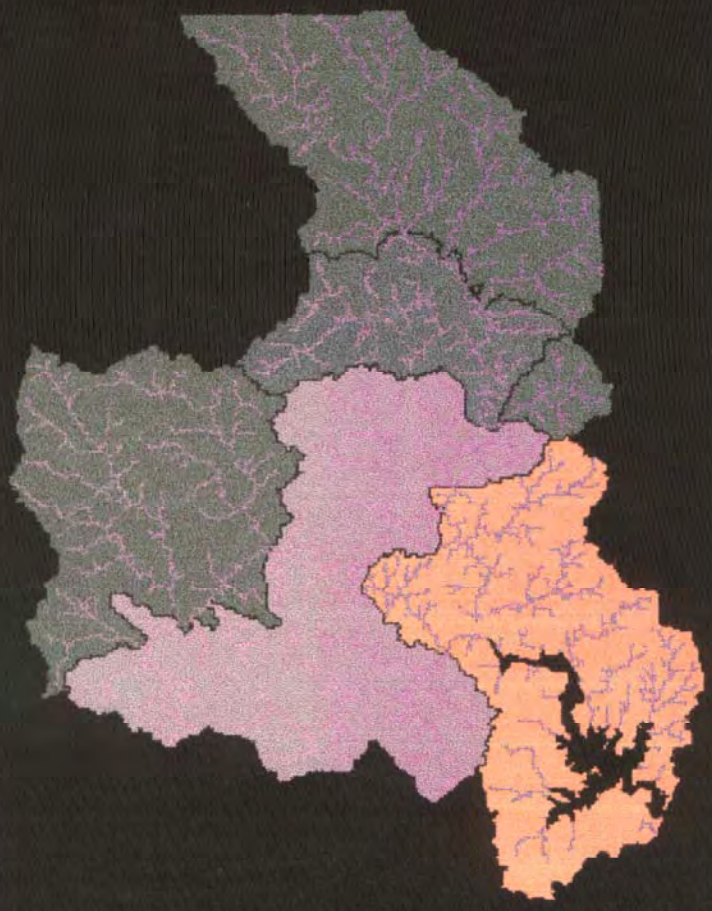
Water Quality Management Plan for Loch Raven Watershed



Executive Summary

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Executive Summary

Introduction

This report presents a water quality and watershed management plan for the Loch Raven watershed study area in Baltimore County, Maryland. The Loch Raven watershed is a large and highly diverse watershed with many concerns typical of developing fringe watersheds. The plan integrates stream assessment, modeling, spatial GIS information, and environmental data, in an innovative fashion, to develop a comprehensive and transferrable watershed management approach. To address the scale and complexity of the watershed, the management plan was developed at two levels. At the watershed-wide scale, the watershed is grouped into four management areas with similar characteristics and an associated set of ecologically based management actions are identified for ensuring the long-term integrity of the natural resources of the watershed (Figure ES-1). At the site-specifc scale, a set of case studies representative of typical restoration needs are used to explore the procedures for identifying management needs in a more detailed fashion, including site-specific recommendations for stormwater management facilities or retrofits, and stream restoration. The plan prioritizes problems and management actions at both the management area and site-specific scales by integrating field assessments, modeling, historical monitoring, soils, land use, and stormwater facility information. The field assessment of the stream systems employed an expanded suite of stream stability indicators beyond those typically used for Rosgen Level I assessment. This broader set of indicators collected during the field stream assessment process provide information valuable for supporting the prioritization and ranking steps. The final recommended management actions for the management areas and case study sites integrate structural stormwater management, nonstructural management actions, and stream restoration in a comprehensive approach to restoration addressing both the short- and long-term impacts on the watershed.

The plan is designed to meet several distinct objectives of the Baltimore County Department of Environmental Protection and Resource Management (DEPRM). One objective of this water quality management plan for the Loch Raven watershed is to assist inthe identification and evaluation of nonpoint source stormwater pollution and to provide a watershed restoration and management plan framework to be implemented through the Department's Capital Improvements Program as well as a variety of other programs. The water quality management plan will be used by the County in partial fulfillment of federal mandates under the National Pollutant Discharge Elimination System (NPDES) Municipal Stormwater Discharge Permit. In addition, the plan supports Baltimore County's Partnership Agreement with the State of Maryland in the Chesapeake Bay Program's Tributary Strategies for nutrient reduction.

The fundamental basis for evaluation of the watershed problems and identification of options is a clear set of goals for the watershed. The specific goals for the Loch Raven watershed, developed by Baltimore County DEPRM, are based on the historical and current watershed concerns, designated uses and water quality standards, ongoing programs such as the NPDES and Chesapeake Bay programs, and existing County programs and initiatives. The overall goals of the Loch Raven water quality management efforts include:

- Protection of the quality and quantity of the drinking water supplied by the Loch Raven Reservoir.
- Protection of the headwater subwatersheds to preserve a stable sediment production zone and high water quality inflow to stream orders 3 and higher.
- Protection of living resources, including aquatic and terrestrial habitat.
- Preservation of the rural character of the watershed.

The plan development process described in this report includes the following major elements:

- Watershed Characterization (Chapter 1)
- Pollutant Loading Estimates (Chapter 2)
- Stream Stability Assessment (Chapter 3)
- Problem Identification and Prioritization (Chapter 4)
- Management Planning Analysis (Chapter 5)
- Implementation Plan (Chapter 6)

The results of each of the elements of the study are summarized below. Figure ES-2 graphically displays the relationships between the various study elements and illustrates how the data and information gathered or developed under this project have been integrated into each step of the analysis.. This figure also provides the prioritization and ranking steps, as well as the criteria used throughout the study.

Watershed Characteristics and Background

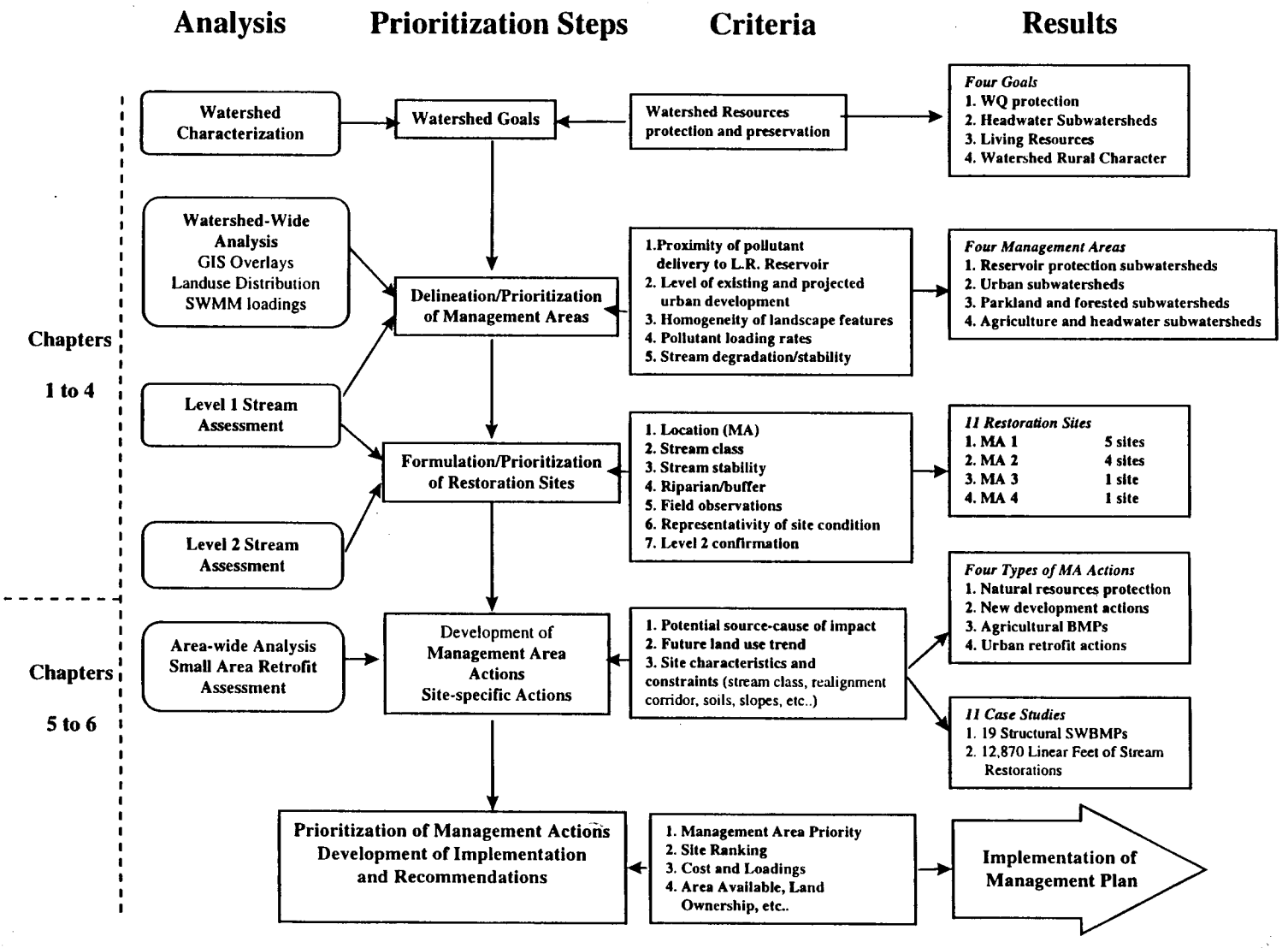
The Loch Raven Reservoir and its contributing watershed are located within the Gunpowder River subbasin. The watershed drains an area of approximately 140,000 acres. For the purpose of this water quality management planning study, the Loch Raven study area consists of the portion of the drainage area above the Loch Raven Reservoir lower dam to the dam at the Prettyboy Reservoir, bounded by the Maryland/Pennsylvania state line to the north, Harford County to the east, and Carroll County to the west. The watershed is characterized by predominately urban uses in the south and southeastern portions and forested and agricultural uses in the northern and western portions of the watershed. Historically, the primary water quality concern has been accelerated eutrophication in the reservoir due to nutrient loadings from both point and nonpoint sources

Because of the importance of the Loch Raven Reservoir as a public drinking water supply and natural trout habitat, all waters upstream of the Loch Raven dam have been designated

Loch Raven Study Area

Figure ES-1 . Case Study Locations

Figure ES-2 Prioritization Process



by the Maryland Department of the Environment (MDE) as Class III-P, Natural Trout Waters and Public Water Supplies (COMAR 26.08.02.08I).

The Loch Raven watershed has a long history of watershed management and water supply protection through the Reservoir Watershed Action Strategy. In 1979, local jurisdictions, including Baltimore City, Baltimore County, Baltimore County Soil Conservation District, Carroll County, Carroll County Soil Conservation District, Regional Planning Council, Department of Agriculture, and the Department of Health and Mental Hygiene, formulated and signed the Reservoir Agreement. In 1984, the cooperating jurisdictions signed a strengthened Reservoir Watershed Management Agreement. The Agreement, and its *1984 Action Strategy for the Reservoir Watersheds* (Action Strategy), provided a framework for improving water quality in the reservoir watersheds. In 1984, the Action Strategy established goals of preventing increased phosphorus and sediment loadings and restoring Loch Raven phosphorus loadings to pre-1970 levels as soon as possible. The 1990 Action Strategy eliminated this as distinct goal because of lack of confidence in the pre-1970 phosphorus load levels. The current reservoir protection goal defined by the Action Strategy for Loch Raven is the reduction of phosphorus loadings to acceptable levels as soon as possible.

Pollutant Loading Estimates

The planning-level SWMM model, developed for a 10-year continuous simulation of existing land use distribution, is used as the fundamental framework for the various analyses of the Loch Raven land use condition and management alternatives. A modeling framework was developed to estimate pollutant loadings for 10 pollutants and total suspended solids. Loadings were predicted for 55 subwatersheds for a 10-year period. The results of this continuous simulation were validated through various comparative analyses between model results and available observed data or published values, and they were found to be adequate for analysis of the overall watershed loading as well as for the analysis of the spatial distribution of pollutant loadings at the subwatershed scale. Based on a review of the watershed concerns, total phosphorus, total nitrogen, total suspended solids (TSS), and zinc were selected as indicators of watershed loading conditions from rural, developing, and urban areas. Average annual loadings of the indicator pollutants were used to identify high-priority subwaterheds under existing and future land use conditions. Three future land use scenarios were used to investigate the possible implications of various build-out conditions. The land use zoning categories that predominate in the watershed, RC2 and RC4, can be developed in a variety of fashions. RC2 build-out is not just of function of zoning, but also reflects changes in farming demographics and viability. The future conditions examined constitute a range of possible conditions. Conclusions of the SWMM analysis include designation of a set of high-priority subwatersheds based on average annual loading of the indicator pollutants. Evaluation of the existing stormwater management facilities identified subwatersheds with high loading potential and minimal controls under existing conditions.

Statistical analysis of monitoring data in the tributaries and the reservoir was performed to evaluate trends in loading over time. The tributary stations show a statistically significant increasing trend in nitrate concentrations and a decreasing trend in ammonia concentrations. Analysis of the reservoir monitoring stations showed a slight negative trend in total phosphorus concentrations at two of the sampling stations.

A simplified phosphorus model was developed and calibrated to the Loch Raven Reservoir. The reservoir model showed excellent representation of observed reservoir phosphorus conditions. The model was applied to a 10-year scenario of reservoir conditions. The longer-term simulation indicated that the reservoir would respond slowly to changes in phosphorus loading. Releases of phosphorus from bottom sediments are likely contributing to the overall conditions in the reservoir. Over the longer term, reductions in phosphorus loading will occur as bottom sediment

sources are slowly depleted, resulting in a system that is more responsive to changes in tributary inflows rather than bottom-sediment phosphorus fluxes.

Stream Stability Assessments

Streams are an important indicator of overall watershed health, and an assessment of the magnitude and extent of environmental impairment in the watershed stream network is a significant component of watershed characterization. The stream assessment process was designed to define potential in-stream sources of sediment, describe and assess the physical characteristics and condition of stream systems in the watershed, and identify opportunities for stream restoration and management.

For the Loch Raven watershed, a set of 14 subwatersheds and associated stream reaches were identified as representative of a cross section of the overall watershed condition. The Loch Raven watershed has over 822 stream miles, distributed among first, second, third, fourth, and higher order streams. Because of the size of the watershed and the large number of stream reaches, a subset of the total stream reaches, 80 miles total (or approximately 10 percent), was selected. For the Loch Raven watershed, the traditional Level I approach (Rosgen, 1994) was enhanced to include additional parameters, more extensive field surveys, and limited data collection. The stream assessment protocols developed for the Loch Raven watershed employ a combination of accepted techniques to describe stream type, stability, and riparian cover conditions. A fundamental difference was the use of in-field assessments to obtain basic parameters rather than relying on estimates from topographic maps. The results of the field survey were evaluated in terms of classification (stream type), stream stability scores, and riparian condition. The stream assessment results were used to identify a set of high-priority reaches for additional investigation.

Problem Identification and Prioritization

To perform the problem identification and recognize the size and diversity of the Loch Raven watershed, an approach was developed to group problems into four large management areas. Each management area represents a different set of typical water quality management concerns. The plan development process considers management strategies on various implementation scales. Two planning levels were developed to address the variability of the watershed. Development of both a watershed-wide management plan and a site-specific management plan provided a comprehensive and integrated approach to restoration of problems at multiple scales.

Management Area-wide Analysis. A management areawide analysis was performed to address watershed-wide objectives. Problem identification within each management area was determined on two levels—management area-wide and site-specific. Water quality conditions, pollutant loading estimates, land use, and zoning designations, were used to delineate and rank management areas.

Site-specific analysis. Management area-wide problems were further analyzed at the site level. Site-specific problem identification included identification of stream restoration sites and restoration alternatives and analysis of estimated pollutant loadings from each site to select sites requiring additional or retrofitted stormwater management facilities. Site visits also identified areas requiring stabilization and velocity controls.

Management Area-wide Analysis

Figure ES-2 describes the process used to select, prioritize, and rank water quality management opportunities. Information collected and analyzed during the watershed characterization and the watershed pollutant loading estimates were used to group Loch Raven subwatersheds into management areas (Figure ES-1). Each management area was ranked according to its impact on the four goals of reservoir protection. The management areas and their priority objectives are listed in Table ES-1.

Recommended management actions include source controls and nonstructural methods of regulating the impacts of urbanization and agricultural practices on the watershed and its receiving streams. They are intended to be applied on a broad scale throughout the management area as opportunities arise. Management actions can be grouped by type of program that may be required for implementation as follows:

- Seven new development management actions
- Three urban retrofit management actions
- Seven natural resources protection management actions
- Five agricultural BMP management actions

Protection of reservoir drinking water quality and quantity has been given the highest ranking of importance for the overall Loch Raven watershed plan. Therefore, management actions addressing management area 1 are considered a priority for implementation.

Table ES-1. Management Areas

Number	Name	Priority Objective
1	Reservoir Protection Subwatersheds	Protection of drinking water supply of Loch Raven Reservoir
2	Urban and Rapidly Urbanizing Subwatersheds	Retrofits in existing urban areas and management of new and projected urban sprawl
3	Parkland and Forested Subwatersheds	Preservation of stable parkland and forested areas
4	Agriculture and Headwater Subwatersheds	Agricultural management and protection of headwater streams

Site Specific Management Action Plan

The site-specific management action plan provides a framework for addressing implementation of management actions at the site level. Both stream restoration actions for the 11most degraded stream reaches assessed and site-specific urban stormwater management actions have been identified. A case study approach was used to illustrate implementation of a framework for identifying and addressing urban water quality and quantity as source controls for the stream restoration reaches. The case studies represent a cross section of problems found in the management areas. Figure ES-1 also shows case study locations with respect to management areas and subwatersheds. Ranking of the stream restoration sites was based on the following criteria, among others:

Restoration actions address site specific stream restoration as well as an identification of stormwater management practices within their drainage areas.

Site-Specific Stream Restoration Management Actions

A case study approach was used to illustrate the implementation of this framework. The case studies selected represent a cross section of the priority problems found in each of the management areas. Figure ES-1 also shows case study locations with respect to management areas and subwatersheds. Ranking of the stream restoration sites were based primarily on the following criteria:

- Degradation severity (Pfankuch ratings).
- Extent of the area impacted (linear feet impacted).
- Representativeness of typical sources/causes (urban, crop, pasture, forest).
- Opportunity for restoration (from field observations).
- Potential for recovery inferred from Level II and I classifications.

The majority of these stream restoration sites were found within Management Area 1, as shown in Table ES-2.

Table ES-2. Summary of Stream Restoration Sites

Case Study Site No.	MA	Subbasin	Length of Stream Restoration (linear feet)	Type of Restoration Proposed
1	2	Beaverdam Run	1,500	Bc
2	2	Goodwin Run	1,500	B
3	2	Oregon Run	1,870	fencing + Bc
4	2	Beaverdam Run	3,800	Bc or B
5	1	Loch Raven	500	B4c
6	1	Loch Raven	700	C
7	1	Loch Raven	600	B
8	1	Loch Raven	1,700	B
9	1	Carroll Branch	1,700	riparian buffer restoration
10	4	Blackrock Run	2,000	Bc
11	3	Panther Branch	500	Monitor for recovery

For each stream restoration site, an associated case study was developed to determine specific stream restoration and structural stormwater best management practices for source controls. Stream restoration recommendations were made based on the stream reach Rosgen classification, the recovery potential and the length of stream corridor available for realignment based on field observations. The cost of the proposed stream restoration was estimated to be $1,835,246 for 16,370 linear feet of restoration. More detailed information on these estimates is

provided in Chapter 5. The proposed restoration represents approximately 4 percent of the total stream miles assessed (using enhanced Level I). Opportunities for additional restoration most likely exist for other areas exhibiting stream degradation in the remainder of unassessed watershed streams.

Site-Specific Urban Stormwater Management Actions

Opportunities for structural and nonstructural stormwater best management practices (SWBMP) were evaluated for the 11 key case study areas exhibiting the most severe stream bank erosion conditions. Table ES-3 provides a summary of recommended site-specific management actions. A total of 19 structural SWBMPs are included in the stormwater management plan. At locations where no single BMP can manage the whole drainage area several BMP practices have been combined to address stormwater discharges from a single outfall. For example, for outfall CS-1-3B, an oil/grit separator will be used in conjunction with an extended detention pond to provide stormwater management for the whole contributing area. In another example, maximizing the stormwater treatment for outfall CS-1-4B required the use of both a bioretention area and an infiltration trench. Additional management actions are also suggested in the form of nonstructural source controls and in minimal impact requirements for new development, riparian forest protection, rezoning, and improved sediment and erosion controls.

The total design and construction costs associated with implementation of the structural SWBMPs is estimated at $1,260,831. Cost estimates were based on construction costs and the total water volume controlled. Further explanation on cost estimates procedures is provided in Chapter 5. These costs do not include costs of land acquisition or easements or maintenance costs. The cost per acre controlled provided by this suite of structural SWBMPs is approximately $3,109/acre controlled. The overall costs per pound per year controlled for nitrogen, phosphorous, and total suspended solids are $2,068, $9,129, and $43, respectively.

Implementation Plan

The following recommendations were identified in the implementation plan:

- Management Area 1 has been given highest priority due to its proximity to the reservoir, and the primary watershed management goal of drinking water protection. It is therefore recommended that implementation of management actions, structural SWMBPs, and stream restoration actions receive the highest priority here.
- Management Area 2 has been given high priority due to the potential for land conversion and impacts of future development on the watershed stream stability and reservoir total suspended solids and total phosphorus loadings.
- Within each management area, worst-case stream stability problems and associated stream restoration and SWBMPs should receive high priority.
- Within each subwatershed, implementation of structural management actions such as SWBMPs and stream restoration should occur in the headwater areas first and proceed downstream. This will avoid the impacts of upstream construction on downstream restoration projects.
- Within each case study area, stream restoration actions should generally be implemented after construction of upstream structural SWBMPs. This will avoid

impacts of subsequent erosion and deposition that may be caused during SWBMP construction.

- Some management actions can be implemented through minor changes in existing programs. Where this is possible, these actions should be given high priority to jump-start the watershed plan implementation process.
- The success of the watershed plan and its implementation to meet the watershed management goals should be monitored through a number of methods including biological monitoring, streambank stability studies, program implementation tracking, and reservoir quality improvement monitoring.
- Within the assessed study areas the overall cost of both the proposed stream restoration and SWBMP management actions were estimated at $3,096,077.

Recommendations for supplemental analyses and study include:

- Expansion of stream assessment data collection and analysis to a sample of stream reaches that is statistically representative of the watershed as a whole.
- Additional upland habitat data collection including habitat inventory, habitat classification, baseline species, and population assessments.
- Detailed analysis of on-site septic system siting and design, including determination of nitrogen loading impacts to the Loch Raven Reservoir.
- Continued and expanded monitoring to support evaluation of the results and progress and creation of a feedback mechanism to revise original goals and objectives.
- Development of a quantitative reservoir protection goal for phosphorus using an enhanced version of the PhosMod screening model.
- Evaluation of the build-out conditions and in-stream impacts from development in RC2-zoned areas. The application of RC4 performance criteria to RC2 areas should be considered throughout the Loch Raven watershed.

Selected special studies were identified to address areas with critical unknowns, including:

- Identify and monitor stable F channels.
- Further identify and implement agricultural BMPs that provide protection from stream degradation.
- Evaluate order 1 streams in the previously assessed watersheds. Previous stream surveys focused on stream orders 2 and 3, although significant impairments of order 1 streams were observed. Selection of the streams should be based on land use, ongoing activities, management area, and new development.
- Extend the Level I stream assessment to additional subwatersheds. Options for selection of field survey sites include high-loading subwatersheds (based on SWMM analysis) not previously analyzed and high-priority retrofit sites not included in the existing case studies.
- Perform a retrofit study to evaluate opportunities for additional management of water quality. The retrofit study should include field investigation and Level I assessment of the stream channel.

Table ES.3. Summary of Recommended Site Specific Management Actions

Case Study No.	MA	Subwatershed	Location	Drainage Area (Acres)	Dominant Land Use	Proposed BMP Type(s)	Proposed Stream Restoration Alternative	Additional Management Actions
1	2	Beaverdam Run	Padonia Road, Warren Road, York Road, west of reservoir	~500	MDR, HDR	1 Detention Pond (dry) 2 Extended Detention Ponds (wet) 2 Oil/Grit Separators	1,500 linear feet of restoration to Bc type channel	Source controls for SW from roofs and driveways in residential and commercial areas.
2	2	Goodwin Run	I-83, Padonia Road	~300	HDR, MDR	2 Extended Detention Ponds	1,500 linear feet of restoration to B type channel	Improve sediment and erosion controls. Riparian forest protection.
3	2	Oregon Run	Tufton Ave, Falls Road, Oregon Ridge Park	~350	Ag, LDR	Grassed Waterways Conservation tillage Gully Prevention 1,000 Riparian Fencing	Fencing to exclude cattle and 1,870 linear feet restoration to Bc channel	Rezone area from RC2 to RC4.
4	2	Beaverdam Run	Ridge Road, Greenspring Ave, Broadway Road, Berans Road	~400	LDR	3 Detention Ponds (dry) 1 Bioretention Area 1 Infiltration Basin 1 Wetland	3,800 linear feet of restoration to Bc/B type channel	Additional outfall stabilization and energy dissipation. Riparian reforestation as requirement for new development.
5	1	Loch Raven Reservoir	Northwest portion of reservoir	~25	LDR, MDR	2 Infiltration Trenches	500 linear feet of restoration to a B4c channel with grade control provided by vortex rock weirs	On-lot SWBMPs such as bioretention, infiltration trenches. Rock-lined step pools to stabilize headcuts.
6	1	Loch Raven Reservoir	Northwest portion of reservoir	~110	LDR, MDR	1 Extended Detention Pond 1 Bioretention Area	700 linear feet of restoration to a C type channel	On-lot SW source controls for roofs and driveways.
7	1	Loch Raven Reservoir	Eastern portion of reservoir	~70	LDR, Forest	None	600 linear feet of restoration to a B4 type channel	On-lot SW source controls for roofs and driveways.
8	1	Loch Raven Reservoir	Northeast portion of reservoir	~120	Ag, LDR	Ag BMPs to minimize erosion such as grassed waterways, diversion structures, and grassed buffer strips.	1,700 linear feet of restoration to a B type channel	Expansion of parkland to preserve riparian buffer.

Case Study No.	MA	Subwatershed	Location	Drainage Area (Acres)	Dominant Land Use	Proposed BMP Type(s)	Proposed Stream Restoration Alternative	Additional Management Actions
9	1	Carroll Branch	Carroll Road, Sparks Road, Glencoe Road	~230	Ag, LDR	None	Reestablish 1,700 feet of riparian buffer on both sides of stream	Monitor existing pond outfall and downstream channel for stability changes. Potential for existing pond retrofit. Maintain forested areas within Manor Loam soils. Develop areas with minimal impact. Limit imperviousness in new developments. Limit disturbance to existing vegetation. Improve sediment and erosion controls on new developments. Encourage woodlot management.
10	4	Blackrock Run	Carmel Road, Yeoho Road, Benson Mill Road, Pretty Boy Dam Road	~300	Ag	Potential for Ag Wet pond. Ag BMPs in form of diversion structures and grassed waterways.	2,000 linear feet of restoration to Bc type channel.	Develop areas with minimal impact. Limit imperviousness in new developments. Limit disturbance to existing vegetation. Maintain vegetated riparian buffers. Stabilize road crossings.
11	3	Panther Branch	Hereford High School	~37	Inst.	None	Monitor 500 linear feet of stream for recovery	None