2.0 Watershed Planning Process

2.1 Watershed Goals and Objectives

The County's first six comprehensive watershed management plans outlined intentions for protecting, maintaining or improving streams and the measures that could be taken to meet them. Although the plans conveyed similar aims overall, there were some differences in the way goals and objectives were developed. As a result of these differences, the initial six plans were analyzed to identify common themes in order to create standardized goals and objectives for the remaining watershed management plans. Standardization improved efficiency in the planning process and achieved greater consistency among the plans.

As part of the standardization process, the County selected three overarching goals, or intended outcomes of the watershed management plans:

1. Improve and maintain watershed functions in Fairfax County, including water quality, habitat and hydrology
2. Protect human health, safety and property by reducing stormwater impacts
3. Involve stakeholders in the protection, maintenance and restoration of County watersheds

Ten objectives were developed related to the three goals. Each objective may achieve one or more goals, and each goal may be achieved by one or more objectives. These ten objectives were grouped into five categories based on certain aspects of watershed management the objectives could influence:

1. **Hydrology** - healthy movement and distribution of water through the environment in a way that is protective of streams and human dwellings
2. **Habitat** - suitable environment for sustaining plants and animals
3. **Stream water quality** - general chemical and physical properties of surface waters
4. **Drinking water quality** - quality of water used for human consumption
5. **Stewardship** - the roles the County, other jurisdictions and members of the general public can play in caring for the environment

Under the new approach, County staff and the public had the flexibility to add objectives that were unique and important to a particular watershed, but all plans included the standard goals and objectives as a baseline as presented in Table 2.1

Table 2.1
Countywide Objectives

Objective	Linked to Goal(s)
CATEGORY 1. HYDROLOGY	
1A. Minimize impacts of stormwater runoff on stream hydrology to promote stable stream morphology, protect habitat, and support biota.	1
1B. Minimize flooding to protect property and human health and safety.	2

Table 2.1 Countywide Objectives	
Objective	**Linked to Goal(s)**
CATEGORY 2. HABITAT	
2A. Provide for healthy habitat through protecting, restoring, and maintaining riparian buffers, wetlands, and instream habitat.	1
2B. Improve and maintain diversity of native plants and animals in the County.	1
CATEGORY 3. STREAM WATER QUALITY	
3A. Minimize impacts to stream water quality from pollutants in stormwater runoff.	1, 2
CATEGORY 4. DRINKING WATER QUALITY	
4A. Minimize impacts to drinking water sources from pathogens, nutrients, and toxics in stormwater runoff.	2
4B. Minimize impacts to drinking water storage capacity from sediment in stormwater runoff.	2
CATEGORY 5 STEWARDSHIP	
5A. Encourage the public to participate in watershed stewardship.	3
5B. Coordinate with regional jurisdictions on watershed management and restoration efforts such as Chesapeake Bay initiatives.	3
5C. Improve watershed aesthetics in Fairfax County.	1, 3

Standardizing the goals and objectives made it easier to integrate plan recommendations into a countywide data management system for prioritizing projects, tracking implementation and evaluating the long-term influence of the plans on the health of County streams.

2.2 Indicators

Since accomplishment of objectives cannot be directly measured, indicators that are able to detect changes in the watershed were developed. Indicators are used to assess the condition of the environment, as early-warning signals of changes in the environment, and to diagnose causes of ecological problems. *Observed* indicators are based upon data and observations collected in the field/area of interest, and are useful in assessing existing watershed conditions. *Predictive* indicators respond in a predictable manner to ecosystem stressors, and can be used in models of hydrologic and ecosystem processes (such as soil erosion, pollutant loading, etc.) to compare existing and future conditions.

Each indicator was measured by one or more metrics. A metric is an analytical benchmark that responds in a predictable way to increasing human, climatic or other environmental stress. Metrics may be actual numeric values (such as pH or Dissolved Oxygen values) or parameters that have been scored to a numeric scale (such as 1 – 10).

The indicators used by Fairfax County may be grouped into the following categories:

- **Watershed Impact Indicators –** Measure the extent that reversal or prevention of a particular watershed impact, sought by the goals and objectives, has been achieved ("What's there now, and how is it doing?").
- **Source Indicators –** Quantify the presence of a potential stressor or pollutant source ("Is there a problem, and what's causing it?").
- **Programmatic Indicators** –After the plans are adopted, these will assess outcomes of resource protection and restoration activities ("What's the County doing about the problem, and how is it doing?").

2.2.1 Watershed Impact Indicators

One or more watershed impact indicators for each objective were identified, including predictive and observed indicators. These indicators and the objectives to which they are linked are shown in Table 2.2.

Table 2.2
Watershed Impact Indicators

Objective	Indicators
1A Stormwater Runoff	Observed: Benthic Communities, Fish Communities, Aquatic Habitat Predictive: Channel Morphology, Instream Sediment, Hydrology
1B Flooding Hazards	Observed: Flood Complaints Predictive: Number of Road Hazards, Magnitude of Road Hazards, Residential Building Hazards, Non-residential Building Hazards
2A Habitat Health	Observed: Aquatic Habitat Predictive: RPA Riparian Habitat, Headwater Riparian Habitat, Protected Wetland Habitat
2B Habitat Diversity	Observed: Benthic Communities, Fish Communities Predictive: None
3A Stream Water Quality	Observed: *E. coli*, Benthic Communities, Fish Communities Predictive: Upland Sediment, Instream Sediment, Nitrogen, Phosphorus
4A Drinking Water Quality	Observed: *E. coli* Predictive: Nitrogen, Phosphorus, Upland Sediment
4B Storage Capacity	Observed: None Predictive: Upland Sediment, Instream Sediment
5A Public Participation	Programmatic Indicators to be tracked by the County

Table 2.2 Watershed Impact Indicators	
Objective	**Indicators**
5B Regional Coordination	Programmatic Indicators to be tracked the County
5C Aesthetics	Programmatic Indicators to be tracked the County

For predictive indicators, three scenarios were considered. Metrics and scores were calculated for:

- Existing conditions
- Future without project implementation
- Future with project implementation

The future condition metrics and scores reflect the simulated conditions at ultimate build-out based on the County's Comprehensive Plan.

The watershed impact indicator scores were used at multiple stages of watershed planning. First, they were used to assess current and future conditions without project implementation in the watershed. Indicator scores were then used to identify management needs and problem areas during subwatershed ranking (see Section 2.3). Once candidate projects were identified, the indicators were used to prioritize projects alongside cost and feasibility.

2.2.2 Source Indicators

Source indicators were used to evaluate the sources and stressors that impact watershed processes. Examples include:

- Numeric Source Indicators
  - Amount of Channelized/Piped Streams
  - Amount of Directly Connected Impervious Area (DCIA) (predictive)
  - Amount of Impervious Surface (predictive)
  - Number of Stormwater Outfalls
  - Number of Sanitary Sewer Crossings
  - Streambank Buffer Deficiency
  - Total amount of Nitrogen (predictive)
  - Total amount of Phosphorus (predictive)
  - Total Suspended Solids (predictive)
- Field Reconnaissance Observations
  - Hot Spot Investigations
  - Neighborhood Source Assessments
  - All other field reconnaissance observations

The contributions of these indicators to existing and future watershed impacts were evaluated. Metrics and scores were developed for all source indicators under existing conditions. In addition, three scenarios were considered for the predictive indicators, as noted in the list above. Metrics and scores were calculated for these scenarios:

- Existing conditions
- Future without project implementation
- Future with project implementation

The future condition metrics and scores reflect the simulated conditions at ultimate build-out based on the County's Comprehensive Plan.

Like the watershed impact indicators, source indicator scores were used to rank subwatersheds according to their problems and needs and to assist with candidate project identification.

2.2.3 Programmatic Indicators

Programmatic indicators will be used by the County to help evaluate watershed management needs. These indicators illustrate the extent and location of existing and past management efforts. The following types of management in the watershed were inventoried during plan development:

- Detention Facilities
- Stream Restoration
- Riparian Buffer Restoration
- BMP Facilities
- Low Impact Development
- Inspection and Maintenance of Stormwater Management Facilities
- Inspection and Repair of Stormwater Infrastructure and Outfalls
- Dumpsite Removal
- Regional Ponds
- Volunteer Monitoring
- Subarea Treatment (used in watershed modeling studies)

Information for these indicators will be considered to identify and evaluate watershed management needs for individual watersheds and for the County as a whole.

2.2.4 Composite Scores

After metric values were translated into scores, objective, composite and overall composite scores were calculated for use in subwatershed ranking. Weighting factors were used when calculating composite scores to give more importance to certain indicators and objectives. First, watershed impact indicators were grouped by objective. Each metric score was multiplied by a predetermined weighting factor specific to that indicator, and the products were summed within objectives to generate an objective composite score for each objective. Each objective composite score was then multiplied by a predetermined weighting factor specific to that objective, and the products were summed to generate an overall composite score. A similar process was used for source indicators, but without an objective composite score (since source indicators are not directly linked to objectives).

2.3 Subwatershed Ranking

The composite scores calculated under the methods previously described were used to identify problem areas in the watershed and rank subwatersheds for management priority. Subwatersheds were further categorized based on which management opportunities were most likely to restore functions to the problem areas identified. The resulting data were then utilized to identify key issues and select projects that would achieve the watershed planning goals and objectives.

The subwatershed ranking procedure involved reviewing watershed impact objective, composite, overall composite and source indicator scores. Since some of the indicators are predictive, i.e. based on modeling, it was possible to pose "what if?" questions and test future scenarios with and without management actions. Existing management facilities and programs which were inventoried for programmatic indicators and data collected during field reconnaissance were also considered. The ranking process consisted of the following steps:

1. Used the watershed impact overall composite scores and identified subwatersheds that were potential problem areas under existing and future conditions.
2. Used the watershed impact objective composite scores and identified subwatersheds that were potential problem areas under existing and future conditions for each objective.
3. Reviewed source indicator composite scores and identified additional problem areas.
4. Used individual source indicator scores to identify potential sources of impacts in downstream problem areas.
5. In combination with the above data, used the programmatic indicator data inventory to identify subwatersheds where management was most needed.
6. Consulted available field reconnaissance data throughout the above steps to confirm that results reflected conditions in the field.

All this information was combined to rank subwatersheds in order from the most problematic (higher priority for management actions) to the least problematic (lower priority for management actions). Subwatershed ranking provided guidance as to where management was most needed and could be applied successfully, but the final determination was ultimately based on best professional judgment.

2.4 Stormwater Modeling

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 both predict the ability man-made culverts/channels have in conveying stormwater runoff and the spatial extent of potential flooding.

Table 2.3 shows three storm events and the rationale for being modeled:

Table 2.3
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

2.4.1 Hydrologic Model (SWMM)

The Environmental Protection Agency (EPA) Storm Water Management Model (SWMM) was first developed in the early 1970s. Over the past 30 years, the model has been updated and refined and is now used throughout the country as a design and planning tool for stormwater runoff. Specifically, SWMM is a dynamic rainfall-runoff simulation model used for single event or long-term (continuous) simulation of runoff quantity and quality from primarily urban areas.

The runoff component of SWMM operates on a collection of subwatershed areas where rain falls and runoff is generated. The routing (or hydraulic) portion of SWMM transports this runoff through a conveyance system of pipes, channels and storage/treatment devices. SWMM tracks the quantity and quality of runoff generated within each subwatershed, and the flow rate and depth of water in the conveyance system during a simulation period.

2.4.2 Pollution Model (STEPL)

While the SWMM model can calculate pollutant loads, the Spreadsheet Tool for Estimating Pollutant Load (STEPL) was used to determine pollutant loads for the watershed planning effort. Also developed by EPA, STEPL employs simple algorithms to calculate surface runoff. This includes nutrient loads, such as nitrogen and phosphorus, and sediment loads from various land uses. STEPL also calculates load reductions that would result from the implementation of various Best Management Practices (BMPs). The nutrient loading is calculated based on the runoff volume and the pollutant concentrations in the runoff as influenced by factors such as land use distribution and management practices. Sediment loads are calculated based on the Universal Soil Loss Equation (USLE) and the sediment delivery ratio. The sediment and pollutant load reductions that result from the implementation of BMPs are computed using known BMP efficiencies.

2.4.3 Hydraulic Model (HEC-RAS)

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.

The geographic input data for the HEC-RAS model was extracted using HEC-GeoRAS. HEC-GeoRAS 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.

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. This crossing data was 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.

2.5 Public Involvement Plan

A consistent approach for public involvement was important to enable comparisons among planning processes and final watershed management plans. Conversely, as each watershed has unique characteristics, the strategies employed must also address the diverse needs, interests and conditions of the watershed and its community. The principal goals for public involvement were:

- Increase community awareness and understanding of stormwater management
- Provide meaningful participation options for a diversity of stakeholders
- Incorporate community ideas into the scope of the watershed plans
- Strive for community support for the final plans

Recognizing the need for public acceptance of the final plans, County staff created a public involvement process with multiple feedback loops to facilitate informed participation by the public and key stakeholder groups at all development stages. The first step of the public involvement process was to host an Introductory and Issues Scoping forum that was open to all residents. The primary purpose of this forum was to solicit informed input on the development of the watershed management plan. Other objectives were to explain the planning process to the community and develop an initial list of watershed issues and concerns.

After the forum, stakeholder groups were invited to be part of a Watershed Advisory Group (WAG) for each plan. These were comprised of local stakeholders who represented various interests (HOA representatives, environmental groups, etc) and advised County staff about community outreach opportunities and key issues affecting their watershed and potential projects. They also were invited to comment on draft and final versions of the watershed management plan. Each WAG met with County staff five to six times throughout the plan development in order to provide guidance and comments at critical junctures of the process.

The WAG also provided support at the second public forum, the Draft Plan Review Workshop. The workshop provided the extended community with an opportunity to review the first draft of the watershed plan and provide input. Comments were collected at the end of a 30-day period and addressed as appropriate. The final plan was then adopted by the Board of Supervisors.

More information on the public involvement process including WAG meeting minutes, public forum meeting minutes and public comments and responses can be found in Volume 2, Appendix C.