR-0015	0.11	0.10	-11.32%	6.98	6.68	-4.23%	0.95	0.89	-6.23%
LR9522L	5	LR-LR-0015	0.11	0.11	-2.23%	6.98	6.91	-1.00%	0.95	0.94	-1.33%
LR9523L	5	LR-LR-0016	0.15	0.15	-0.41%	8.23	8.20	-0.30%	1.13	1.13	-0.33%
LR9524L	5	LR-LR-0016	0.15	0.15	-1.86%	8.23	8.14	-1.07%	1.13	1.12	-1.48%
LR9525L	5	LR-LR-0019	0.04	0.04	-2.91%	5.68	5.83	2.69%	0.50	0.51	1.04%
LR9526L	5	LR-WS-0002	0.10	0.09	-16.93%	4.81	4.50	-6.45%	0.73	0.66	-9.88%
LR9527L	5	LR-WS-0002	0.10	0.10	-1.73%	4.81	4.78	-0.69%	0.73	0.72	-1.06%
LR9528L	5	LR-LR-0024	0.04	0.04	-0.01%	6.11	6.11	0.00%	0.55	0.55	-0.04%
LR9529L	5	LR-LR-0025	0.03	0.02	-13.00%	3.89	3.65	-6.27%	0.43	0.39	-8.92%
LR9530L	5	LR-WS-0003	0.02	0.02	0.19%	3.33	3.33	0.18%	0.35	0.35	0.19%
LR9600L	6	LR-LR-0018	0.17	0.17	-0.07%	6.68	6.68	-0.05%	1.05	1.04	-0.05%
LR9700L	7	LR-LR-0008	0.11	0.11	0.01%	6.40	6.40	0.08%	0.92	0.92	0.06%

Attachment 3 - Impact Score Overrides

	Regional Pond/ Alternatives	New/ Retrofit SWM Pond	Stream Restoration	Culvert Retrofit	New/Retrofit BMP/LID	Flood Protection/ Mitigation	Outfall Improvement
Benthic Communities							
Fish Communities							
Aquatic Habitat							
Channel Morphology							
Instream Sediment							
Hydrology	**5**	**5**			**5**	**5**	**3**
Number of Road Hazards				**5**		**5**	
Magnitude of Road Hazards				**5**		**5**	
Residential Building Hazards						**5**	
Non-residential Building Hazards						**5**	
Flood Complaints							
RPA Riparian Habitat			**3**		**3**		
Headwater Riparian Habitat			**3**		**3**		
Wetland Habitat			**3**		**5**		
Terrestrial Forested Habitat					**3**		
E. coli							
TSS Concentration							
TN Concentration							
TP Concentration							

Attachment 4

Impact Indicator Scores for Structural Projects

Project Number	Project Type	Subwatershed	Benthic Communities	Fish Communities	Aquatic Habitat	Channel Morphology	Instream Sediment	Hydrology	Number of Road Hazards	Magnitude of Road Hazards	Number of Building Hazards	Non-residential Building Hazards	Flood Complaints	Riparian Habitat	Headwater Riparian Habitat	Wetland Habitat	Terrestrial Forested Habitat	E. coli	TSS Concentration	TN Concentration	TP Concentration	Sum	Score
JM9100L	1	JM-JM-0003	-	-	-	5	5	5	-	-	-	-	-	-	-	-	-	5	2	4	4	30	4.29
JM9101L	1	JM-JM-0009	-	-	-	5	5	5	-	-	-	-	-	-	-	-	-	5	1	1	1	23	3.29
JM9200L	2	JM-JM-0001	4	4	2	5	5	-	-	-	-	-	-	3	3	3	-	5	5	-	5	44	4.00
JM9201L	2	JM-PC-0001	2	4	5	5	5	-	-	-	-	-	-	3	3	3	-	5	4	-	4	43	3.91
JM9202L	2	JM-JM-0003	2	4	5	5	5	-	-	-	-	-	-	3	3	3	-	5	4	-	4	43	3.91
JM9203L	2	JM-JM-0005	2	4	5	5	5	-	-	-	-	-	-	3	3	3	-	5	5	-	5	45	4.09
JM9400L	4	JM-PC-0001	-	-	5	-	-	-	5	5	-	-	3	-	-	-	-	-	-	-	-	18	4.50
JM9500L	5	JM-PC-0002	-	-	-	-	-	5	-	-	-	-	3	3	3	5	3	5	5	5	5	42	4.20
JM9700L	7	JM-JM-0011	2	4	5	5	5	3	-	-	-	-	-	-	-	-	-	5	1	1	1	32	3.20
LR9005S	0	LR-LR-0010	-	-	-	2	4	5	-	-	-	-	-	-	-	-	-	5	5	5	5	31	4.43
LR9010S	0	LR-WS-0005	-	-	-	5	4	5	-	-	-	-	-	-	-	-	-	5	5	5	5	34	4.86
LR9013S	0	LR-LR-0013	-	-	-	3	5	5	-	-	-	-	-	-	-	-	-	5	5	5	5	33	4.71
LR9100L	1	LR-LR-0005	-	-	-	5	4	5	-	-	-	-	-	-	-	-	-	5	1	4	4	28	4.00
LR9101L	1	LR-LR-0006	-	-	-	2	4	5	-	-	-	-	-	-	-	-	-	5	2	4	4	26	3.71
LR9102L	1	LR-LR-0008	-	-	-	2	4	5	-	-	-	-	-	-	-	-	-	5	2	4	4	26	3.71
LR9103L	1	LR-LR-0010	-	-	-	2	4	5	-	-	-	-	-	-	-	-	-	5	2	4	5	27	3.86
LR9104L	1	LR-LR-0011	-	-	-	3	4	5	-	-	-	-	-	-	-	-	-	5	1	3	4	25	3.57
LR9105L	1	LR-LR-0009	-	-	-	2	4	5	-	-	-	-	-	-	-	-	-	5	2	3	3	24	3.43
LR9106L	1	LR-LR-0009	-	-	-	2	4	5	-	-	-	-	-	-	-	-	-	5	2	3	3	24	3.43
LR9107L	1	LR-LR-0012	-	-	-	3	4	5	-	-	-	-	-	-	-	-	-	5	3	4	4	28	4.00
LR9108L	1	LR-LR-0012	-	-	-	3	4	5	-	-	-	-	-	-	-	-	-	5	3	3	2	25	3.57
LR9109L	1	LR-LR-0012	-	-	-	3	4	5	-	-	-	-	-	-	-	-	-	5	4	4	4	29	4.14
LR9110L	1	LR-LR-0015	-	-	-	2	4	5	-	-	-	-	-	-	-	-	-	5	3	4	4	27	3.86
LR9111L	1	LR-LR-0015	-	-	-	2	4	5	-	-	-	-	-	-	-	-	-	5	3	4	3	26	3.71
LR9112L	1	LR-LR-0016	-	-	-	5	5	5	-	-	-	-	-	-	-	-	-	5	3	3	2	28	4.00
LR9113L	1	LR-LR-0014	-	-	-	3	5	5	-	-	-	-	-	-	-	-	-	5	1	5	5	29	4.14
LR9114L	1	LR-LR-0014	-	-	-	3	5	5	-	-	-	-	-	-	-	-	-	5	1	3	4	26	3.71
LR9115L	1	LR-LR-0018	-	-	-	5	5	5	-	-	-	-	-	-	-	-	-	5	3	3	3	29	4.14
LR9116L	1	LR-LR-0019	-	-	-	5	5	5	-	-	-	-	-	-	-	-	-	5	1	1	1	23	3.29
LR9117L	1	LR-LR-0020	-	-	-	5	4	5	-	-	-	-	-	-	-	-	-	5	2	3	2	26	3.71
LR9118L	1	LR-LR-0021	-	-	-	5	4	5	-	-	-	-	-	-	-	-	-	5	4	5	5	33	4.71
LR9119L	1	LR-LR-0022	-	-	-	5	4	5	-	-	-	-	-	-	-	-	-	5	1	1	1	22	3.14
LR9120L	1	LR-WS-0002	-	-	-	5	4	5	-	-	-	-	-	-	-	-	-	5	1	4	4	28	4.00
LR9121L	1	LR-WS-0004	-	-	-	5	4	5	-	-	-	-	-	-	-	-	-	5	2	5	5	31	4.43
LR9200L	2	LR-LR-0003	4	3	2	2	5	-	-	-	-	-	-	3	3	3	-	5	5	-	5	40	3.64

Attachment 4

Impact Indicator Scores for Structural Projects

Project Number	Project Type	Subwatershed	Benthic Communities	Fish Communities	Aquatic Habitat	Channel Morphology	Instream Sediment	Hydrology	Number of Road Hazards	Magnitude of Road Hazards	Number of Building Hazards	Non-residential Building Hazards	Flood Complaints	Riparian Habitat	Headwater Riparian Habitat	Wetland Habitat	Terrestrial Forested Habitat	E. coli	TSS Concentration	TN Concentration	TP Concentration	Sum	Score
LR9201L	2	LR-LR-0007	4	3	2	2	4	-	-	-	-	-	-	3	3	3	-	5	4	-	4	37	3.36
LR9202L	2	LR-LR-0008	2	3	5	2	4	-	-	-	-	-	-	3	3	3	-	5	3	-	3	36	3.27
LR9203L	2	LR-LR-0010	4	3	2	2	4	-	-	-	-	-	-	3	3	3	-	5	3	-	3	35	3.18
LR9204L	2	LR-LR-0013	4	3	5	3	5	-	-	-	-	-	-	3	3	3	-	5	4	-	2	40	3.64
LR9205L	2	LR-LR-0014	4	3	5	3	5	-	-	-	-	-	-	3	3	3	-	5	3	-	3	40	3.64
LR9206L	2	LR-LR-0020	5	5	5	5	4	-	-	-	-	-	-	3	3	3	-	5	5	-	4	47	4.27
LR9207L	2	LR-LR-0022	5	5	5	5	4	-	-	-	-	-	-	3	3	3	-	5	4	-	2	44	4.00
LR9208L	2	LR-WS-0003	5	4	5	5	4	-	-	-	-	-	-	3	3	3	-	5	4	-	2	43	3.91
LR9209L	2	LR-WS-0003	5	4	5	5	4	-	-	-	-	-	-	3	3	3	-	5	3	-	3	43	3.91
LR9210L	2	LR-WS-0003	5	4	5	5	4	-	-	-	-	-	-	3	3	3	-	5	3	-	3	43	3.91
LR9500L	5	LR-LR-0003	-	-	-	-	-	5	-	-	-	-	3	3	3	5	3	5	3	4	3	37	3.70
LR9501L	5	LR-LR-0004	-	-	-	-	-	5	-	-	-	-	3	3	3	3	3	5	4	3	3	35	3.50
LR9502L	5	LR-LR-0004	-	-	-	-	-	5	-	-	-	-	3	3	3	3	3	5	4	4	4	37	3.70
LR9503L	5	LR-LR-0004	-	-	-	-	-	5	-	-	-	-	3	3	3	3	3	5	3	2	2	32	3.20
LR9504L	5	LR-LR-0005	-	-	-	-	-	5	-	-	-	-	4	3	3	5	3	5	5	4	4	41	4.10
LR9505L	5	LR-LR-0006	-	-	-	-	-	5	-	-	-	-	5	3	3	3	3	5	4	3	3	37	3.70
LR9506L	5	LR-LR-0006	-	-	-	-	-	5	-	-	-	-	5	3	3	5	3	5	4	1	3	37	3.70
LR9507L	5	LR-LR-0006	-	-	-	-	-	5	-	-	-	-	5	3	3	3	3	5	4	4	4	39	3.90
LR9508L	5	LR-LR-0007	-	-	-	-	-	5	-	-	-	-	5	3	3	5	3	5	3	2	2	36	3.60
LR9509L	5	LR-LR-0007	-	-	-	-	-	5	-	-	-	-	5	3	3	5	3	5	5	5	5	44	4.40
LR9510L	5	LR-LR-0007	-	-	-	-	-	5	-	-	-	-	5	3	3	5	3	5	3	3	3	38	3.80
LR9511L	5	LR-LR-0009	-	-	-	-	-	5	-	-	-	-	4	3	3	3	3	5	2	2	2	32	3.20
LR9512L	5	LR-LR-0010	-	-	-	-	-	5	-	-	-	-	5	3	3	5	3	5	5	5	5	44	4.40
LR9513L	5	LR-LR-0011	-	-	-	-	-	5	-	-	-	-	4	3	3	3	3	5	3	2	2	33	3.30
LR9514L	5	LR-LR-0009	-	-	-	-	-	5	-	-	-	-	4	3	3	3	3	5	4	4	4	38	3.80
LR9515L	5	LR-LR-0009	-	-	-	-	-	5	-	-	-	-	4	3	3	3	3	5	3	2	2	33	3.30
LR9516L	5	LR-LR-0011	-	-	-	-	-	5	-	-	-	-	4	3	3	5	3	5	2	2	3	35	3.50
LR9517L	5	LR-LR-0012	-	-	-	-	-	5	-	-	-	-	3	3	3	3	3	5	4	3	3	35	3.50
LR9518L	5	LR-LR-0012	-	-	-	-	-	5	-	-	-	-	3	3	3	5	3	5	4	3	3	37	3.70
LR9519L	5	LR-LR-0012	-	-	-	-	-	5	-	-	-	-	3	3	3	5	3	5	5	5	5	42	4.20
LR9520L	5	LR-LR-0012	-	-	-	-	-	5	-	-	-	-	3	3	3	3	3	5	3	3	3	34	3.40
LR9521L	5	LR-LR-0015	-	-	-	-	-	5	-	-	-	-	5	3	3	3	3	5	5	4	4	40	4.00
LR9522L	5	LR-LR-0015	-	-	-	-	-	5	-	-	-	-	5	3	3	5	3	5	4	3	3	39	3.90
LR9523L	5	LR-LR-0016	-	-	-	-	-	5	-	-	-	-	3	3	3	3	3	5	3	2	2	32	3.20
LR9524L	5	LR-LR-0016	-	-	-	-	-	5	-	-	-	-	3	3	3	5	3	5	4	3	3	37	3.70

Attachment 4

Impact Indicator Scores for Structural Projects

Project Number	Project Type	Subwatershed	Benthic Communities	Fish Communities	Aquatic Habitat	Channel Morphology	Instream Sediment	Hydrology	Number of Road Hazards	Magnitude of Road Hazards	Number of Building Hazards	Non-residential Building Hazards	Flood Complaints	Riparian Habitat	Headwater Riparian Habitat	Wetland Habitat	Terrestrial Forested Habitat	E. coli	TSS Concentration	TN Concentration	TP Concentration	Sum	Score
LR9525L	5	LR-LR-0019	-	-	-	-	-	5	-	-	-	-	3	3	3	5	3	5	4	1	1	33	3.30
LR9526L	5	LR-WS-0002	-	-	-	-	-	5	-	-	-	-	4	3	3	5	3	5	5	5	5	43	4.30
LR9527L	5	LR-WS-0002	-	-	-	-	-	5	-	-	-	-	4	3	3	5	3	5	4	3	3	38	3.80
LR9528L	5	LR-LR-0024	-	-	-	-	-	5	-	-	-	-	3	3	3	5	3	5	2	2	1	32	3.20
LR9529L	5	LR-LR-0025	-	-	-	-	-	5	-	-	-	-	3	3	3	5	3	5	5	5	5	42	4.20
LR9530L	5	LR-WS-0003	-	-	-	-	-	5	-	-	-	-	5	3	3	5	3	5	1	1	1	32	3.20
LR9600L	6	LR-LR-0018	-	-	-	5	-	5	5	5	5	5	3	-	-	-	-	-	-	-	-	33	4.71
LR9700L	7	LR-LR-0008	2	3	5	2	4	3	-	-	-	-	-	-	-	-	-	5	2	1	1	28	2.80

Attachment 5 – Project Type/Source Indicator Association

	Regional Pond/ Alternatives	New/ Retrofit SWM Pond	Stream Restoration	Culvert Retrofit	New/Retrofit BMP/LID	Flood Protection/Mitigation	Outfall Improvement
Channelized/Piped Streams			X	X		X	X
Directly Connected Impervious Area	X	X			X	X	
Impervious Surface	X	X			X	X	
Stormwater Outfalls	X	X	X		X	X	X
Streambank Buffer Deficiency			X				
TSS Concentration	X	X	X		X		X
TN Concentration	X	X	X		X		X
TP Concentration	X	X	X		X		X

Attachment 6

Source Indicator Scores for Structural Projects

Project Number	Project Type	Subwatershed	Channelized/Piped Streams	Directly Connected Impervious Area	Impervious Surface	Stormwater Outfalls	Streambank Buffer Deficiency	TSS Concentration	TN Concentration	TP Concentration	Sum	Score
JM9100L	1	JM-JM-0003	-	1	1	5	-	2	4	4	17	2.83
JM9101L	1	JM-JM-0009	-	1	1	5	-	1	1	1	10	1.67
JM9200L	2	JM-JM-0001	-	-	-	-	-	5	5	5	15	5.00
JM9201L	2	JM-PC-0001	-	-	-	-	-	4	4	4	12	4.00
JM9202L	2	JM-JM-0003	-	-	-	-	-	4	4	4	12	4.00
JM9203L	2	JM-JM-0005	-	-	-	-	-	5	5	5	15	5.00
JM9400L	4	JM-PC-0001	3	-	-	-	-	-	-	-	3	3.00
JM9500L	5	JM-PC-0002	-	2	2	1	-	5	5	5	20	3.33
JM9700L	7	JM-JM-0011	3	-	-	5	-	1	1	1	11	2.20
LR9005S	0	LR-LR-0010	-	5	5	5	-	5	5	5	30	5.00
LR9010S	0	LR-WS-0005	-	2	2	1	-	5	5	5	20	3.33
LR9013S	0	LR-LR-0013	-	4	5	5	-	5	5	5	29	4.83
LR9100L	1	LR-LR-0005	-	4	5	5	-	1	4	4	23	3.83
LR9101L	1	LR-LR-0006	-	4	5	5	-	2	4	4	24	4.00
LR9102L	1	LR-LR-0008	-	4	5	5	-	2	4	4	24	4.00
LR9103L	1	LR-LR-0010	-	5	5	5	-	2	4	5	26	4.33
LR9104L	1	LR-LR-0011	-	4	5	5	-	1	3	4	22	3.67
LR9105L	1	LR-LR-0009	-	4	5	5	-	2	3	3	22	3.67
LR9106L	1	LR-LR-0009	-	4	5	5	-	2	3	3	22	3.67
LR9107L	1	LR-LR-0012	-	4	5	5	-	3	4	4	25	4.17
LR9108L	1	LR-LR-0012	-	4	5	5	-	3	3	2	22	3.67
LR9109L	1	LR-LR-0012	-	4	5	5	-	4	4	4	26	4.33
LR9110L	1	LR-LR-0015	-	5	5	5	-	3	4	4	26	4.33
LR9111L	1	LR-LR-0015	-	5	5	5	-	3	4	3	25	4.17
LR9112L	1	LR-LR-0016	-	5	5	5	-	3	3	2	23	3.83
LR9113L	1	LR-LR-0014	-	2	2	5	-	1	5	5	20	3.33
LR9114L	1	LR-LR-0014	-	2	2	5	-	1	3	4	17	2.83
LR9115L	1	LR-LR-0018	-	2	2	1	-	3	3	3	14	2.33
LR9116L	1	LR-LR-0019	-	4	5	5	-	1	1	1	17	2.83
LR9117L	1	LR-LR-0020	-	4	5	5	-	2	3	2	21	3.50
LR9118L	1	LR-LR-0021	-	2	2	5	-	4	5	5	23	3.83
LR9119L	1	LR-LR-0022	-	2	2	5	-	1	1	1	12	2.00
LR9120L	1	LR-WS-0002	-	4	5	5	-	1	4	4	23	3.83
LR9121L	1	LR-WS-0004	-	2	2	5	-	2	5	5	21	3.50
LR9200L	2	LR-LR-0003	-	-	-	-	-	5	5	5	15	5.00
LR9201L	2	LR-LR-0007	-	-	-	-	-	4	4	4	12	4.00
LR9202L	2	LR-LR-0008	-	-	-	-	-	3	2	3	8	2.67
LR9203L	2	LR-LR-0010	-	-	-	-	-	3	3	3	9	3.00
LR9204L	2	LR-LR-0013	-	-	-	-	-	4	2	2	8	2.67
LR9205L	2	LR-LR-0014	-	-	-	-	-	3	3	3	9	3.00
LR9206L	2	LR-LR-0020	-	-	-	-	-	5	4	4	13	4.33
LR9207L	2	LR-LR-0022	-	-	-	-	-	4	2	2	8	2.67
LR9208L	2	LR-WS-0003	-	-	-	-	-	4	1	2	7	2.33
LR9209L	2	LR-WS-0003	-	-	-	-	-	3	3	3	9	3.00
LR9210L	2	LR-WS-0003	-	-	-	-	-	3	3	3	9	3.00
LR9500L	5	LR-LR-0003	-	1	1	1	-	3	4	3	13	2.17
LR9501L	5	LR-LR-0004	-	4	5	5	-	4	3	3	24	4.00

Attachment 6

Source Indicator Scores for Structural Projects

Project Number	Project Type	Subwatershed	Channelized/Piped Streams	Directly Connected Impervious Area	Impervious Surface	Stormwater Outfalls	Streambank Buffer Deficiency	TSS Concentration	TN Concentration	TP Concentration	Sum	Score
LR9502L	5	LR-LR-0004	-	4	5	5	-	4	4	4	26	4.33
LR9503L	5	LR-LR-0004	-	4	5	5	-	3	2	2	21	3.50
LR9504L	5	LR-LR-0005	-	4	5	5	-	5	4	4	27	4.50
LR9505L	5	LR-LR-0006	-	4	5	5	-	4	3	3	24	4.00
LR9506L	5	LR-LR-0006	-	4	5	5	-	4	1	3	22	3.67
LR9507L	5	LR-LR-0006	-	4	5	5	-	4	4	4	26	4.33
LR9508L	5	LR-LR-0007	-	5	5	5	-	3	2	2	22	3.67
LR9509L	5	LR-LR-0007	-	5	5	5	-	5	5	5	30	5.00
LR9510L	5	LR-LR-0007	-	5	5	5	-	3	3	3	24	4.00
LR9511L	5	LR-LR-0009	-	4	5	5	-	2	2	2	20	3.33
LR9512L	5	LR-LR-0010	-	5	5	5	-	5	5	5	30	5.00
LR9513L	5	LR-LR-0011	-	4	5	5	-	3	2	2	21	3.50
LR9514L	5	LR-LR-0009	-	4	5	5	-	4	4	4	26	4.33
LR9515L	5	LR-LR-0009	-	4	5	5	-	3	2	2	21	3.50
LR9516L	5	LR-LR-0011	-	4	5	5	-	2	2	3	21	3.50
LR9517L	5	LR-LR-0012	-	4	5	5	-	4	3	3	24	4.00
LR9518L	5	LR-LR-0012	-	4	5	5	-	4	3	3	24	4.00
LR9519L	5	LR-LR-0012	-	4	5	5	-	5	5	5	29	4.83
LR9520L	5	LR-LR-0012	-	4	5	5	-	3	3	3	23	3.83
LR9521L	5	LR-LR-0015	-	5	5	5	-	5	4	4	28	4.67
LR9522L	5	LR-LR-0015	-	5	5	5	-	4	3	3	25	4.17
LR9523L	5	LR-LR-0016	-	5	5	5	-	3	2	2	22	3.67
LR9524L	5	LR-LR-0016	-	5	5	5	-	4	3	3	25	4.17
LR9525L	5	LR-LR-0019	-	4	5	5	-	4	1	1	20	3.33
LR9526L	5	LR-WS-0002	-	4	5	5	-	5	5	5	29	4.83
LR9527L	5	LR-WS-0002	-	4	5	5	-	4	3	3	24	4.00
LR9528L	5	LR-LR-0024	-	5	5	5	-	2	2	1	20	3.33
LR9529L	5	LR-LR-0025	-	4	5	5	-	5	5	5	29	4.83
LR9530L	5	LR-WS-0003	-	4	5	5	-	1	1	1	17	2.83
LR9600L	6	LR-LR-0018	3	2	2	1	-	-	-	-	8	2.00
LR9700L	7	LR-LR-0008	3	-	-	5	-	2	1	1	12	2.40

Attachment 7
Scores and Rankings

Name	Subwatershed	Type	Comments	Impact Indicators Score	Source Indicators Score	Priority Subwatersheds Score	Watershed Sequencing Score	Project Implement-ability Score	Composite Project Score	Rank
LR9509L	LR-LR-0007	New BMP/LID	Flooding complaint at WAG - retrofit area u/s of culvert for SWM	4.40	5.00	4	5	3	4.52	1
LR9512L	LR-LR-0010	New BMP/LID	Treatment at culvert outlet, upstream opportunities - community not supportive of regional pond in area	4.40	5.00	3	5	3	4.42	2
LR9118L	LR-LR-0021	Pond Retrofit	Regional R-7 - opportunity to regrade/plant/direct more flow to pond - clogged during field visit	4.71	3.83	3	5	5	4.36	3
LR9529L	LR-LR-0025	New BMP/LID	Missed facility? - opportunity for LID	4.20	4.83	3	5	3	4.31	4
LR9103L	LR-LR-0010	Pond Retrofit	Modify pond to provide additional capacity, pollutant removal in replacement of Regional Pond R-5	3.86	4.33	3	5	5	4.26	5
LR9510L	LR-LR-0007	New BMP/LID	Retrofit opportunities at school	3.80	4.00	4	5	5	4.24	6
LR9504L	LR-LR-0005	New BMP/LID	Possible site for culvert retrofit	4.10	4.50	3	5	3	4.18	7
LR9104L	LR-LR-0011	Pond Retrofit, Stream Stabilization	Erosion in area from issues forum/Remove trickle ditches, add micropools/plantings	3.57	3.67	5	5	5	4.17	8
LR9100L	LR-LR-0005	Pond Retrofit	Retrofit to include wetland plantings	4.00	3.83	3	5	5	4.15	9
LR9113L	LR-LR-0014	Pond Retrofit	Remove trickle ditches, add micropools/plantings - stabilize eroded areas	4.14	3.33	4	5	5	4.14	10
LR9102L	LR-LR-0008	Pond Retrofit, Outfall Improvement	Remove trickle ditches, plantings, enlarge to improve downstream conditions/Erosion downstream of trail - WAG comment	3.71	4.00	3	5	5	4.11	11
LR9519L	LR-LR-0012	New BMP/LID	Centreville HS drains to dry pond, opportunities for LID onsite	4.20	4.83	5	2	5	4.11	12
LR9516L	LR-LR-0011	New BMP/LID	Union Mill ES drains to dry pond, opportunities for LID onsite	3.50	3.50	5	5	5	4.10	13
JM9202L	JM-JM-0003	Stream Restoration	Issues Scoping Forum Comment - flooding and erosion	3.91	4.00	3	5	3	3.97	14
LR9528L	LR-LR-0024	New BMP/LID	New outfall treatment for Regional Pond R-12	3.20	3.33	5	5	5	3.96	15
LR9526L	LR-WS-0002	New BMP/LID	Outlet treatment for uncontrolled area	4.30	4.83	5	2	3	3.94	16
LR9201L	LR-LR-0007	Stream Restoration	Erosion/poor flow in channel - comment from Kevin Marley - Green Trails HOA - phone conversation	3.36	4.00	4	5	3	3.91	17
LR9525L	LR-LR-0019	New BMP/LID	Colin Powell ES drains to R-161 - opportunities for onsite LID	3.30	3.33	4	5	5	3.89	18
LR9508L	LR-LR-0007	New BMP/LID	Bioretention to treat back side of townhouses/Add tree box filters or treatment at culvert outlet for untreated system	3.60	3.67	4	5	3	3.88	19
LR9209L	LR-WS-0003	Stream Restoration	Stream in concrete channel being undermined - restore buffer and natural channel	3.91	3.00	5	5	3	3.87	20
LR9210L	LR-WS-0003	Stream Restoration, Flood Protection	Concrete channel - restore to natural channel - stabilize downstream erosion - address pipestem flooding	3.91	3.00	5	5	3	3.87	20
LR9114L	LR-LR-0014	Pond Retrofit	Dry pond retrofit with wetland plantings, micropool	3.71	2.83	4	5	5	3.86	22
LR9107L	LR-LR-0012	Pond Retrofit	Remove trickle ditches, add micropools/plantings	4.00	4.17	5	2	5	3.85	23
LR9513L	LR-LR-0011	New BMP/LID	Inlet treatment for uncontrolled area	3.30	3.50	5	5	3	3.84	24
LR9530L	LR-WS-0003	New BMP/LID	Willow Springs ES drains to dry pond - onsite LID opportunities	3.20	2.83	5	5	5	3.81	25
LR9206L	LR-LR-0020	Stream Restoration	Erosion at pond outfalls	4.27	4.33	5	2	3	3.78	26
JM9201L	JM-PC-0001	Stream Restoration	Issues Scoping Forum Comment - erosion, verified in field investigation	3.91	4.00	1	5	3	3.77	27
JM9500L	JM-PC-0002	New BMP/LID	Detention upstream of road - created wetland	4.20	3.33	2	5	3	3.76	28
LR9120L	LR-WS-0002	Pond Retrofit	Existing dry pond not in StormNet - Remove trickle ditches, add micropools/plantings	4.00	3.83	5	2	5	3.75	29
JM9100L	JM-JM-0003	Pond Retrofit, Dump Site	Hot tub couches in stream/Existing pond with dam break on golf course property near piplines - repair/retrofit to provide treatment	4.29	2.83	3	5	3	3.74	30
LR9205L	LR-LR-0014	Stream Restoration	Relace paved ditch with natural stream	3.64	3.00	4	5	3	3.69	31
LR9121L	LR-WS-0004	Pond Retrofit	Remove trickle ditches, add micropools/plantings - enlarge in replacement of R-10?	4.43	3.50	2	3	5	3.68	32
LR9208L	LR-WS-0003	Stream Restoration	Erosion from SPA and field visit	3.91	2.33	5	5	3	3.67	33
LR9108L	LR-LR-0012	Pond Retrofit	Enlarge pond to provide more treatment in replacement of Regional R-13	3.57	3.67	5	2	5	3.57	34
LR9117L	LR-LR-0020	Pond Retrofit (x2)	Trickle ditches, dry pond holding water during field visit, clogging and smell/Remove trickle ditches, add micropools/plantings	3.71	3.50	5	2	5	3.56	35
LR9524L	LR-LR-0016	New BMP/LID, Pond Retrofit (x2)	Inlet/outlet treatment for uncontrolled area/Remove trickle ditches, add micropools/plantings	3.70	4.17	5	1	5	3.56	36
LR9112L	LR-LR-0016	Pond Retrofit, Non-Structural	Remove trickle ditches, add micropools/plantings/Illicit discharge education (noted in NSA) - sweeping/trash in commercial shopping center	4.00	3.83	5	1	5	3.55	37
LR9109L	LR-LR-0012	New SWM	New pond to provide treatment in replacement of Regional R-13	4.14	4.33	5	2	1	3.54	38
LR9527L	LR-WS-0002	New BMP/LID	Outlet treatment for uncontrolled area	3.80	4.00	5	2	3	3.54	39

Attachment 7
Scores and Rankings

Name	Subwatershed	Type	Comments	Impact Indicators Score	Source Indicators Score	Priority Subwatersheds Score	Watershed Sequencing Score	Project Implement-ability Score	Composite Project Score	Rank
JM9203L	JM-JM-0005	Stream Restoration, Buffer Restoration	Significant erosion identified - flooding noted during field investigation	4.09	5.00	3	1	3	3.53	40
JM9200L	JM-JM-0001	Stream Restoration	Significant bank erosion - access issues	4.00	5.00	3	1	3	3.50	41
LR9110L	LR-LR-0015	Pond Retrofit	Remove trickle ditches, add micropools/plantings	3.86	4.33	3	1	5	3.46	42
LR9203L	LR-LR-0010	Stream Restoration	Remove paved ditch	3.18	3.00	3	5	3	3.45	43
LR9517L	LR-LR-0012	New BMP/LID	Inlet/outlet treatment for uncontrolled area	3.50	4.00	5	2	3	3.45	44
JM9400L	JM-PC-0001	Culvert Retrofit, Buffer Restoration	Pro rata project - comment in WAG#2/Plant trees - private property	4.50	3.00	1	5	1	3.45	44
LR9521L	LR-LR-0015	New BMP/LID (x3)	Inlet/outlet treatment for uncontrolled area	4.00	4.67	3	1	3	3.40	46
JM9101L	JM-JM-0009	Pond Retrofit	Facility Treating School, retrofit, educational opportunities?	3.29	1.67	4	5	5	3.39	47
LR9202L	LR-LR-0008	Stream Restoration, Buffer Restoration	Erosion area with headcut/Restore buffer, remove paved and trickle ditches, add plantings to ponds	3.27	2.67	3	5	3	3.38	48
LR9520L	LR-LR-0012	New BMP/LID	Inlet/outlet treatment for uncontrolled area	3.40	3.83	5	2	3	3.37	49
LR9111L	LR-LR-0015	Pond Retrofit	Space for modification, need for more plantings	3.71	4.17	3	1	5	3.36	50
LR9115L	LR-LR-0018	Pond Retrofit, New BMP/LID	LID for uncontrolled area/Remove trickle ditches, add micropools/plantings	4.14	2.33	5	2	5	3.34	51
LR9116L	LR-LR-0019	Pond Retrofit	Regional Pond R-161 - wetland plantings needed - at time of visit growth was sparse	3.29	2.83	4	5	1	3.34	52
LR9502L	LR-LR-0004	New BMP/LID	Inlet treatment for uncontrolled area	3.70	4.33	4	1	3	3.31	53
LR9518L	LR-LR-0012	New BMP/LID, Stream Restoration	Culvert retrofit/grassed swale/stream restoration in replacement of Regional R-13	3.70	4.00	5	2	1	3.31	54
LR9204L	LR-LR-0013	Stream Restoration, Buffer Restoration	Address erosion d/s of culvert - possible culvert resize needed/Restore buffer along stream - private property, houses close to stream issues	3.64	2.67	5	3	3	3.29	55
LR9522L	LR-LR-0015	New BMP/LID	Bioretention/LID for uncontrolled area	3.90	4.17	3	1	3	3.22	56
LR9101L	LR-LR-0006	Pond Retrofit	Retrofit ponds to include wetland plantings	3.71	4.00	2	1	5	3.21	57
LR9200L	LR-LR-0003	Stream Restoration, Buffer Restoration	Buffer and stream erosion - on private property	3.64	5.00	1	1	3	3.19	58
LR9507L	LR-LR-0006	New BMP/LID	Inlet treatment for uncontrolled area	3.90	4.33	2	1	3	3.17	59
LR9700L	LR-LR-0008	Outfall Improvement	Erosion at transition from concrete ditch from field investigation	2.80	2.40	3	5	3	3.16	60
LR9501L	LR-LR-0004	New BMP/LID	Inlet treatment for uncontrolled area	3.50	4.00	4	1	3	3.15	61
LR9514L	LR-LR-0009	New BMP/LID	Inlet/outlet controls for uncontrolled area	3.80	4.33	2	1	3	3.14	62
LR9207L	LR-LR-0022	Stream Restoration	Erosion, head cut, oily sheen noted during field visit	4.00	2.67	2	3	3	3.10	63
LR9523L	LR-LR-0016	New BMP/LID	Inlet/outlet treatment for uncontrolled area	3.20	3.67	5	1	3	3.06	64
LR9105L	LR-LR-0009	Pond Retrofit	Retrofit to add plantings - address erosion in pond ditch	3.43	3.67	2	1	5	3.03	65
LR9106L	LR-LR-0009	Pond Retrofit	Good access, space for modifications for wetland plantings, micropools to improve water quality treatment	3.43	3.67	2	1	5	3.03	65
LR9600L	LR-LR-0018	Flood Protection, Buffer Restoration	Structures in floodplain, buffer restoration	4.71	2.00	5	2	1	3.01	67
LR9505L	LR-LR-0006	New BMP/LID	Inlet treatment for uncontrolled area	3.70	4.00	2	1	3	3.01	68
LR9506L	LR-LR-0006	New BMP/LID	Combination of bioretention, tree box filters for untreated area	3.70	3.67	2	1	3	2.91	69
LR9503L	LR-LR-0004	New BMP/LID	Add treatments at inlets for untreated system	3.20	3.50	4	1	3	2.91	69
LR9119L	LR-LR-0022	Pond Retrofit	Regional Pond R-17 Wetland areas, grassed spillways not stable during field visit - replanting and grading	3.14	2.00	2	3	5	2.84	71
LR9515L	LR-LR-0009	New BMP/LID	Inlet/outlet treatment for uncontrolled area	3.30	3.50	2	1	3	2.74	72
LR9511L	LR-LR-0009	New BMP/LID	Add treatment for untreated system	3.20	3.33	2	1	3	2.66	73
JM9700L	JM-JM-0011	Outfall Improvement	Moderate to Severe Impact (SPA)	3.20	2.20	2	3	1	2.52	74
LR9500L	LR-LR-0003	New BMP/LID	Treat uncontrolled flow from subdivision	3.70	2.17	1	1	3	2.36	75

Attachment 8
Scores and Rankings after Modeling

Name	Subwatershed	Type	Comments	Impact Indicators Score	Source Indicators Score	Priority Subwatersheds Score	Watershed Sequencing Score	Project Implement-ability Score	Composite Project Score	Rank
LR9005C	LR-LR-0010	New BMP/LID	Treatment at culvert outlet, upstream opportunities - community not supportive of regional pond in area	4.40	5.00	3	5	3	4.42	1
LR9115	LR-LR-0021	Pond Retrofit	Regional R-7 - opportunity to regrade/plant/direct more flow to pond - clogged during field visit	4.71	3.83	3	5	5	4.36	2
LR9005A	LR-LR-0010	Pond Retrofit	Modify pond to provide additional capacity, pollutant removal in replacement of Regional Pond R-5	4.00	4.50	3	5	5	4.35	3
LR9526	LR-LR-0025	New BMP/LID	Missed facility? - opportunity for LID	3.80	4.83	3	5	3	4.19	4
LR9510	LR-LR-0007	New BMP/LID	Retrofit opportunities at school	3.40	4.00	4	5	5	4.12	5
LR9102	LR-LR-0008	Pond Retrofit, Outfall Improvement	Remove trickle ditches, plantings, enlarge to improve downstream conditions/Erosion downstream of trail - WAG comment	3.71	4.00	3	5	5	4.11	6
LR9103	LR-LR-0011	Pond Retrofit, Stream Stabilization	Erosion in area from issues forum/Remove trickle ditches, add micropools/plantings	3.14	3.83	5	5	5	4.09	7
LR9504	LR-LR-0005	New BMP/LID	Possible site for culvert retrofit	3.70	4.50	3	5	3	4.06	8
LR9516	LR-LR-0012	New BMP/LID	Centreville HS drains to dry pond, opportunities for LID onsite	3.80	4.83	5	2	5	3.99	9
LR9514	LR-LR-0011	New BMP/LID	Union Mill ES drains to dry pond, opportunities for LID onsite	3.10	3.50	5	5	5	3.98	10
LR9100	LR-LR-0005	Pond Retrofit	Retrofit to include wetland plantings	3.43	3.83	3	5	5	3.98	11
JM9202	JM-JM-0003	Stream Restoration	Issues Scoping Forum Comment - flooding and erosion	3.91	4.00	3	5	3	3.97	12
LR9110	LR-LR-0014	Pond Retrofit	Remove trickle ditches, add micropools/plantings - stabilize eroded areas	3.57	3.33	4	5	5	3.97	13
LR9201	LR-LR-0007	Stream Restoration	Erosion/poor flow in channel - comment from Kevin Marley - Green Trails HOA - phone conversation	3.36	4.00	4	5	3	3.91	14
LR9208	LR-WS-0003	Stream Restoration	Stream in concrete channel being undermined - restore buffer and natural channel	3.91	3.00	5	5	3	3.87	15
LR9209	LR-WS-0003	Stream Restoration, Flood Protection	Concrete channel - restore to natural channel - stabilize downstream erosion - address pipestem flooding	3.91	3.00	5	5	3	3.87	15
LR9525	LR-LR-0024	New BMP/LID	New outfall treatment for Regional Pond R-12	2.80	3.33	5	5	5	3.84	17
LR9523	LR-WS-0002	New BMP/LID	Outlet treatment for uncontrolled area	3.90	4.83	5	2	3	3.82	18
LR9205	LR-LR-0020	Stream Restoration	Erosion at pond outfalls	4.27	4.33	5	2	3	3.78	19
LR9207	LR-WS-0003	Stream Restoration	Erosion from SPA and field visit	3.91	2.67	5	5	3	3.77	20
JM9201	JM-PC-0001	Stream Restoration	Issues Scoping Forum Comment - erosion, verified in field investigation	3.91	4.00	1	5	3	3.77	20
LR9522	LR-LR-0019	New BMP/LID	Colin Powell ES drains to R-161 - opportunities for onsite LID	2.90	3.33	4	5	5	3.77	22
LR9508	LR-LR-0007	New BMP/LID	Bioretention to treat back side of townhouses/Add tree box filters or treatment at culvert outlet for untreated system	3.20	3.67	4	5	3	3.76	23
JM9500	JM-PC-0002	New BMP/LID	Detention upstream of road - created wetland	4.20	3.33	2	5	3	3.76	23
LR9114	LR-LR-0020	Pond Retrofit (x2)	Trickle ditches, dry pond holding water during field visit, clogging and smell/Remove trickle ditches, add micropools/plantings	4.00	3.83	5	2	5	3.75	25
JM9100	JM-JM-0003	Pond Retrofit, Dump Site	Hot tub couches in stream/Existing pond with dam break on golf course property near piplines - repair/retrofit to provide treatment	4.29	2.83	3	5	3	3.74	26
LR9511	LR-LR-0011	New BMP/LID	Inlet treatment for uncontrolled area	2.90	3.50	5	5	3	3.72	27
LR9111	LR-LR-0014	Pond Retrofit	Dry pond retrofit with wetland plantings, micropool	3.14	2.83	4	5	5	3.69	28
LR9204	LR-LR-0014	Stream Restoration	Relace paved ditch with natural stream	3.64	3.00	4	5	3	3.69	29
LR9527	LR-WS-0003	New BMP/LID	Willow Springs ES drains to dry pond - onsite LID opportunities	2.80	2.83	5	5	5	3.69	30
LR9106	LR-LR-0012	Pond Retrofit	Remove trickle ditches, add micropools/plantings	3.43	4.17	5	2	5	3.68	31
LR9117	LR-WS-0002	Pond Retrofit	Existing dry pond not in StormNet - Remove trickle ditches, add micropools/plantings	3.57	4.00	5	2	5	3.67	32
LR9202	LR-LR-0008	Stream Restoration, Buffer Restoration	Erosion area with headcut/Restore buffer, remove paved and trickle ditches, add plantings to ponds	3.36	3.33	3	5	3	3.61	33
LR9013D	LR-LR-0012	Pond Retrofit	Enlarge pond to provide more treatment in replacement of Regional R-13	3.57	3.67	5	2	5	3.57	34
LR9509	LR-LR-0007	New BMP/LID	Flooding complaint at WAG - retrofit area u/s of culvert for SWM	3.20	3.00	4	5	3	3.56	35
JM9203	JM-JM-0005	Stream Restoration, Buffer Restoration	Significant erosion identified - flooding noted during field investigation	4.09	5.00	3	1	3	3.53	36
LR9521	LR-LR-0016	New BMP/LID, Pond Retrofit (x2)	Inlet/outlet treatment for uncontrolled area/Remove trickle ditches, add micropools/plantings	3.40	4.33	5	1	5	3.52	37
LR9010B	LR-WS-0004	Pond Retrofit	Remove trickle ditches, add micropools/plantings - enlarge in replacement of R-10?	3.86	3.50	2	3	5	3.51	38
JM9200	JM-JM-0001	Stream Restoration	Significant bank erosion - access issues	4.00	5.00	3	1	3	3.50	39
LR9109	LR-LR-0016	Pond Retrofit, Non-Structural	Remove trickle ditches, add micropools/plantings/Illicit discharge education (noted in NSA) - sweeping/trash in commercial shopping center	3.71	3.83	5	1	5	3.46	40
LR9203	LR-LR-0010	Stream Restoration	Remove paved ditch	3.18	3.00	3	5	3	3.45	41
JM9400	JM-PC-0001	Culvert Retrofit, Buffer Restoration	Pro rata project - comment in WAG#2/Plant trees - private property	4.50	3.00	1	5	1	3.45	42
LR9524	LR-WS-0002	New BMP/LID	Outlet treatment for uncontrolled area	3.40	4.00	5	2	3	3.42	43
LR9013A	LR-LR-0013	Stream Restoration, Buffer Restoration	Address erosion d/s of culvert - possible culvert resize needed/Restore buffer along stream - private property, houses close to stream issues	3.73	3.00	5	3	3	3.42	44
LR9515	LR-LR-0012	New BMP/LID	Inlet/outlet treatment for uncontrolled area	3.10	4.00	5	2	3	3.33	45
LR9107	LR-LR-0015	Pond Retrofit	Remove trickle ditches, add micropools/plantings	3.29	4.33	3	1	5	3.29	46
LR9518	LR-LR-0015	New BMP/LID (x3)	Inlet/outlet treatment for uncontrolled area	3.60	4.67	3	1	3	3.28	47
LR9517	LR-LR-0012	New BMP/LID	Inlet/outlet treatment for uncontrolled area	3.00	3.83	5	2	3	3.25	48
JM9101	JM-JM-0009	Pond Retrofit	Facility Treating School, retrofit, educational opportunities?	2.71	1.67	4	5	5	3.21	49
LR9108	LR-LR-0015	Pond Retrofit	Space for modification, need for more plantings	3.14	4.17	3	1	5	3.19	50

Attachment 8
Scores and Rankings after Modeling

Name	Subwatershed	Type	Comments	Impact Indicators Score	Source Indicators Score	Priority Subwatersheds Score	Watershed Sequencing Score	Project Implement-ability Score	Composite Project Score	Rank
LR9200	LR-LR-0003	Stream Restoration, Buffer Restoration	Buffer and stream erosion - on private property	3.64	5.00	1	1	3	3.19	51
LR9013B	LR-LR-0012	New BMP/LID, Stream Restoration	Culvert retrofit/grassed swale/stream restoration in replacement of Regional R-13	3.30	4.00	5	2	1	3.19	52
LR9502	LR-LR-0004	New BMP/LID	Inlet treatment for uncontrolled area	3.30	4.33	4	1	3	3.19	53
LR9013C	LR-LR-0012	New SWM	New pond to provide treatment in replacement of Regional R-13	3.29	4.00	5	2	1	3.19	54
LR9112	LR-LR-0018	Pond Retrofit, New BMP/LID	LID for uncontrolled area/Remove trickle ditches, add micropools/plantings	3.57	2.33	5	2	5	3.17	55
LR9113	LR-LR-0019	Pond Retrofit	Regional Pond R-161 - wetland plantings needed - at time of visit growth was sparse	2.71	2.83	4	5	1	3.16	56
LR9501	LR-LR-0004	New BMP/LID	Inlet treatment for uncontrolled area	3.20	4.17	4	1	3	3.11	57
LR9206	LR-LR-0022	Stream Restoration	Erosion, head cut, oily sheen noted during field visit	4.00	2.67	2	3	3	3.10	58
LR9519	LR-LR-0015	New BMP/LID	Bioretention/LID for uncontrolled area	3.50	4.17	3	1	3	3.10	59
LR9700	LR-LR-0008	Outfall Improvement	Erosion at transition from concrete ditch from field investigation	2.60	2.40	3	5	3	3.10	59
LR9507	LR-LR-0006	New BMP/LID	Inlet treatment for uncontrolled area	3.50	4.33	2	1	3	3.05	61
LR9101	LR-LR-0006	Pond Retrofit	Retrofit ponds to include wetland plantings	3.14	4.00	2	1	5	3.04	62
LR9512	LR-LR-0009	New BMP/LID	Inlet/outlet controls for uncontrolled area	3.40	4.33	2	1	3	3.02	63
LR9520	LR-LR-0016	New BMP/LID	Inlet/outlet treatment for uncontrolled area	2.80	3.67	5	1	3	2.94	64
LR9505	LR-LR-0006	New BMP/LID	Inlet treatment for uncontrolled area	3.30	4.00	2	1	3	2.89	65
LR9104	LR-LR-0009	Pond Retrofit	Retrofit to add plantings - address erosion in pond ditch	2.86	3.67	2	1	5	2.86	66
LR9105	LR-LR-0009	Pond Retrofit	Good access, space for modifications for wetland plantings, micropools to improve water quality treatment	2.86	3.67	2	1	5	2.86	66
LR9600	LR-LR-0018	Flood Protection, Buffer Restoration	Structures in floodplain, buffer restoration	4.14	2.00	5	2	1	2.84	68
LR9506	LR-LR-0006	New BMP/LID	Combination of bioretention, tree box filters for untreated area	3.30	3.67	2	1	3	2.79	69
LR9503	LR-LR-0004	New BMP/LID	Add treatments at inlets for untreated system	2.80	3.50	4	1	3	2.79	69
LR9116	LR-LR-0022	Pond Retrofit	Regional Pond R-17 Wetland areas, grassed spillways not stable during field visit - replanting and grading	2.57	2.00	2	3	5	2.67	71
LR9513	LR-LR-0009	New BMP/LID	Inlet/outlet treatment for uncontrolled area	2.90	3.50	2	1	3	2.62	72
LR9005B	LR-LR-0009	New BMP/LID	Add treatment for untreated system	2.80	3.33	2	1	3	2.54	73
JM9700	JM-JM-0011	Outfall Improvement	Moderate to Severe Impact (SPA)	3.00	2.20	2	3	1	2.46	74
LR9500	LR-LR-0003	New BMP/LID	Treat uncontrolled flow from subdivision	3.40	2.33	1	1	3	2.32	75