6.0 Benefits of Plan Implementation

There are numerous watershed restoration strategies that may have a significant impact on the overall health and quality of the Nichol Run and Pond Branch watersheds. In order to quantify the costs and benefits of implementing the watershed restoration strategies discussed in previous sections, additional analyses were required. This section discusses and summarizes the results of the pollutant load, hydrologic and hydraulic modeling used in the development of the watershed management plans to quantify any reductions in pollutant loading, total stormwater runoff volumes, peak rate of runoff and the extent of flooding. A summary of cost estimates and an analysis of the costs and benefits of the project plan are also discussed.

6.1 Stormwater Models

As discussed in Section 2, 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 models* take into account 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 a 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* are used to evaluate 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 man-made culverts/channels have in conveying stormwater runoff and the spatial extent of potential flooding.

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 discussed below. Detailed information on the setup and calibration of the STEPL pollution models, SWMM hydrologic models and HEC-RAS hydraulic models can be found in Technical Memo 3.6 in Appendix B.

6.2 Analysis of Stormwater Modeling Results

Results of the modeling efforts were compiled and analyzed to determine pollutant load and flow reductions. The reduction in values shown and discussed below indicates the overall benefits of implementing the restoration strategies described within the plan.

6.2.1 Nichol Run

Tables 6.1 and 6.2 below summarize the results of the pollutant and hydrologic models in terms of pollutant loading and stormwater flow reductions for the Nichol Run Watershed. All values were normalized to the drainage area to allow for direct and accurate comparisons. Values were normalized by weighting them to account for the size of the drainage area and remove the effect of drainage area variability in comparisons between WMAs. Runoff volume and peak flow values were obtained from SWMM hydrologic models and were calculated cumulatively. In other words, flows were summed from upstream to downstream and were divided by the total contributing drainage area. Total suspended solids (TSS), total nitrogen (TN) and total phosphorus (TP) values were obtained from the results of the STEPL pollutant models. These values were calculated based on the individual land area contributions and may not increase from upstream to downstream. Non-area weighted pollutant loading values can be found in Technical Memo 3.6 in Appendix B.

Table 6.1
Nichol Run Pollutant Loading and Flow Reductions by WMA

WMA	Area (ac)	Scenario[3]	Runoff Volume (in)[1]		Peak Flow (cfs/ac)[1]		TN[2] (lb/ac/yr)	TP[2] (lb/ac/yr)	TSS[2] (lb/ac/yr)
			2 Year	10 Year	2 Year	10 Year			
Jefferson Branch WMA	1,184.94	Existing Condition	2.19	4.12	0.278	0.593	1.91	0.280	73.25
		Future Without Projects	2.20	4.13	0.281	0.598	1.99	0.290	73.60
		Future With 10-yr Projects	2.03	3.93	0.251	0.564	1.97	0.290	71.73
		Reduction (10-year Plan)	0.16 (7%)	0.19 (5%)	0.03 (11%)	0.03 (6%)	0.02 (1%)	0.00 (0%)	1.87 (3%)
		Future With 0-25 yr Projects	N/A	N/A	N/A	N/A	1.92	0.280	69.53
		Reduction (25-year Plan)	N/A	N/A	N/A	N/A	0.07 (4%)	0.01 (3%)	4.07 (6%)
Nichol-Lower WMA	820.52	Existing Condition	0.20	0.53	0.236	0.537	1.44	0.220	69.43
		Future Without Projects	0.21	0.54	0.240	0.543	1.84	0.280	70.58
		Future With 10-yr Projects	0.21	0.53	0.213	0.502	1.80	0.260	66.96
		Reduction (10-year Plan)	0.00 (2%)	0.01 (2%)	0.03 (11%)	0.04 (8%)	0.04 (2%)	0.02 (7%)	3.62 (5%)
		Future With 0-25 yr Projects	N/A	N/A	N/A	N/A	1.77	0.260	64.78
		Reduction (25-year Plan)	N/A	N/A	N/A	N/A	0.07 (4%)	0.02 (7%)	5.80 (8%)

[1] Flow is cumulative.
[2] Loads are representative of individual land area contributions.
[3] 25-year projects were not evaluated in the hydrologic model.
[4] No projects were proposed in this WMA.

Table 6.1
Nichol Run Pollutant Loading and Flow Reductions by WMA

WMA	Area (ac)	Scenario[3]	Runoff Volume (in)[1]		Peak Flow (cfs/ac)[1]		TN[2] (lb/ac/yr)	TP[2] (lb/ac/yr)	TSS[2] (lb/ac/yr)
			2 Year	10 Year	2 Year	10 Year			
Nichol-Potomac WMA[4]	697	Existing Condition	0.65	2.25	0.139	0.473	0.95	0.160	75.01
		Future Without Projects	0.68	2.30	0.182	0.537	1.19	0.190	73.82
		Future With 10-yr Projects	0.68	2.30	0.182	0.537	1.19	0.190	73.82
		Reduction (10-year Plan)	0.00 (0%)	0.00 (0%)	0.00 (0%)	0.00 (0%)	0.00 (0%)	0.00 (0%)	0.00 (0%)
		Future With 0-25 yr Projects	N/A	N/A	N/A	N/A	1.19	0.190	73.82
		Reduction (25-year Plan)	N/A	N/A	N/A	N/A	0.00 (0%)	0.00 (0%)	0.00 (0%)
Nichol-Upper WMA	2,548	Existing Condition	2.32	4.33	0.306	0.656	2.31	0.360	153.57
		Future Without Projects	2.33	4.34	0.315	0.672	2.41	0.370	153.31
		Future With 10-yr Projects	2.05	4.00	0.278	0.598	2.31	0.340	89.29
		Reduction (10-year Plan)	0.28 (12%)	0.34 (8%)	0.04 (12%)	0.07 (11%)	0.10 (4%)	0.03 (8%)	64.02 (42%)
		Future With 0-25 yr Projects	N/A	N/A	N/A	N/A	2.26	0.330	84.66
		Reduction (25-year Plan)	N/A	N/A	N/A	N/A	0.15 (6%)	0.04 (11%)	68.65 (45%)

[1] Flow is cumulative.
[2] Loads are representative of individual land area contributions.
[3] 25-year projects were not evaluated in the hydrologic model.
[4] No projects were proposed in this WMA.

Table 6.2
Nichol Run Overall Pollutant Loading and Flow Reductions

WMA	Area (ac)	Scenario[2]	Runoff Volume (in)[1]		Peak Flow (cfs/ac)[1]		TN (lb/ac/yr)	TP (lb/ac/yr)	TSS (lb/ac/yr)
			2 Year	10 Year	2 Year	10 Year			
Nichol Run Watershed	5,250	Existing Condition	1.08	2.18	0.129	0.303	1.90	0.290	111.87
		Future Without Projects	1.09	2.19	0.131	0.307	2.07	0.310	111.84
		Future With 10-yr Projects	0.99	2.07	0.117	0.285	2.01	0.300	79.80
		Reduction (10-year Plan)	0.10 (9%)	0.12 (5%)	0.01 (10%)	0.02 (7%)	0.06 (3%)	0.01 (3%)	32.04 (29%)
		Future With 0-25 yr Projects	N/A	N/A	N/A	N/A	1.96	0.290	76.72
		Reduction (25-year Plan)	N/A	N/A	N/A	N/A	0.11 (5%)	0.02 (6%)	35.12 (31%)

[1] Flow is cumulative.
[2] 25-year projects were not evaluated in the hydrologic model.

Based on modeling results, implementation of the restoration strategies and projects described in the 10-year plan will result in reductions in stormwater runoff flows and pollutant loads. The values shown in these tables have all been normalized to the drainage area and the reductions shown here indicate reductions per unit area.

The model results show the greatest reductions in Nichol-Upper WMA where stormwater management generally has the greatest effect and where projects have been prioritized. WMAs where no projects or restoration strategies are proposed such as Potomac WMA, which is mostly undeveloped and sparsely populated, are shown in Table 6.1 above without any reductions or increases in pollutant loadings or stormwater flow.

6.2.2 Pond Branch

Tables 6.3 and 6.4 below summarize the results of the pollutant and hydrologic models in terms of pollutant loading and stormwater flow reductions for the Pond Branch Watershed. All values were normalized to the drainage area to allow for direct and accurate comparisons. Values were normalized by weighting them to account for the size of the drainage area and remove the effect

of drainage area variability in comparisons between WMAs. Runoff volume and peak flow values were obtained from SWMM hydrologic models and were calculated cumulatively. In other words, flows were summed from upstream to downstream and were divided by the total contributing drainage area. Total suspended solids (TSS), total nitrogen (TN) and total phosphorus (TP) values were obtained from the results of the STEPL pollutant models. These values were calculated based on the individual land area contributions and may not increase from upstream to downstream. Non-area weighted pollutant loading values can be found in Technical Memo 3.6 in Appendix B.

Table 6.3
Pond Branch Pollutant Loading and Flow Reductions by WMA

WMA	Area (ac)	Scenario[3]	Runoff Volume (in)[1]		Peak Flow (cfs/ac)[1]		TN[2] (lb/ac/yr)	TP[2] (lb/ac/yr)	TSS[2] (lb/ac/yr)
			2 Year	10 Year	2 Year	10 Year			
Clark Run WMA	1,759	Existing Condition	1.99	3.87	0.295	0.669	2.20	0.340	90.30
		Future Without Projects	2.00	3.88	0.300	0.677	2.35	0.360	90.35
		Future With 10-yr Projects	1.35	3.09	0.159	0.412	2.19	0.330	76.98
		Reduction (10-year Plan)	0.65 (32%)	0.79 (20%)	0.14 (47%)	0.26 (39%)	0.16 (7%)	0.03 (8%)	13.37 (15%)
		Future With 0-25 yr Projects	N/A	N/A	N/A	N/A	2.01	0.280	60.78
		Reduction (25-year Plan)	N/A	N/A	N/A	N/A	0.34 (14%)	0.08 (22%)	29.57 (33%)
Pond Branch WMA	742	Existing Condition	2.00	3.88	0.361	0.815	2.70	0.430	226.29
		Future Without Projects	2.01	3.90	0.372	0.837	2.84	0.450	226.97
		Future With 10-yr Projects	1.17	2.86	0.220	0.482	2.69	0.400	98.59
		Reduction (10-year Plan)	0.84 (42%)	1.04 (27%)	0.15 (41%)	0.36 (42%)	0.15 (5%)	0.05 (11%)	128.38 (57%)
		Future With 0-25 yr Projects	N/A	N/A	N/A	N/A	2.69	0.400	98.59
		Reduction (25-year Plan)	N/A	N/A	N/A	N/A	0.15 (5%)	0.05 (11%)	128.38 (57%)
Mine Run WMA	1,633	Existing Condition	1.93	3.79	0.334	0.731	2.37	0.360	114.36
		Future Without Projects	1.94	3.80	0.347	0.740	2.50	0.380	114.99
		Future With 10-yr Projects	1.11	2.77	0.133	0.313	2.24	0.320	86.06
		Reduction (10-year Plan)	0.83 (43%)	1.03 (27%)	0.21 (62%)	0.43 (58%)	0.26 (10%)	0.06 (16%)	28.93 (25%)
		Future With 0-25 yr Projects	N/A	N/A	N/A	N/A	2.24	0.320	86.06
		Reduction (25-year Plan)	N/A	N/A	N/A	N/A	0.26 (10%)	0.06 (16%)	28.93 (25%)
Pond-Potomac WMA	1,270	Existing Condition	0.41	1.07	0.263	0.775	1.23	0.210	87.40
		Future Without Projects	0.41	1.07	0.271	0.785	1.30	0.220	86.82
		Future With 10-yr Projects	0.41	1.07	0.271	0.785	1.30	0.220	86.80
		Reduction (10-year Plan)	0.00 (0%)	0.00 (0%)	0.00 (0%)	0.00 (0%)	0.00 (0%)	0.00 (0%)	0.02 (0%)
		Future With 0-25 yr Projects	N/A	N/A	N/A	N/A	1.26	0.210	82.44
		Reduction (25-year Plan)	N/A	N/A	N/A	N/A	0.04 (3%)	0.01 (5%)	4.38 (5%)

[1] Flow is cumulative.
[2] Loads are representative of individual land area contributions.
[3] 25-year projects were not evaluated in the hydrologic model.
[4] No projects were proposed in this WMA.

Table 6.4 Pond Branch Overall Pollutant Loading and Flow Reductions									
WMA	Area (ac)	Scenario[2]	Runoff Volume (in)[1]		Peak Flow (cfs/ac)[1]		TN (lb/ac/yr)	TP (lb/ac/yr)	TSS (lb/ac/yr)
			2 Year	10 Year	2 Year	10 Year			
Pond Branch Watershed	5,404	Existing Condition	1.72	3.52	0.276	0.647	2.09	0.330	115.55
		Future Without Projects	1.73	3.53	0.282	0.656	2.21	0.350	115.72
		Future With 10-yr Projects	1.16	2.83	0.155	0.417	2.07	0.310	85.00
		Reduction (10-year Plan)	0.57 (33%)	0.70 (20%)	0.13 (45%)	0.24 (36%)	0.14 (6%)	0.04 (11%)	30.72 (27%)
		Future With 0-25 yr Projects	N/A	N/A	N/A	N/A	2.00	0.290	78.70
		Reduction (25-year Plan)	N/A	N/A	N/A	N/A	0.21 (10%)	0.06 (17%)	37.02 (32%)

[1] Flow is cumulative.
[2] 25-year projects were not evaluated in the hydrologic model.

Based on modeling results, implementation of the restoration strategies and projects described in the 10-year plan will result in reductions in stormwater runoff flows and pollutant loads. The values shown in these tables have all been normalized to the drainage area and the reductions shown here indicate reductions per unit area.

The model results show the greatest reductions in Mine Run WMA. Mine Run WMA contained the largest number of projects in the watershed management plan of any WMA in Pond Branch watershed. WMAs where no projects or restoration strategies are implemented such as Pond-Potomac WMA, mostly undeveloped and sparsely populated, are shown in Table 6.3 above without any reductions or increases in pollutant loadings or stormwater flow

6.3 Project Costs and Benefits Analysis

An integral element to evaluating the benefits of restoration strategies and projects is associated costs. Cost estimates were calculated for all structural projects detailed in previous sections. Detailed cost estimates, as shown on the project fact sheets, were determined for structural projects in the 0-10 year implementation phase. The total costs of implementing projects in this phase were calculated to be approximately $2 million and $7 million for the Nichol Run and Pond Branch watersheds, respectively. Associated costs for structural projects in the 11-25 year implementation phase were roughly approximated based on the overall costs associated with similar projects in the 10 year implementation plan and are estimated at approximately $4 million. Cost estimates were not calculated for non-structural projects, because non-structural projects do not require traditional construction measures to be implemented and may be programmatic in nature.

In addition to the calculation of cost estimates for projects listed in the implementation plan, a cost benefit analysis was also performed. The project cost distribution for all projects listed in the 10-year implementation plan was evaluated. The evaluation of the project cost distribution allowed for a determination of outliers within the lists of projects. These outliers could be projects that were significantly more or less expensive than other projects in the lists. These projects were further scrutinized and evaluated to determine if they should remain in the 10-year list. Outliers determined to be kept in the list were evaluated separately from the other projects in the 10-year list. A cost to benefit ratio was calculated based on the subwatershed ranking composite score and the projects' associated costs. Using the cost to benefit ratio, all structural projects in the 10-year implementation plan were reordered based on this analysis. See Technical Memo 3.6 in Appendix B for more detailed information on project costs and benefits analysis.

6.4 Overall Costs and Benefits of Plan Implementation

The stormwater modeling and costs and benefits analysis described in this section demonstrates the value of the projects and restoration strategies discussed within the plan. The average cost for a project on the priority 10-year list is approximately $247,000, and the overall cost of implementing all the projects on the 10-year list is approximately $9 million. The costs to implement all projects would total approximately $13 million. Implementation of all projects and restoration strategies in the 10-year priority list will result in significant overall reductions in stormwater flows and pollutant loads, as shown in Table 6.5 and described in non-area-weighted units in Technical Memo 3.6 in Appendix B. Stormwater runoff volume from the 2-year and 10-year storm events would decrease by approximately 24 percent or 0.66 inches and 14 percent or 0.82 inches, respectively. The peak flow rates would also decrease by 34 percent, resulting in a reduction of 0.140 CFS per acre for the 2-year storm event, and 27 percent or 0.260 CFS per acre for the 10-year storm event. Total suspended solids would be reduced by 28 percent overall or 167 tons per year. Total nitrogen would be reduced by 5 percent or 1,113 pounds per year, and total phosphorus would be reduced by 9 percent or 290 pounds per year.

Implementation of all projects within the plan, including projects in the 25-year implementation plan will result in additional reductions in stormwater flows and pollutant loads. Total suspended solids would be reduced by 32 percent overall or 192 tons per year. Total nitrogen would be reduced by 8 percent or 1,714 pounds per year and total phosphorus would be reduced by 12 percent or 433 pounds per year.

Table 6.5
Overall Pollutant Loading and Flow Reductions

Watershed	Area (ac)	Scenario[2]	Runoff Volume (in)[1]		Peak Flow (cfs/ac)[1]		TN (lb/ac/yr)	TP (lb/ac/yr)	TSS (lb/ac/yr)
			2 Year	10 Year	2 Year	10 Year			
Nichol Run and Pond Branch	10,653.73	Existing Condition	2.79	5.70	0.405	0.950	2.00	0.310	113.74
		Future Without Projects	2.81	5.72	0.413	0.962	2.14	0.330	113.81
		Future With 10-yr Projects	2.15	4.90	0.273	0.702	2.04	0.300	82.44
		Reduction (10-year Plan)	0.66 (24%)	0.82 (14%)	0.140 (34%)	0.260 (27%)	0.10 (5%)	0.030 (9%)	31.37 (28%)
		Future With 0-25 yr Projects	N/A	N/A	N/A	N/A	1.98	0.29	77.72
		Reduction (25-year Plan)	N/A	N/A	N/A	N/A	0.16 (8%)	0.040 (12%)	36.09 (32%)

[1] Flow is cumulative.
[2] 25-year projects were not evaluated in the hydrologic model.