The Wetlands-At-Risk Protection Tool

A five-step process to identify and protect wetland functions

2010

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About this Project

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Introduction

The Wetlands-At-Risk Protection Tool, or WARPT, is a process for local governments and watershed groups that acknowledges the role of wetlands as an important part of their community infrastructure, and is used to develop a plan for protecting at-risk wetlands and their functions. The basic steps of the process include quantifying the extent of at-risk wetlands, documenting the benefits they provide at various scales, and using the results to select the most effective protection mechanisms.
To begin using the WARPT, complete the quick characterization of wetlands in your community provided in Attachment A. Not a wetland expert? Don't worry, the characterization is simple to complete, and should help determine which portions of the WARPT are right for your community or watershed. Most of the WARPT steps require some expertise in mapping and/or wetland science, and these may be completed in-house if the expertise is available or by contracting with a wetland expert. The Washington State Department of Ecology provide some excellent tips for hiring a qualified wetland professional, as do the Association of State Wetland Managers in their document How to Hire the Right Wetlands Consultant, and the EPA provides information on federal and state funding sources for wetlands protection and restoration that may be used to fund implementation of the WARPT in your community.

What are Wetlands at Risk?

Wetlands-at-risk are those that are vulnerable to impacts from development or other land use activities and that have little protection from these impacts through federal, state or local measures. Many states, tribes, and local governments rely solely on the Clean Water Act to protect their wetland resources. Recent court rulings (see SWANNC and Rapanos) have highlighted potential gaps in this protection, prompting state and local governments to inventory their wetlands that may no longer be considered 'jurisdictional' and try to fill in these gaps. Yet, the reality is that even streams and wetlands that are regulated under the Clean Water Act may be at risk of being filled or otherwise impacted for two key reasons:

1. The Clean Water Act Section 404 is a permitting program under which permits for disposal of dredge or fill material into wetlands are issued all the time. Just because a wetland is regulated under this program does not mean it can never be filled.
2. The Section 404 program does not regulate all types of activities, such as discharges of stormwater runoff into wetlands, and removal of wetland vegetation.

Given this, in many rapidly developing areas of the country, almost all wetlands can be considered at-risk unless some kind of permanent protective measure (e.g., a conservation easement, protective zoning) is in place to prevent their destruction.

Who Should Use the WARPT?

The WARPT is recommended for all local governments (counties, cities, towns, boroughs, townships) because these entities have control over land use practices that ultimately determine the extent of indirect impacts to wetlands. The WARPT can also be used by watershed groups as a tool to help identify, protect, and restore wetlands in their watershed.

Since most local governments and watershed groups have limited resources, it may not be possible for them to protect all their wetlands. The WARPT process allows communities to target resources towards protecting the most sensitive or vulnerable wetlands, or the ones that provide the most benefit to the community, while still allowing for growth. The WARPT process can bring to light the important functions performed by wetlands, the loss of which would contribute to environmental and/or economic problems for the community. This can be an important selling point to elected officials when weighing the costs and benefits of resources protection versus growth. Every community operates under a unique set of environmental issues, politics, history, and resources and is subject to differing state and local regulations. Therefore, the WARPT is not a one-size-fits-all process. It is scalable and flexible. It is not necessary for every community using the WARPT to complete the entire process.

An important note is that although the WARPT process assigns values to individual wetlands or wetland types and identifies priority wetlands in a community, this designation does not replace the need for jurisdictional determinations under the Clean Water Act Section 404. In addition to implementing local protection for at-risk wetlands, communities can provide their results to the local Army Corps district office to aid in making these decisions based on wetland functions.

What Scale is Appropriate for the WARPT?

The WARPT can be completed at three different scales, depending on community needs, interest and available resources, as described below.

Watershed scale

This is the ideal scale for managing wetlands because of the important relationship between wetlands and watersheds. The capacity of wetlands to attenuate floods, absorb pollutants, recharge groundwater, provide wildlife habitat, and protect erodible shorelines are important watershed functions. Despite performing these critical functions, wetland managers typically regulate wetlands on a site-by-site basis, an approach that fails to consider cumulative wetland functions. Communities are realizing they can only solve their water resource problems by using a watershed approach. The watershed approach requires a broader understanding of how wetlands function within the watershed and the benefits they provide. Completing the WARPT at this scale allows communities to make better choices on preserving the highest quality wetlands, protecting the most vulnerable wetlands, realize improved achievement of watershed goals and ability to allocate lands to their most appropriate uses.

Subwatershed scale

This is a variation on the watershed approach but involves targeting resources towards one or more subwatersheds that have been identified as high priority (for protection or restoration) within a local watershed plan. This is a more cost-effective option for completing the WARPT because it requires fewer resources, but still preserves the idea of managing water resources along drainage boundaries. A phased approach can be used to update wetland maps and complete the rest of the WARPT in the remaining subwatersheds over time. Another advantage to the subwatershed approach is that a subwatershed (e.g., less than 10 square miles) is more likely to be located within a single jurisdiction, as opposed to larger watersheds (e.g., 10-100 square miles) that may cross jurisdictional boundaries.

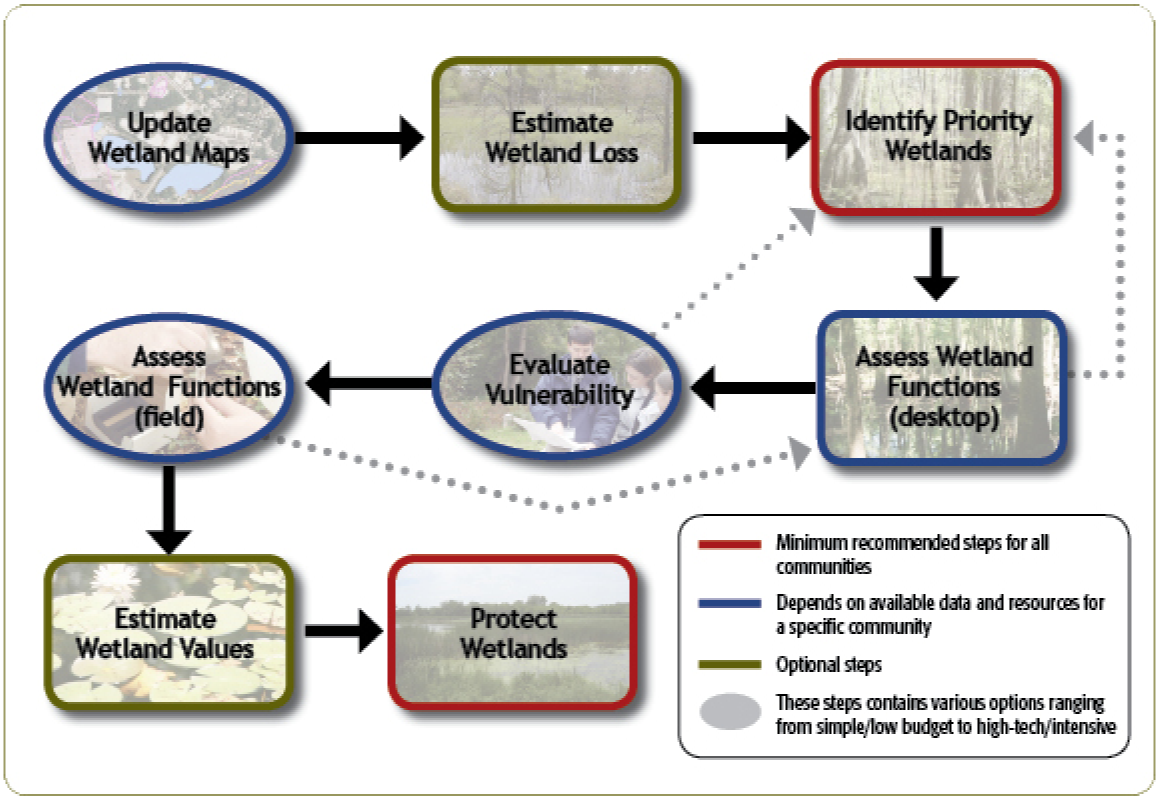
Jurisdiction scale

Most communities manage their water resources at the jurisdiction scale since these are the lands they have control over. While this is certainly a viable and practical approach, another option that may be effective in rural areas is for multiple small communities to pool their resources to complete the WARPT at a regional watershed scale. This requires strong partnerships and coordination but can be a valuable experience for each community to see their contribution to the watershed as a whole.

Why do the WARPT?

Each step of the WARPT process provides a unique result that addresses one aspect of a comprehensive wetland protection strategy and may also help to meet other community objectives.

For each of these major endpoints, several possible variations are presented that range from simple and low-budget to high-tech and intensive, with greater accuracy of results on the higher budget end. The WARPT can also be done in stages, using results of earlier stages to sell the need to local officials to complete remaining steps. The information below describes how the results of each step may be used, to help determine which ones are most useful for your community.



Step 1. Update Wetland Maps

The end result of this step is an updated local wetland map. This step is particularly useful for communities whose wetlands maps are outdated or are not very accurate or comprehensive. Communities that have recently updated wetland maps and whose maps include all wetland types, regardless of size or connection to perennial waters may skip this step and move on to Step 2.

Why update wetland maps?

- It is easier to protect wetland resources when you have detailed maps of their locations and types.
- Provides up-front information or prioritization to inform local plan review and Clean Water Act Section 404 evaluations.

Step 2. Estimate Wetland Loss

This optional step results in an estimate of historic wetland loss through a wetland mapping analysis.

Why estimate wetland loss?

- This is a good first step towards identifying potential sites for wetland restoration, which may be a goal for communities that have lost a lot of their wetland coverage. The results can be used to help set targets for wetland restoration in terms of acreage and types.

- Quantifying the extent of wetland loss and estimating the functions and values of these lost wetlands can help to make the case for wetlands protection and restoration to local decision makers.

Step 3. Identify Priority Wetlands

The end result of this step is a map of priority sites for wetland protection and/or restoration. Most communities will need to do this important step, which includes three substeps: 3a) assess wetland functions (desktop), 3b) evaluate vulnerability and 3c) assess wetland functions (field). It is recommended that, at a minimum, communities complete 3a and 3b. Step 3c can be completed later on as resources permit or it can be integrated into the plan review process as a required element. If you've already identified priority wetlands for conservation and/or restoration, you can skip this step and move on to Step 4.

Why identify priority wetlands?

- Prioritizing wetlands helps to target limited resources to those sites that are most important for providing the functions/services of interest to the community (e.g., drinking water, recreation, flood control) and are most vulnerable to impacts from development pressure or other planned activities.
- The resulting map of priority sites can be used in a number of ways:
  - Determine wetland areas to include in sending zones for a transfer of development rights program or target areas for purchase of development rights or conservations easement program.
  - Include wetlands important for flood protection in community floodplain program.
  - Incorporate priority wetlands into wetland protection ordinance or zoning, and conservation planning for the community and/or watershed.
  - Provides a ready list of wetland sites to include as part of a wetland banking program.
  - Provide this map to state and federal agencies as an information tool in making jurisdictional determinations that require information on wetland functions.
  - Provides a ready list of sites as part of an off-site mitigation program for stormwater or wetlands/streams and for wetland restoration projects.

Step 4. Estimate Wetland Values

The end result of this step is an estimate of values provided by wetlands in your community. If the public is not convinced that wetlands have value, and dollar signs are what sways your local decisions makers to make changes, this step may be helpful in your community. An initial estimate can be derived using data from existing studies to make the case for doing the complete WARPT process. A more detailed economic analysis of wetland values is more costly and time consuming but the data generated can then be used to make an informed decision regarding the future use of individual wetlands based on the true costs and benefits of proposed development versus resource conservation.

Why estimate wetland values?

- Placing a dollar value on the wetland benefits that could potentially be lost with future wetland impacts helps to make the case for wetlands protection and restoration.

Step 5. Protect Wetlands

The end result of this step is a plan for protecting wetlands locally using regulatory or voluntary measures. This is the most important step of the WARPT! Even if your state or municipality already has a regulation that protects wetlands, it may not fully protect your community's priority wetlands from all impacts. A combination of regulatory and voluntary measures to protect wetlands from direct and indirect impacts is usually most effective. Decisions about which techniques to use will be based on the existing local programs and regulations, political climate and available resources.

Why protect wetlands?

- Wetlands provide important services to communities such as flood storage, maintenance of water quality, erosion control, and recreation and educational opportunities.
- Wetland protection at the local level is important because that is where land use decisions are made.

Step 1: Update Local Wetland Maps

It is much easier to protect wetland resources when you have good maps of their locations and types. In addition, wetland maps provide "red flag" or up-front information or prioritization to inform local plan review and Clean Water Act Section 404 evaluations. Some states and local jurisdictions have a detailed and reasonably accurate wetlands mapping layer. However, many jurisdictions rely solely on the National Wetlands Inventory (NWI), maintained by the U.S. Fish and Wildlife Service (FWS). The NWI is the most comprehensive digital coverage of United States wetlands available and serves as a primary source of wetland mapping data for the country. However, the NWI does have a number of data limitations that suggest an update may be beneficial before it is used in subsequent steps of the WARPT:

- As of 2010, digital NWI maps are available for approximately 61% of the country; much of the data are over 20 years old (Tiner, 2009).
- Federal funding has typically only allowed for an average of less than two percent of the national wetlands map to be completed each year (Awl et al., 2009; Tiner, 2009).
- In addition, the NWI typically does not include wetlands smaller than one to three acres, ephemeral wetlands, farmed wetlands, and certain wetland types that are difficult to interpret from aerial photos.

Several options that are available for updating wetland maps include digitizing directly from digital imagery, manual stereoscopic interpretation, and using wetland indicator layers to identify potential wetlands.

Determine if an Update to your Local Wetland Maps is Necessary

Whether your community relies on the NWI for its wetlands mapping or has a state, regional or local wetland map, the following questions should be considered to determine if an update to these maps is necessary to help strengthen local wetland protection:

- How old are the data? Has there been much recent development activity since the maps were created?
- What is the resolution of the data or minimum mapping unit?
- Are there known issues or inaccuracies with the data?

To determine the status of wetland mapping in your area, check with the following sources:

- Your local planning or natural resources department may have developed a wetlands map, or have included wetlands as part of a local land use/land cover layer.
- Association of State Wetland Managers Wetland Mapping highlights the latest state-level wetland mapping efforts and State Wetland Programs provides information and links for individual states to determine the status of state wetland maps.
- To determine whether digital NWI maps are available, refer to Regional Wetlands Coordinators. At the main NWI page, you can download digital data, order hard copy maps, and obtain metadata that describes when the maps were created for your region and identifies the minimum mapping unit.
- Natural Resources Conservation Service (NRCS) Wetland Determinations (aka "Swampbuster" maps) were used to determine compliance with swampbuster provisions in the 1985 Farm Bill and

are available as paper maps only for individual sites. However, many of these wetlands are isolated and small (<1 ac), which are easily missed on NWI and other wide-scale maps or imagery. They may be useful to supplement your NWI by digitizing the wetland boundaries. Contact your local or regional NRCS office to access these maps.

- If the wetland maps available from the above sources are outdated or there has been a lot of recent development activity in your community, the U.S. Army Corps of Engineers (USACE) Section 404 Permit Wetland Determinations may be useful to identify wetlands for which some type of permitted impact or mitigation has been authorized You can request this information from your USACE district office.

In general, if your wetland maps are more than 20 years old (10 if there has been a lot of recent development), has known inaccuracies, or is of a relatively small scale (e.g., smaller than 1:40,000), you should consider updating the maps. On the other hand, if your wetland maps include very small wetlands (e.g., less than 1 acre), as well as wetlands associated with intermittent and ephemeral streams, they are probably of sufficient detail to protect wetlands locally and you can continue on to Steps 3, 4 and 5 of the WARPT.

Options for Updating Wetland Maps

Several options are available for updating local wetland maps (Table 1.1). The most accurate yet resource intensive methods include digitizing or photo-interpreting wetlands directly from digital imagery or high resolution aerial photos. To offset the associated costs, agencies and organizations may want to collaborate on a regional basis to acquire imagery (which has many uses besides wetland mapping) and/or mapping wetland resources. Potential partners may include: land trusts, non-profits, transportation and utility departments, universities, federal and state agencies, private consultants, and regional governing bodies. For additional information on identifying partners and building mapping coalitions, refer to Stetson (2009), Christie and Stetson (2009), and NACo (2007).

One option is to hire a government agency like the U.S. Fish and Wildlife Service (FWS), one of its mapping contractors, or a mapping company/organization with experience applying the Federal Geographic Data Committee's (FGDC) wetland mapping standard. The U.S. FWS may be interested in a wetland mapping project if it covers a relatively large geographic area and falls within one of their priority areas. Costs for these services vary with the type and density of wetlands in a geographic area, the recency of the NWI data, and the availability of digital data sources (e.g., land use/cover and soils).

Some of the wetland mapping contractors utilized by the U.S. FWS include:

Conservation Management Institute
Virginia Polytechnic Institute and State University
1900 Kraft Street
Blacksburg, VA 20160
(540) 231-8825

St. Mary's University of Minnesota
Department of Resource Analysis
360 Vila Street #7
Winona, MN 55987
(507) 457-8712

Atkins North America
1616 East Millbrook Road
Suite 310
Raleigh, NC 27609
(919) 431-5276

Contact your U.S. FWS Regional Wetland Coordinator for other possible contractors.

Some additional partners for wetland mapping include:
- Statewide GIS Coordinators know about mapping efforts within the state where they are located.
- USGS National Spatial Data Infrastructure (NSDI) Specialists are knowledgeable about mapping efforts within federal agencies.
- The Farm Services Agency does aerial photography on a regular basis.
- The Farm Services Agency does aerial photography on a regular basis.

Table 1.1. Wetland Mapping Methods

Method	**Description**	**Limitations**	**Resources**
“Heads-Up” method of wetland delineation	Digitize wetlands directly from digital imagery	Requires image analysts experienced in the identification and classification of wetlands	Dahl et al.(2009)

Table 1.1. Wetland Mapping Methods			
Method	**Description**	**Limitations**	**Resources**
Manual stereoscopic interpretation	Stereoscopic viewing of aerial photos to interpret them in three dimensions and delineate wetlands	Requires photo interpreters who can see in stereo and have an understanding of surface water hydrology and wetland ecology	USFWS (1995)
Addition of “potential wetlands” to existing wetland maps	Use wetland indicator layers to identify areas with high likelihood of wetland presence	Requires field confirmation of wetland presence and boundaries	Munoz et al. (2009) Ralph Tiner

A less intensive method of improving local wetland mapping is to use wetland indicator layers to identify potential wetlands using Geographic Information Systems (GIS). Ralph Tiner of the U.S. FWS has developed a method to identify potential wetlands based on hydric soils, while Munoz et al. (2009) describe such a method for identifying potential isolated wetlands. The State of Wisconsin has used the former method to develop a map of “potential wetlands” (Figure 1.1). The Munoz et al. (2009) method may be most useful in regions with a known abundance of isolated wetland types that are insufficiently mapped. However, the method may need to be adapted for the isolated wetland types in your region. This analysis can be done with in-house GIS staff in conjunction with a wetland consultant, or may be contracted out if GIS capabilities are not available within your jurisdiction. If the results are to be incorporated into local wetland maps and assigned wetland functions, field verification of all “potential wetlands” is needed to confirm that they exist.

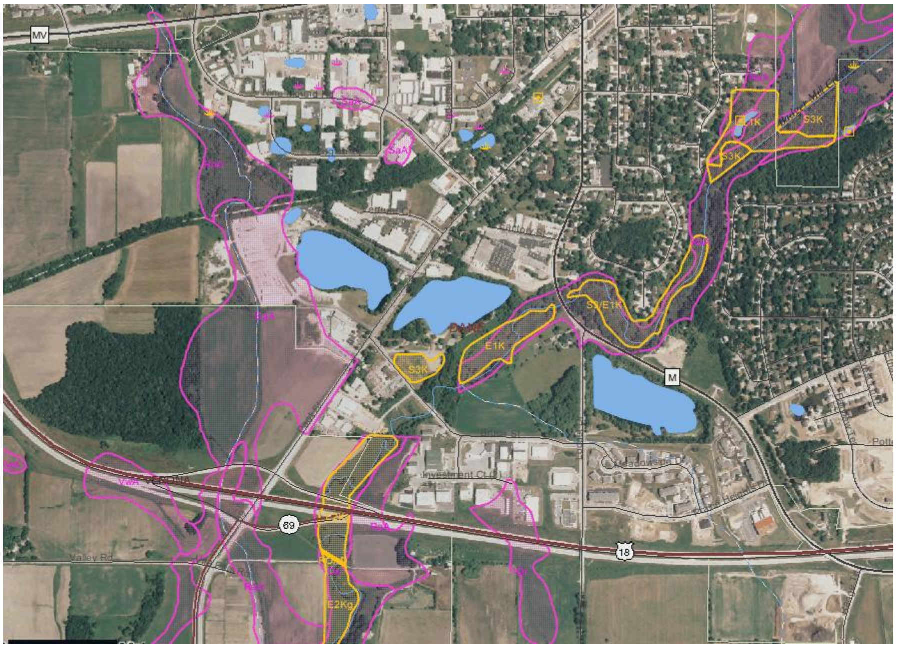


Figure 1.1. Map of wetlands (shown in orange) and potential wetlands (shown in pink) for Verona, Wisconsin (source: http://dnr.wi.gov/wetlands/mapping.html)

Whichever mapping method is used, you should be aware of the recently implemented Federal Geographic Data Committee (FGDC) wetland mapping standard. Compliance with these standards is required for all federal agencies and other organizations that use federal funds to map wetlands. However, states, local governments, and non-profit organizations are also encouraged to utilize the wetland mapping standard in an effort to contribute to the national wetland mapping effort being conducted by the U.S. FWS. An average of less than two percent of the national wetlands map is completed per year due to funding limitations. The mapping standard will allow diverse groups to produce wetlands mapping data that is compatible and consistent in quality so that it can be included in the NWI (Awl et al., 2009).

The basic FGDC wetland mapping standard requirements are listed below. For a more comprehensive list, refer to FGDC (2009). In addition, the U.S. FWS has created a companion document to the FGDC wetland mapping standard (Dahl et al., 2009) that describes the technical procedures and requirements for wetlands map data. It explains the appropriate application of wetland classification, wetland mapping process, and how to achieve the data quality requirements now required by the wetland mapping standard. The U.S. FWS, in conjunction with USGS, have developed customized GIS tools for performing data checks on wetland map data. These Attribution and Verification Tools are extensions to the ESRI ArcMap desktop software and have been designed to address geo-positional errors, digital anomalies, and logic checks for data included in the NWI. A Wetland Mapping training course is also available from the U.S. FWS for learning how to successfully submit standards-compliant wetlands geospatial data to the NWI.

- Imagery should have a minimum resolution of 1 m
- Wetland classification following Cowardin et al. (1979)
- Topological verification (how point, line, and polygon features share coincident geometry)
- Valid attribute coding for wetland habitat type
- Metadata should conform to the most recent FGDC Content Standard for Digital Geospatial Metadata (CSDGM).

For additional information on the process of contributing your data to the Wetlands Master Geodatabase, please visit http://www.fws.gov/wetlands/WetlandsLayer/ContributedData.html.

Step 2: Estimate Wetland Loss

On a national basis, it is estimated that around 53% of wetlands present at the time of European settlement in the early 1600s have since been lost for the conterminous U.S. (Dahl and Johnson, 1991). Six states lost 85% or more of their original wetland acreage, while twenty-two lost 50% or more (Dahl, 1990). If wetland losses from agriculture and urban development have been significant in your community, it is likely that your community has also lost valuable functions provided by these wetlands, such as flood storage or water quality. Historic wetland data can provide some insight into the extent of wetland losses and can help to make the case for protecting remaining wetlands. A more detailed mapping exercise can also be completed to estimate the extent, types and functions associated with historic wetlands. These maps can also provide the basis for identifying potential sites for wetland restoration to replace lost wetland functions. For some communities, historic maps and other data that provide an estimate of historic wetland coverage may be readily available. If this is the case, all that may be required is scanning, digitizing and/or geo-referencing old maps, or weeding through a large dataset to pull out and compile data for your area of interest. Some potential sources of historic wetlands data include:

- U.S. Fish and Wildlife Service (USFWS) Status and Trends reports. Dahl (1990) provides state-wide estimates of wetland losses from the 1780s to the 1980s. Other reports provide state or region-wide estimates of wetland losses documented since the 1950s.
- Old U.S. Geological Survey maps

- General Land Office Survey Maps and Notes, which are surveys conducted of newly acquired U.S. territories by the General Land Office (GLO) that was formed in 1812.
- Statistics on acres and types of wetlands filled under Section 404 permits can be obtained from your U.S. Army Corps of Engineers (USACE) District Office.
- Historic maps and vegetation surveys and interviews with botanists familiar with local historical plant communities. Old maps may be available from local libraries or natural heritage agencies.
- For some areas of the country, the NWI contains historic wetlands map Information. Information about the wetland types, vegetation, regional and temporal conditions and geographic features are captured in a historic map document. This document can be accessed by selecting a wetland polygon on the Wetlands Mapper and then clicking on the link next to "Historic Map Info" in the pop-up window.
- The NRCS Natural Resources Inventory data, a statistical survey of land use and natural resources conditions and trends on non-federal lands, can provide a general estimate of wetland losses on a state or national level for specific time periods.
- NRCS Wetland Determinations (aka "Swampbuster" maps) were used to determine compliance with swampbuster provisions in the 1985 Farm Bill. These wetland determinations are available as paper maps only for individual sites and contain wetlands classified as Prior Converted (PC) or Farmed Wetlands (FW). Prior converted wetlands are those converted to a non-wetland state prior to 1985. Farmed wetlands are those manipulated and planted prior to 1985, but that still meet wetland criteria. Digitizing these wetlands may be useful to supplement your map of historic wetlands.

Note that the above sources may simply provide an estimate of historic wetlands acreage that can then be compared to current wetland acreage to quantify loss. Specifics on wetland types, locations, and functions may not be available from these sources. Also, keep in mind that differences in the quality and resolution of historic and current wetland datasets will influence the results; for instance, the data may show "no change" or even a net "gain" in wetlands due to these inconsistencies. If a historic wetland map does not exist for your community, has known inaccuracies, or is of a relatively small scale (e.g., smaller than 1:40,000), using wetland indicator layers to map historic wetlands provides a method to generate a detailed map of historic wetlands.

Step 3: Identify Priority Sites for Wetland Conservation and/or Restoration

Once your community has an updated local wetland map, identifying priority wetland sites for conservation and/or restoration is an important step to guide decisions about how to target wetland programs, funding, and local regulations. This step is especially useful for communities with extensive wetland resources who wish to accommodate future growth while protecting the most sensitive or valuable lands. It is recommended that communities include prioritization of wetlands as part of broader-scale conservation and/or restoration planning efforts. This may include watershed plans, regional green infrastructure assessments, wildlife action plans, and habitat conservation plans.

This analysis can also be conducted as part of a service provided by the U.S. Fish and Wildlife Service (FWS), its primary cooperator, Virginia Tech's Conservation Management Institute, or an organization or firm with experience in these techniques. This service generates an historical assessment of pre-settlement wetland types, acreage, functions and general trends; a watershed characterization of current wetland status and functions; and an identification of potential wetland restoration sites. Costs for these services vary with the type and density of wetlands in a geographic area, the amount of historic loss, the age of the NWI data, and the availability of digital data sources (e.g., land use/cover and soils).

The criteria used to prioritize sites for conservation and restoration is different, but the overall process is the same:

1. Identify potential sites for conservation/restoration from local wetland maps
2. Rank sites based on specific criteria derived from mapping
3. Evaluate top sites (or all sites) in the field to collect more detailed site information (optional)
4. Revise ranking to reflect field conditions (optional)

Note that if the process of updating your wetland maps has resulted in a new map of "potential wetlands," there are three options for dealing with these sites in the ranking exercise: 1) field-verify all potential wetlands before including them in the ranking; 2) rank these sites separately; or 3) leave these sites out of the ranking entirely, and evaluate them on a case-by-case basis over time as resources become available to conduct field verifications.

Step 1. Identify potential sites for conservation/restoration from local wetland maps

To identify potential sites for wetland conservation, we suggest that communities begin by using their local wetland maps and making a preliminary assessment of wetland function to identify specific wetlands that have high or moderate potential to provide the functions of interest to the community (e.g., flood control, shoreline protection). The preliminary assessment of wetland function assigns wetland functions to wetlands in the community by adding abiotic and landscape feature descriptors through a desktop GIS exercise. While field assessments of individual wetlands are necessary to more accurately evaluate wetland functions, a remote sensing approach to estimate wetland function provides a cost-effective way to rapidly identify priority sites for conservation and/or restoration. It is considered preliminary because on-the-ground conditions can affect wetland functions and these must be evaluated in the field (see Step 3).

Potential sites for wetland restoration include former wetlands or existing degraded wetlands. These can be identified using maps of historic wetlands, and local wetland maps using a method described by Tiner (2005). Potential restoration sites include:

Former wetlands with:

- effectively drained hydric soil map units
- filled areas with no development
- impounded areas
- excavated areas
- farmed wetlands

Degraded wetlands that are:

- partly drained
- impounded
- excavated
- farmed
- tidally restricted

The results of this step are maps of potential wetland conservation and restoration sites.

Step 2. Rank sites based on specific criteria derived from mapping

Because not all potential sites identified in Step 1 can actually be conserved or restored due to cost and other factors, ranking criteria are used to prioritize sites. Communities should develop wetland ranking criteria that reflect local goals, regulatory requirements, community interest, and/or wetland characteristics. In general, ranking criteria that relate to environmental benefits, feasibility and community benefits of the proposed project, as well as development pressure on individual sites should be considered. Table 3.1 provides some example ranking criteria for wetland conservation and restoration sites.

<table>
<tr><td colspan="2">Table 3.1. Example Ranking Criteria for Wetland Conservation and Restoration Sites</td></tr>
<tr><th>Wetland Conservation</th><th>Wetland Restoration</th></tr>
<tr><td colspan="2">• Located in priority watershed/subwatershed
• Located in headwaters, stream valley, floodplain
• Adjacent to existing wetland or protected land
• Landowner willingness to sell or donate
• Low project cost/acre
• High community acceptance of project</td></tr>
<tr><td>• High ecological significance (e.g., rare wetland type or habitat for RTE species)
• Currently unprotected
• Vulnerability to development pressure
• Wetland type is highly sensitive to changes in hydrology/pollutant inputs (e.g., bogs, fens)
• High economic value</td><td>• High potential to provide functions of interest
• Low potential for impacts from surrounding areas</td></tr>
</table>

Of the criteria listed in Table 3.1, at a minimum, communities should evaluate vulnerability to impacts from development and include this as a major factor for ranking conservation sites so that those valuable wetlands with a high likelihood of being developed can be protected if possible. A spreadsheet is helpful for this ranking exercise, and communities can determine how to score each criterion and assign each a different weight if desired.

The ranking results in a list and map of sites that are the highest priorities for conservation and/or restoration. For communities with limited funds for wetland protection, this ranking can serve as the basis for a local wetland conservation or restoration program. However, because the ranking is primarily based on mapping data, it is also helpful to visit the top priority sites in the field to verify wetland presence, further evaluate function and collect additional data to refine the ranking. Therefore, communities with additional resources may wish to continue on to Steps 3 and 4.

Step 3. Evaluate top sites (or all sites) in the field to collect more detailed site information

Field assessments can be used to confirm the assumptions made in Steps 1 and 2 about the presence, function, and condition of individual wetlands. Site visits can also be used to further evaluate restoration feasibility. For example, site evaluation for restoration potential can tell you whether the causes of impacts are known and controllable, whether the hydrology is suitable for restoration, and give you a sense of the complexity of the proposed restoration project.

Given the complexity of most wetland assessment methods and the expertise and time needed to conduct them, it may not be realistic to assess all potential wetland conservation and restoration sites in the field. This is where the ranking in Step 2 comes in handy to help narrow down the number of sites that are field-assessed.

Step 4. Revise ranking to reflect field conditions

Results of field assessments should be used to update the spreadsheet ranking and maps of priority wetland conservation and restoration sites. This may mean deleting sites from the list that have since been developed, or that do not concur with the initial functional assessment. It could also include adding criteria to the ranking and re-ranking the sites based on new, more detailed, information collected in the field. Additional guidance for this Step of the WARPT is provided in the following 3 sub steps:

- Assess Wetland Functions (Desktop) - A desktop GIS analysis designed to make a preliminary estimate of wetland functions.
- Evaluate Vulnerability - An evaluation of the potential for wetlands to be impacted by future development or other land use activities.
- Assess Wetland Functions (Field) - A field-based assessment to verify wetland function and evaluate factors, such as wetland condition, boundaries and potential stressors.

After identifying priority wetlands for protection and restoration, the next step is to protect wetlands locally using regulatory or voluntary measures (Step 5).

Desktop Assessment of Wetland Function

This step of the WARPT is designed to make a preliminary estimate of wetland functions remotely through a desktop GIS analysis. While field assessments of individual wetlands are necessary to more accurately evaluate wetland functions, a remote sensing approach to estimate wetland function provides a cost-effective way to rapidly identify priority sites for conservation and/or restoration. This screening process can also reduce a large number of wetland sites to a manageable level that can then be assessed in the field. In this step, hydrogeomorphic descriptors interpreted using GIS are added to wetland inventory data and are then correlated to wetland functions based on best professional judgment of various specialists. For a technical review of wetland functions, see Mitsch and Gosselink (2000).

Assigning functions to wetlands provides some basis for determining which ones have the most value, in terms of the wetland functions and services (Table 3a.1) that are of most importance to the community, or by assigning economic value to wetland functions. Tiner (2003b) has identified ten major functions provided by wetlands. Not all wetlands perform all functions nor do they perform all functions equally well. Factors that may affect wetland functions include geographic location, location within a watershed, climatic conditions, quantity and quality of water entering the wetlands, and disturbances or alteration within the wetland or surrounding ecosystem. This information can be useful to guide conservation efforts towards those wetlands providing the functions of interest. Communities can go one step further and evaluate vulnerability of wetlands to future land use changes and quantify the associated loss of function to help make the case for protecting wetlands through conservation, changes to development codes or comprehensive plans, or adoption of more stringent wetland protection measures.

Table 3a.1. Wetland Services and Functions

Wetland Services	**Wetland Functions Associated with Services**
Flood protection	• Surface water detention • Coastal storm surge detention
Recreation	• Provision of habitat for fish and other aquatic animals • Provision of waterfowl and waterbird habitat • Provision of other wildlife habitat
Maintain drinking water quality	• Nutrient transformation • Retention of sediments and other particulates
Shoreline property protection	• Shoreline stabilization • Coastal storm surge detention
Maintain baseflow in streams	• Streamflow maintenance

Table 3a.1. Wetland Services and Functions	
Wetland Services	**Wetland Functions Associated with Services**
Wildlife habitat and biodiversity	• Provision of habitat for fish and other aquatic animals • Provision of waterfowl and waterbird habitat • Provision of other wildlife habitat • Provision of habitat for unique, uncommon, or highly diverse wetland plant communities
Commercial products from wetlands (e.g., peat, timber, cranberries, rice, fish, shellfish)	• Provision of habitat for fish and other aquatic animals • Provision of waterfowl and waterbird habitat • Provision of other wildlife habitat • Provision of habitat for unique, uncommon, or highly diverse wetland plant communities
Reduce pollutants in streams and stormwater	• Nutrient transformation • Retention of sediments and other particulates

Identifying the specific functions that individual wetlands are providing can offer more regulatory "teeth" to protect wetlands from direct impacts. For example, if certain wetlands are designated as being critical to water quality, then states can use this information to support conditioning or denying permits that would impact these wetlands under CWA Section 401 water quality certification. Communities can also provide their results to the local Army Corps district office to aid in making CWA Section 404 permitting decisions that require information on wetland functions. This information can be particularly useful in watersheds with very high wetland density where most development approvals require making decisions about which wetland impacts will be allowed.

The process of estimating wetland functions in a watershed can also be applied to historic wetland data to determine what functions have been lost over time and identify candidate wetland restoration sites based on potential to provide certain functions.

There are two potential options for assigning preliminary functions to wetlands in your community:

1. Hire the U.S. Fish and Wildlife Service (FWS) or its primary cooperator, Virginia Tech's Conservation Management Institute, to do it for you. This service generates an historical assessment of pre-settlement wetland types, acreage, functions and general trends; a watershed characterization of current wetland status and functions; and an identification of potential wetland restoration sites. Costs for these services vary with the type and density of wetlands in a geographic area, the amount of historic loss, the recency of the NWI data, and the availability of digital data sources (e.g., land use/cover and soils).
2. Follow the "Watershed-based Preliminary Assessment of Wetland Functions" approach developed by the U.S. FWS.

Evaluate Vulnerability

The goal of this step is to evaluate the potential for wetlands in your community to be impacted by future development or other land use activities. The resulting data can be used as one ranking factor when prioritizing wetlands for conservation and/or restoration. This exercise involves identifying portions of the community with a significant likelihood of being developed in the future in order to assign a relative risk of future impacts to individual wetlands. As a result, wetlands that provide important functions and are highly vulnerable to impacts may be given a higher priority for conservation or other protective measure so there is no associated loss of function.

The basic idea is to determine how much growth is anticipated in your community over the next 20-30 years, and where that growth will likely occur. Most communities can use available GIS data to answer these questions. Table 3b.1 provides a list of potential data sources to use for this analysis. This analysis can be supplemented with other non-GIS data sources such as population projections, comprehensive plans, and interviews with local planners.

Table 3b.1. Potential Data to Identify Future Development Pressure

Data layer	How do I use this data?	Where do I find this data?
Comprehensive or land use plan designation	Areas designated for future development would be assigned a higher development pressure. The plan may also designate	Local planning department

Table 3b.1. Potential Data to Identify Future Development Pressure		
Data layer	**How do I use this data?**	**Where do I find this data?**
	other lands uses, such as resource extraction, that would also be considered high vulnerability.	
Zoning map	Areas zoned for high or medium density, commercial, industrial, institutional, and/or resource extraction would be assigned a higher development pressure. Resource protection or conservation zones would have low development pressure. The zoning map may have to be overlaid with existing development to extract future development pressure.	Local planning department
Infrastructure	Areas that have planned water/sewer service as well as areas with future road extensions have a higher likelihood of being developed	Local GIS, planning or public works department
Urban growth boundaries	Areas designated for urban growth would be assigned high development pressure	Local GIS, planning or public works department
Conservation easements	Lands protected by easement would have low development pressure	Local planning or natural resources department
Buildout analysis	Areas identified as "developed" in future buildout would have high development pressure	State or regional planning department

Based on the available data, a GIS layer should be created that identifies areas of the community with a high probability of being developed. If desired, the entire jurisdiction can be rated in terms of its development potential (e.g., high, medium, low). This layer can then be intersected with the map of potential sites for conservation and/or restoration so that each individual wetland is assigned a value that represents vulnerability to development impacts.

The results of this step can provide a sense of how urgent the need is for local wetland protection in your community and should be incorporated into the ranking of potential sites for wetland conservation and/or restoration. The wetland functions, condition, boundaries, and potential stressors should then be verified through field assessments to further refine the prioritized list of wetlands for conservation and/or restoration.

Field Assessments of Wetland Function

The watershed-based preliminary assessment of wetland functions is a useful tool to predict the likely functions of individual wetlands. However, it is not intended to replace field-based assessments, which are necessary to verify actual functions and can also evaluate factors such as wetland condition, boundaries and potential stressors. Communities can conduct field assessments of wetland function and use the results to refine their initial prioritization of wetlands for conservation/restoration in their watersheds.

Note that in the context of the WARPT, wetland functional assessments are only recommended for mapped wetlands that have been assigned preliminary functions. Sites designated as "potential wetlands" will require field confirmation of wetland presence (e.g., delineation of boundaries), which must be done prior to conducting functional assessments. Both wetland confirmation and functional assessments can be conducted during the same field assessment, but it is important to consider when budgeting time and resources.

Determine the Scope of Wetlands to Assess

Detailed and accurate wetland functional assessments are usually expensive and require multi-disciplinary expertise. Therefore, choices must be made in terms of the geographic range and number of wetlands assessed, types of information gathered, and the scales and degrees of accuracy. Some potential options for determining the scope of wetlands to assess in the field are listed below:

- Conduct a brief field visit of all wetlands identified as priority conservation sites and also to confirm the presence of the wetland, if this has not already been done in a previous step. This "Simple

Approach (Attachment B)" can be used to conduct a preliminary assessment of wetland functions and help to narrow down the list of wetlands for which to conduct functional assessments in the future. It can also help to screen out any sites that have recently been developed or otherwise altered. While this simple approach can glean valuable information if conducted by trained professionals, it is important to understand that it does NOT replace a more formal functional assessment using an accepted methodology (see below). However, it may be a less time-consuming and valuable exercise for certain mapping efforts (see Table 3c.1). *This step does not include field delineation of wetland boundaries and is primarily a quick check to identify sites where there is obviously no wetland present.*

- Conduct functional assessments for all wetlands identified as priority conservation sites. This option is most expensive, but may be doable for a community with few remaining wetlands.
- Conduct functional assessments for a subset of wetlands identified as priority conservation sites. For example, survey the top 20 to 30 sites of a particular wetland type, or the top sites located in a priority subwatershed. Set a schedule for continuing the assessment process each year.
- Coordinate wetland functional assessments with the Section 404 permit program. Functional assessments are encouraged under this program for all proposed impacts to wetlands, and this approach shifts the burden onto the developer. However, identifying wetland functions at this late stage is less likely to result in any significant protection for the wetland in question.

Select a Wetland Functional Assessment Protocol

Field-based wetland functional assessments of individual wetlands are important to verify the preliminary assessment of wetland functions and can also be used to assess condition, establish compensatory mitigation ratios, evaluate restoration potential, or to design appropriate restoration projects. Many (perhaps several hundred) different wetland assessment methodologies exist across the country. Most protocols are designed to be conducted by trained environmental consultants and/or wetland ecologists due to the complexity of wetland ecosystems. These assessments can be time consuming and are often applicable to specific regions or wetland types.

Table 3c.1 provides some guidance on selecting an appropriate method based on the overall purpose of the wetland mapping or inventory effort. A "Simple Approach" has also been developed as part of the WARPT (Attachment B). This method is not designed to replace a formal functional assessment, but represents a quick field check for wetland inventories and mapping efforts (non-regulatory) in cases where staff time and budgets are limited. The "Simple Approach" should still be conducted by trained wetland professionals, as it is simply a structured checklist for professionals to make quick observations in the field. In some cases, this approach can be used to narrow the list of sites that will require a fuller functional assessment.

Table 3c.1. Guidance for Selecting An Assessment Method Based on Overall Purpose

Purpose of Field Assessment	**Guidance on Selecting a Method**
General mapping for comprehensive plans, community inventories, or watershed plans. Purposes that are NOT related to regulatory considerations (e.g., feed into Section 401 or 404 reviews). Situations where the list of potential wetlands must be narrowed down to limit the number of future functional assessments.	Use "Simple Approach" as part of WARPT (Attachment B) OR consult Bartoldus (2000) Step 1b for methods applicable to "inventory or planning"
Purposes that require a more detailed functional assessment, such as for regulatory review, impact analysis, related to possible use as a mitigation site, guide to mitigation or restoration design, prioritizing sites for purchase or protection, or as part of development review.	Review and select an available method from Table 3c.2, select approved method for state or region, OR consult Bartoldus (2000) or other resources listed below to select an appropriate functional assessment method. *Careful consideration should be given to choosing an appropriate method that corresponds to your community's goals. The suitability of the assessment depends on the objectives, geographic area, wetland type, level of detail, availability of applicable models, etc.*

No single method for evaluating wetland functions can be widely recommended because no one method is suitable for all assessment situations. Even the USACE does not recognize any one methodology as the best or most acceptable. The suitability of a procedure for a project depends upon the assessment objectives, geographic area, wetland type, desired level of detail, availability of applicable models, and other considerations. Therefore, special consideration should be given to choosing an appropriate method that corresponds to your community's goals.

Several researchers have compiled and reviewed information on the numerous wetland functional assessment protocols that are available today. Based on this data and considering the goals of the WARPT, we present a limited number of techniques in Attachment C that appear to be most applicable. The factors we considered to narrow down the list of protocols included:

- Considers watershed or landscape-scale functions as opposed to site-specific functions
- Provides a quantitative scoring system so that wetlands of the same type can be compared to one another
- Ability to rank each function separately
- Is "rapid" (this is a relative term), e.g., looks at indicators of function
- Can be applied to isolated wetlands
- Also considers condition and/or social values (these can be used in prioritizing sites)
- Provides good documentation of the protocols to ensure they are applied consistently

Note that just because a method is not included in Attachment C does not mean it should not be used to conduct wetland functional assessments. Communities conducting this step of the WARPT should carefully consider their specific objectives related to field assessments of wetlands and use the additional following tools to select an appropriate procedure.

- Some states have developed their own wetland assessment protocols and/or have adopted them as part of their regulatory programs. The Environmental Law Institute's 50-state study of wetland programs can be used to determine if your state has officially adopted a specific wetland assessment method, keeping in mind that this data may be as old as 2003, so you should double-check it with your state wetlands program. If your state has a required methodology, you might simply decide to use it for the WARPT, particularly if you intend to coordinate your wetland functional assessments with the state wetland regulatory program.
- Bartoldus (2000) has developed a selection matrix to assist wetland managers in distinguishing between approximately 40 existing wetland assessments and for choosing an appropriate protocol for

use. These protocol descriptions and selection guidance are available on the [USACE Ecosystem Management and Restoration Information System] website.

- The [Natural Resources Monitoring Partnership] provides a searchable database of monitoring protocols
- The New Jersey Department of Environmental Protection compiled a [database of assessment tools for evaluating wetland quality and functions] as part of a study to evaluate the utility of these rapid assessment tools.

Once you determine the scope of wetlands to field-assess and select an assessment method, you will need to either train staff in using the method or hire a qualified wetland consultant to evaluate each site using the established protocols. While each protocol is different, some general guidelines should be considered for wetland field assessments:

- While in the field, take representative photographs of wetland types or land use and use GPS to provide accurate locations for each of the photos. This will allow you to look back at the wetland to help resolve any questions that arise after fieldwork has been conducted.
- Training among team members conducting the assessment is important to ensure everyone is conducting the assessment in the same manner. This will help to calibrate the results.
- Send letters out to local residents and businesses to notify them about the assessment and when it will be taking place. Before conducting the assessment, have a list of back-up sites selected in case some landowners refuse permission, or sites are not accessible.

It is also important to keep in mind the difficulties of wetland assessment when determining the method your community will be conducting. These difficulties include:

- Season - it is difficult to use a single observation of wetland hydrology, plants, and animals to describe or characterize a wetland because vegetation and water regime change throughout the season. Different water conditions and plant species may predominate on the same site, depending on season.
- Wetland Alteration - most wetlands are altered to some degree and water regimes are changing due to land use and watershed development.

Next Steps

These field assessments should result in a score for each wetland (and possibly an individual score for each function of interest) that represents that wetland's potential to provide or actual provision of certain functions (the output will vary depending on the method selected). These quantitative scores can be used to update and refine your preliminary assessment of wetland functions and re-rank sites as needed to identify priorities for conservation and restoration.

Step 4: Estimate Wetland Values

Wetlands provide an abundance of valuable functions and services, including flood storage, wildlife habitat, pollutant removal, recreation and commercial products. These "free" services are often taken for granted and can be difficult (if not impossible) as well as very expensive to replace, as wetlands are altered or degraded in a watershed.

Despite the expense and uncertainty associated with replacing the lost ecological services of wetlands, urban and rural development, which accounted for 61% of wetland losses during 1998-2004 (Dahl, 2006), continues to impact wetlands. Preventing the loss of wetland functions is a challenge, particularly when financial gains for individual parcel development seemingly outweigh non-market wetland values for the greater community. To address this concern, scientists have begun to assign economic values to the important roles of wetlands. This is done through a process known as economic valuation that aims to make ecosystem goods and services directly comparable to other sectors of the economy. Some examples include:

- Constanza (1997) estimated the global value of wetland ecosystems at $14.9 trillion
- In a recent study by NJ DEP (2007), wetland services in NJ were valued at $9.4 billion per year for freshwater wetlands and $1.2 billion per year for saltwater wetlands.

Placing an economic value on wetland functions and services may serve as a useful tool to help a community justify wetland protection. Wetland valuation may be particularly useful in communities where wetlands are still viewed as nuisance features or mosquito havens. The data generated from a wetland valuation study can be used to:

- Make the case to local officials and justify allocation of budget to wetland conservation and restoration programs
- Educate the public about wetland benefits
- Assist with ranking priority sites for wetland conservation and/or restoration

- Estimate the costs associated with loss of wetland functions for wetlands that are highly vulnerable to development impacts
- Estimate the costs associated with historic wetland loss in the community
- Make informed decisions regarding the future use of wetlands by putting wetlands and economic development on a level playing field

Economic valuation studies can be costly and will likely require assistance from an environmental economist. If this is not an option for your community, readily available economic data from local sources or existing studies may be sufficient to begin educating decisions makers about the true value of wetlands and cost to replace their services. Table 4.1 lists some of the replacement options for lost wetland services that communities can begin to put a price on using up-to-date and local cost data. If data from scientific studies are beneficial to local decision-makers, Table 4.2 presents some values for different wetland types from two major wetland valuation studies. These values represent the cost incurred from wetland mitigation projects to restore wetlands and do not represent the cost to replace a wetland. These costs are used by state and federal regulators as a threshold for the costs to replace lost wetland services and values. Additional wetland valuation studies can be found in the GecoServ Gulf of Mexico Ecosystem Services Valuation Database developed by the Harte Research Institute for Gulf of Mexico Studies at the Texas A&M University.

Table 4.1. Replacement Options for Wetland Services

Wetland Services	**Replacement Options**
Flood protection	Stormwater treatment practices (storage); dikes and levees; advanced floodplain construction design
Recreation	Wetland restoration; species stocking
Maintain drinking water quality	Water filtration plants, develop new water source
Shoreline property protection	Revetments; stream bank stabilization and repair practices; stormwater treatment practices for channel protection
Maintain baseflow in streams	Deeper wells; alternative water source
Wildlife habitat and biodiversity	Wetland restoration; species stocking

Table 4.1. Replacement Options for Wetland Services	
Wetland Services	**Replacement Options**
Commercial products from wetlands (e.g., peat, timber, cranberries, rice, fish, shellfish)	Wetland restoration
Reduce pollutants in streams and stormwater	Stormwater facilities designed to meet water quality criteria (WQv)

Table 4.2. Wetland Values			
Study #1: King and Bohlen, 1994		**Study #2: Louis Berger and Associates, Inc., 1997**	
Wetland Type	**1997 $ Cost/Acre**	**Wetland Type**	**1997 $ Cost/Acre**
Aquatic bed	$45,000	Emergent	$43,675
Complex	$95,000	Scrub/Shrub	$124,144
Freshwater mixed	$52,000	Intertidal emergent	$415,007
Freshwater forested	$124,000	Open water – emergent	$273,700
Freshwater emergent	$84,000	Open water - shrub/forest	$130,220
Freshwater tidal	$78,000	Emergent scrub/shrub	$351,591
Salt marshes	$49,000	Emergent/intertidal	$59,238
Mangroves	$24,000	Emergent - forested	$235,799
Prairie potholes	$4,000	Riverine emergent	$82,928
Other agricultural	Less than $1,000		

These numbers do not reflect the full cost of restoring wetland services or the full value of wetland services. The numbers represent how much money U.S. state and federal agencies have spent to attempt to restore wetland services. The numbers include pre-construction, construction, and post-construction tasks but they do not include the time and resources of government agencies. Numbers were not adjusted to account for significant failure rates for restoration or delays in wetland recovery after restoration (King, 1998).

Estimating Values Provided by Wetlands in Your Community

Seven basic steps to conducting a wetland valuation study are summarized below. Before starting an economic valuation it should be noted that while several economic valuation methods are available, each method has advantages and disadvantages that could lead to over or under valuation. In addition, conducting a wetland valuation study alone is not sufficient to provide wetland protection (as noted by King, 1998). For this reason, we recommend economic valuation as an educational and informational tool to use in conjunction with other wetland protection measures. The process outlined below is taken from The International Union for Conservation of Nature's (IUCN) 2009 publication An Integrated Wetland Assessment Toolkit.

Step 1. Determine the Objective of the Wetland Valuation for your Community

The results of the valuation tool may be used to:

- Make the case to local officials for wetland protection
- Choose among wetland protection tools based on costs/benefits
- Justify allocation of budget to wetland mapping or wetland conservation and restoration programs
- Educate the public about wetland benefits
- Assist with ranking priority sites for wetland conservation and/or restoration
- Estimate the costs associated with loss of wetland functions for wetlands that are highly vulnerable to development impacts
- Estimate the costs associated with historic wetland loss in the community
- Make informed decisions regarding the future use of wetlands by putting wetlands and economic development on a level playing field

Step 2. Define the Scale and Geographic Boundary of Wetlands to Include in the Study

Communities should identify the scale at which the study should be conducted. For example, the study could be at the municipal or watershed scale. In addition, the geographic area of wetlands to include in the study should be defined. Examples include:

- wetlands in a municipality or only wetlands in an identified high priority protection subwatershed
- historic wetlands to illustrate the economic impact and make the case for protecting remaining wetlands
- a single type of wetland that the community is highly interested in protecting or that is most at risk

Step 3. Identify and Prioritize Wetland Benefits to be Valued

The next step is to identify the specific wetland functions to be valued in the study, based on the services that are of most importance to the community. Table 4.3 lists common wetland services and their associated functions. Mitsch and Gosselink (2000) provide a more detailed summary of the functions and services provided by wetlands.

Table 4.3. Wetland Services and Functions

Wetland Services	**Wetland Functions Associated with Services**
Flood protection	• Surface water detention • Coastal storm surge detention
Recreation	• Provision of habitat for fish and other aquatic animals • Provision of waterfowl and waterbird habitat • Provision of other wildlife habitat
Maintain drinking water quality	• Nutrient transformation • Retention of sediments and other particulates
Shoreline property protection	• Shoreline stabilization • Coastal storm surge detention
Maintain baseflow in streams	• Streamflow maintenance
Wildlife habitat and biodiversity	• Provision of habitat for fish and other aquatic animals • Provision of waterfowl and waterbird habitat • Provision of other wildlife habitat • Conservation of biodiversity
Commercial products from wetlands (e.g., peat, timber, cranberries, rice, fish, shellfish)	• Provision of habitat for fish and other aquatic animals • Provision of waterfowl and waterbird habitat • Provision of other wildlife habitat • Conservation of biodiversity
Reduce pollutants in streams and stormwater	• Nutrient transformation • Retention of sediments and other particulates

Step 4. Select the Costs and Benefits to be Valued

For each wetland benefit identified in Step 3, you will need to determine the specific costs and benefits that will be measured. For example, if your community identified flood control as an important wetland function, the specific costs and benefits to measure might include the costs associated with building stormwater treatment practices or flood insurance premiums. The costs and benefits selected will be driven in part by what types of data are available.

Step 5. Choose the Appropriate Wetland Valuation Method

Table 4.4 identifies the most commonly used wetland valuation methods associated with various wetland functions. Based on the selected wetlands functions of importance, communities can use this table to identify the most appropriate wetland valuation method. A separate wetland valuation method may be needed to determine the value for each identified wetland benefit. There are three main approaches to wetland valuation that include:

- Market Price Methods - ecosystem goods and services measured by market prices
- Circumstantial Evidence - measured by what people are willing to pay and the cost of actions they are willing to take to avoid the adverse effects that would occur if these services were lost or services needed to be replaced
- Surveys - used when ecosystem services are not traded in markets. Surveys used to ask people what they are willing to pay in a hypothetical scenario

Additional information on each method, including advantages and disadvantages, is provided in Table 4.5 and at www.ecosystemvaluation.org.

Table 4.4. Commonly used Wetland Valuation Methods for Associated Wetland Functions and Services (adapted from Brander et al. 2003)

Function	**Service**	**Valuation Method***
Surface water detention	Flood protection	Replacement cost, Market price
Coastal storm surge detention	Storm protection	Replacement cost, Production function
Shoreline stabilization	Storm protection	Replacement cost, Production function
Retention of sediment	Storm protection	Replacement cost, Production function

Table 4.4. Commonly used Wetland Valuation Methods for Associated Wetland Functions and Services (adapted from Brander et al. 2003)

Function	Service	Valuation Method*
Streamflow maintenance	Water supply	Production function, Replacement Cost
Nutrient transformation	Improved water quality	CVM
	Waste disposal	Replacement cost
Provision of habitat for plant and animal species	Commercial fishing and hunting	Market price
	Recreational fishing and hunting	TCM, CVM
	Harvesting of natural materials	Market price
	Energy resources	Market price
Conservation of biodiversity	Potential future use	CVM
	Appreciation of species existence	CVM
Micro-climate stabilization	Climate stabilization	Production function
Carbon sequestration	Reduced global warming	Replacement cost
Other	Amenity	HP, CVM
	Recreational activities	CVM, TCM
	Appreciation of uniqueness to culture/heritage	CVM

**Acronyms refer to the contingent valuation method (CVM); hedonic pricing (HP); and the travel cost method (TCM). See Table 4.5 for additional information on these and other valuation methods.*

Table 4.5. Wetland Valuation Methods (compiled from IUCN (2009) and www.ecosystemvaluation.org)			
Method	**General Description**	**Advantages**	**Disadvantages**
Market Price Methods			
Hedonic Pricing (HP)	Examines the difference in prices for an ecosystem good or service. Most commonly used to examine the difference between property prices and wage rates between two locations with different environmental qualities (e.g. calculate residents willingness to pay to live close to wetlands)	• Can be used to estimate values based on actual choices • If data are readily available, it can be relatively inexpensive to apply	• Limited to measuring things that are related to housing prices • Requires a large data set • Only captures people's willingness to pay for perceived differences in environmental attributes and their direct consequences
Market Price	Estimates economic values for ecosystem products or services that are bought and sold in commercial markets (e.g. timber, fish and non-	• Data is easy to obtain • Uses observed data of actual consumer preferences and standard, accepted	• Many ecosystem goods and services don't have markets (e.g., nutrient retention) • The markets are often subsidized • The markets are not well-developed and don't provide a true indicator of price

Table 4.5. Wetland Valuation Methods (compiled from IUCN (2009) and www.ecosystemvaluation.org)			
Method	**General Description**	**Advantages**	**Disadvantages**
	timber products)	economic techniques	
Production Function/Net Factor Income (NFI)	Estimates economic values for ecosystem products or services that contribute to the production of commercially marketed goods (e.g. the cost of clean water can be a direct substitute for water purification chemicals and filtration)	• Applicable to a wide range of ecosystem goods and services • Straight forward method	• Difficult to quantify the relationship between change in ecosystem goods and services and production • Large number of other variables that influence product markets
Travel Cost Method (TCM)	Estimate travel costs as a surrogate for the recreational value of ecosystems (e.g. costs of trips for fishing, hunting and water based recreation)	• Limited to calculating recreationa l values	• Depends on large data set • Complex analytical techniques • Expensive and time consuming to conduct
Circumstantial Evidence			

Table 4.5. Wetland Valuation Methods (compiled from IUCN (2009) and www.ecosystemvaluation.org)			
Method	**General Description**	**Advantages**	**Disadvantages**
Replacement Cost/Damage Cost Avoided	Estimating the cost to replace the services provided by ecosystem and/or the potential damage costs if ecosystem services were removed (e.g. loss of wetland flood attenuation may lead to increased downstream flooding and destruction of infrastructure and property)	• Less data and resource intensive that other methods • Provide surrogate measures of value for services that are difficult to measure by any other means • Simple to apply and analyze	• Difficult to find perfect replacements for ecosystem goods and services • May lead to over or under valuation • Based on predicted/hypothetical situations
Surveys			
Contingent Valuation Method (CVM)	Determine the price individuals would pay for ecosystem services using a survey (e.g. how much residents would volunteer to pay to manage an upstream catchment to	• Do not rely on markets and can be used for any situation, good or service • Places value on non-market goods and services	• Large and costly surveys • Large data sets • Sophisticated analysis techniques • Based on hypothetical situation

Table 4.5. Wetland Valuation Methods (compiled from IUCN (2009) and www.ecosystemvaluation.org)			
Method	**General Description**	**Advantages**	**Disadvantages**
	maintain drinking water supplies)		

Step 6. Conduct the Wetland Valuation Study

After selecting the appropriate wetland valuation method, it is time to conduct the study. This will likely require contracting with an environmental economist. It may be worth doing a little research first to find out if an ecosystem valuation study is already being conducted in your region by a local University, state natural resources department or a federal agency, such as EPA's Ecosystem Services Research initiative or the USDA Forest Service's Ecosystem Services and Markets division. Refer to IUCN's Integrated Wetland Assessment Toolkit and http://www.ecosystemvaluation.org/ for further resources on each wetland valuation method.

Step 7. Analyze and Present the Valuation Data

Once the wetland valuation study is conducted, the data should be reported in a way that is useful for decision makers. Decision makers are faced with tough questions concerning different uses of land, funds and other resources. Thus, the data should be provided in a format that makes it easy to understand how their choices will affect wetland values. This may require quantifying wetland costs and benefits for various land use scenarios using a cost-benefit analysis. More details on cost-benefit analyses are presented in IUCN (2009).

For more detail on the general process of conducting a wetland valuation study, refer to An Integrated Wetland Assessment Toolkit. For general information on ecosystem valuation refer to www.ecosystemvaluation.org.

Step 5: Protect Wetlands Locally

Local governments play a key role in filling the gaps in wetland protection, because they have primary responsibility for local land use management. Local action is particularly critical in states that do not have comprehensive wetland protection programs. This step provides a review of regulatory and non-regulatory options for local governments. Ideally, a combination of approaches will be used.

Managing wetlands at the watershed scale can help minimize indirect impacts to wetlands. Direct impacts to wetlands include the removal or addition of material such as dredging, filling, or draining that are largely regulated through the federal and state wetland permitting process. Indirect impacts such as altered hydrology, increased pollutant loadings, and buffer encroachment caused by urbanization are summarized in Wetlands & Watersheds Article 1. Using a watershed approach allows communities to make better choices about preserving the highest quality wetlands, protecting the most vulnerable wetlands, and finding the best sites for wetland restoration. Wetlands & Watersheds Article 2 provides detailed information on using local watershed plans to protect wetlands. Communities vary greatly in their size, technical and financial resources, development review process, and prior experience in wetland management and watershed planning. A menu of different wetland protection techniques that communities can choose from to protect wetlands from direct and indirect impacts is provided in Table 5.1.

The protection techniques are organized by the eight tools of watershed protection that represent a comprehensive approach to protect wetlands in watersheds facing land development (derived from Wetlands & Watersheds Article 3). The eight tools roughly correspond to the stages of the development cycle including initial land use planning, site design and construction, and ultimate occupancy and long-term maintenance. Each of the eight tools should be specifically applied to protect unique wetland resources in watersheds that may be vulnerable to impacts from future development. Communities should examine the numerous techniques within each category that best protects wetlands identified as priorities. Some techniques are more restrictive than others, and the choice of techniques depends on the future wetland protection needs in the community, as well as the capacity of the community to implement the techniques.

Table 5.1 presents each regulatory and voluntary wetland protection measure, and is followed by more detailed information on each measure. Wetlands & Watersheds Article 3 provides more detailed information about each approach.

Table 5.1. Regulatory and Voluntary Wetland Protection Measures		
Watershed Protection Tool	**How to Apply the Tool to Protect Wetlands**	**Regulatory / Voluntary Measure**
1. Land Use Planning	Incorporate wetland management into local watershed plans	Both
	Adopt a local wetland protection ordinance	Regulatory
	Adopt a floodplain, stream buffer, or hydric soil ordinance to indirectly protect wetlands	Regulatory
2. Land Conservation	Identify priority wetlands to be conserved	Voluntary
	Select techniques for conserving wetlands	Both
3. Aquatic Buffers	Require vegetated buffers around all wetlands	Regulatory
	Expand wetland buffers to connect wetlands with critical habitats	Regulatory
	Increase stream buffer widths to protect downstream wetlands	Voluntary
4. Better Site Design	Encourage designs that minimize the number of wetland crossings	Voluntary
	Encourage or require site design techniques to protect wetlands	Voluntary
5. Erosion and Sediment Control	Require perimeter control practices along wetland buffer boundaries	Regulatory
	Encourage more rapid stabilization near wetlands	Voluntary
	Reduce disturbance thresholds that trigger ESC plans	Regulatory

	Increase ESC requirements during rainy season	Regulatory
	Encourage use of site fingerprinting or construction phasing	Voluntary
	Increase frequency of site inspections	Both
6. Stormwater Treatment	Prohibit use of natural wetlands for stormwater treatment	Regulatory
	Restrict discharges of untreated stormwater to natural wetlands	Regulatory
	Discourage installation of stormwater treatment practices within wetland boundaries	Voluntary
	Discourage constrictions at wetland outlets	Voluntary
	Encourage progressive stormwater management techniques	Voluntary
	Develop special sizing criteria for stormwater treatment practices	Regulatory
	Promote effective stormwater treatment practices to protect downstream wetlands	Voluntary
7. Non-Stormwater Discharges	Conduct illicit discharge surveys for all outfalls to wetlands	Voluntary
	Actively enforce restrictions on dumping in wetlands and their buffers	Regulatory
	Require enhanced nutrient removal from on-site wastewater treatment systems	Regulatory
	Require regular septic system inspections	Regulatory

8. Watershed Stewardship	Incorporate wetlands into watershed education programs	Voluntary
	Post signs to identify wetlands, buffers, and wetland drainage area boundaries	Voluntary
	Manage invasive wetland plants	Voluntary
	Establish volunteer wetland monitoring and adoption programs	Voluntary
	Encourage wetland landowner stewardship	Voluntary
	Establish partnerships for funding and implementing wetland projects	Voluntary

Key	
(blue)	Strategies that address direct impacts to wetlands
(green)	Strategies that address indirect impacts to wetlands
(yellow)	Strategies that address both indirect and direct impacts to wetlands

Incorporate Wetland Management into Local Watershed Plans

Incorporating wetland protection into the local watershed planning process can help minimize impacts to wetlands and identify priority wetlands to be conserved. During the watershed planning process, local wetlands must be inventoried, assessed, managed, and prioritized on a watershed scale rather than on a site-by-site basis. This can be done through an initial desktop inventory of wetlands based on available mapping, followed by a detailed field assessment to verify the location of the wetland, function and condition. Selecting priority wetlands for conservation will vary for each community. Factors to consider when choosing wetland conservation sites include: aligning functions provided by the wetland to existing community goals, location in the watershed, size and connection to landscape features, ownership and vulnerability to future development. The wetland inventory is then used by the community to make better choices to preserve the highest quality wetlands, protect the most vulnerable wetlands, and find the best sites for wetland restoration. By identifying the best wetland sites in advance of development, there is an increased chance of permanent protection. Additionally, the watershed plan is shared with the regulatory community as a proactive approach to inform wetland permit decisions made by state and federal agencies, to affect compensatory mitigation decisions regarding impacted wetland resources, or to identify opportunities for voluntary wetland conservation and restoration programs.

Adopt a Local Wetland Protection Ordinance

A local wetland protection ordinance can provide more stringent protection for a greater range of wetland types than is currently being regulated by state and/or federal agencies. Local wetland protection ordinances can restrict or require a special permit for certain activities -- such as dredging, filling, clearing, and paving -- within wetland boundaries or buffers. Communities can either adopt a new wetland protection ordinance or revise existing ordinances such as zoning, erosion and sediment control, and stormwater management ordinances.

Adopt Floodplain, Stream Buffer, or Hydric Soil Ordinance to Indirectly Protect Wetlands

As discussed in Step 1, most communities lack a detailed inventory of their wetlands and instead rely on federally available National Wetlands Inventory maps. These maps are outdated and thus can result in a lack of comprehensive wetland protection. In these cases, communities may choose to protect wetlands indirectly through the protection of other natural resource features as a surrogate for wetlands such as floodplains, stream buffers, and hydric soil features. Figure 5.1 provides an example of how to overlap GIS layers with wetlands to provide significant wetland protection. A more detailed approach to protecting local wetlands is provided in Step 1.

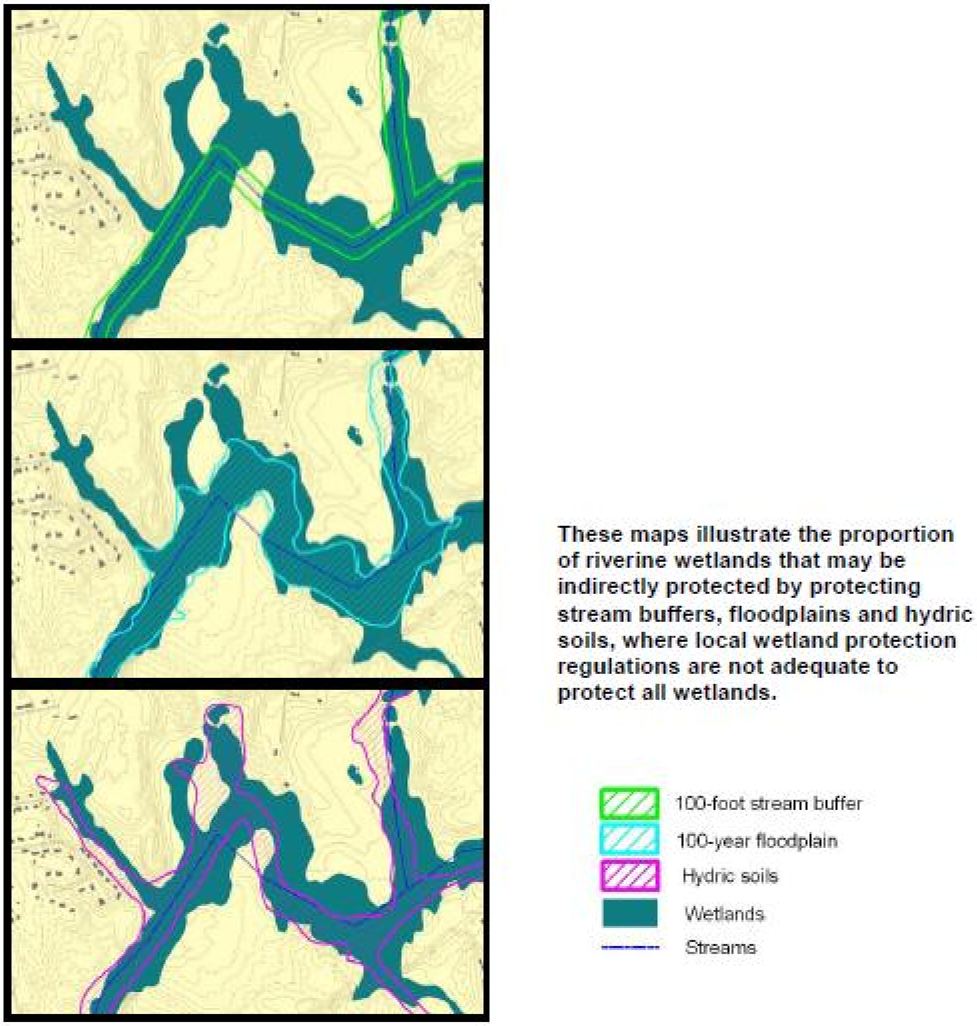


Figure 5.1. Wetland maps showing overlap with the 100-foot stream buffer (top), 100-year floodplain (center), and hydric soils (bottom) (Graphic source: Wetlands & Watersheds Article 3)

Select Techniques for Conserving Wetlands

A Conservation plan should be developed for individual wetlands that include what land conservation tools will be used, who will apply them and when they will be applied. Communities can choose from directly purchasing the land, working with a local land trust or other organization to acquire the land or restrict development using tools such as conservation easements. Several tools available are described below.

- Land acquisition - Outright acquisition of title to conservation areas by a municipality, land trust, or other nonprofit organization that provides full control of the land.
- Conservation easement or Purchase of Development Rights (PDRs) - Conveyances of development rights necessary for protection of specific conservation values from a property's landowner to a

municipality, land trust, or other nonprofit organization. In a PDR program, the development rights are purchased by the program.
- Transfer of Development Rights (TDRs) - Land use planning technique that transfers development potential from environmentally sensitive areas, called sending zones, to specific areas designated for growth, called receiving zones.

Require Vegetated Buffers around all Wetlands

Wetland buffers provide numerous benefits including wildlife habitat, removal of pollutants from runoff, reduction in erosion, temperature moderation, storage of floodwaters, increased aesthetic and recreational value, and providing a visual separation between wetlands and developed areas. The benefits provided by the wetland buffer depend on the buffer width. Widths of 50 -100 feet are recommended to protect wetland water quality, while widths of 100 to 300 feet or more are recommended for wetlands with important wildlife functions (EOR, 2001; Chase et al., 1997; Castelle et al., 1992). Wetland buffer widths can be set for all wetlands, or a community may choose to set buffer widths based on wetland type or wetland functions performed. Communities can choose to require vegetated buffers around wetlands through expanding or adding to a local wetland protection ordinance, adding wetlands to an existing stream buffer ordinance, or incorporating wetland buffers into a post-construction stormwater management ordinance.

Expand Wetland Buffers to Connect Wetlands with Critical Habitats

Communities can provide for flexible wetland buffer widths that allow linking wetlands together with high value upland habitats. Large, unbroken habitat areas are valuable for habitat thus providing for improved habitat value and function of the wetland. In addition, upland habitat adjacent to wetlands provide critical habitat for many semi-aquatic and terrestrial ecotone species (Semlitsch and Jensen, 2001). Communities should be flexible in their ordinance requirements to encourage the creation of large, contiguous habitat areas and linkages between these areas.

Increase Stream Buffer Widths to Protect Downstream Wetlands

Wetland buffers can't provide protection from all activities within the wetland drainage area. To provide for extra protection, communities can increase the stream buffer width on tributaries to sensitive wetland drainage areas or on direct tributaries to sensitive wetlands. Changes to a community's stream buffer ordinance can be made to reflect increased buffer widths for streams that drain to sensitive wetlands.

Encourage Designs that Minimize the Number of Wetland Crossings

Wetland crossings by roads or utilities often result in outlet constrictions and cause hydrologic impacts to wetlands. Communities should limit the number of wetland crossings in a new development by:

- Using efficient road layouts
- Focus development away from the wetlands
- Use existing crossings
- Use a single crossing for utilities and roads

Developers should be required to provide an inventory of natural resources before a site is developed to allow for identification of sensitive areas and the design of the site to avoid these areas at the early planning stages of site design. In addition, the local site plan review process should coordinate with federal and state regulatory processes to determine whether wetland impacts are minimized or avoided altogether.

Encourage or Require Site Design Techniques to Protect Wetlands

Open space design is a site layout technique that achieves the conservation of natural resources on a lot by clustering the development on another portion of the lot. This design creates less impervious cover, preserves forest and wetlands, and reduces stormwater runoff. Communities can require open space design community-wide through their existing subdivision regulations or may require the practice within a wetland protection overlay zone, within drainage areas to sensitive wetlands, or on sites with wetlands. A local open space design ordinance should require a percentage of existing open space be conserved for each zoning district, define allowable and restricted uses for the open space, and an enforcement mechanism.

During the development process, land is cleared and graded often resulting in soil compaction and destruction of natural drainage ways. Communities can minimize these impacts by combining the following goals into the site development regulations as shown in Figure 5.2.

- Avoid construction activity in the most sensitive areas
- Develop the site using the existing terrain
- Use the natural topography and vegetated waterways to convey runoff
- Direct runoff to pervious areas for infiltration

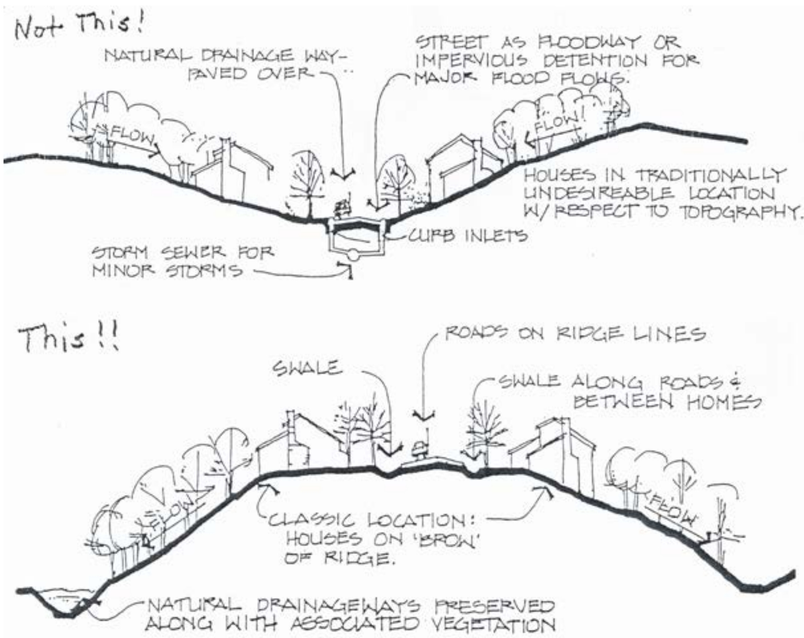


Figure 5.2. Conventional development (top) versus development that works with the existing topography (bottom) (Graphic source: MNSWAG, 1997)

Require Perimeter Control Practices Along Wetland Buffer Boundaries

Perimeter controls at development sites are typically placed on the upland boundary of streams and wetlands during the active construction phase of a project. These devices include sediment traps and basins, diversions/dikes, earthen berms, and silt fences. It is recommended that perimeter controls be installed along the boundary of any required wetland buffer, rather than at the wetland boundary (Figure 5.3). This practice allows for additional sediment filtering in the wetland buffer in case the perimeter control fails. This requirement should be reflected in the local Erosion and Sediment Control (ESC) manuals.


Figure 5.3. Silt fence used as perimeter control to protect wetland (Photo source: MDE, no date)

Encourage more Rapid Stabilization near Wetlands

Immediate soil stabilization on a construction site is important to reduce sediment inputs to wetlands on exposed slopes near wetlands. Communities should encourage developers to permanently stabilize upland areas near wetlands as soon as possible after completion of ground disturbing work and to use temporary seeding and stabilization if disturbed areas will be left exposed for longer than 14 days. The most effective means of stabilization is to establish a vigorous grass cover to prevent erosion from occurring (Figure 5.4). Communities should specify in their ESC program that a native wetland seed mix should be used to stabilize sites immediately adjacent to wetlands.

Figure 5.4. Exposed slope stabilized with erosion control matting

Reduce Disturbance Thresholds that Trigger ESC Plans

Many communities have ESC program regulations that apply to sites disturbing a minimum amount of land (e.g., Federal disturbance threshold is one acre). Communities can reduce the sediment input to wetlands by lowering the minimum threshold that triggers ESC regulations. In addition, communities should review the waivers and exempted projects identified in their ESC regulations. Since ESC regulations are not required at these sites, they can cumulatively provide a large source of sediment to wetlands. Alternatively, communities with limited resources may decide to apply tighter ESC regulations to sites within sensitive wetland drainage areas.

Increase ESC Requirements during Rainy Season

Construction site erosion is directly linked to rainfall events, meaning that if sites do not have ESC, sediment deposition into wetlands can increase significantly. To reduce this occurrence, communities should require more stringent controls during the rainy season, including: restrict major grading operations, require faster vegetative stabilization, and increase the frequency of inspections. In addition, sites should be inspected to ensure stability before the rainy season and after every storm event.

Encourage the Use of Site Fingerprinting or Construction Phasing

The best way to reduce sediment inputs to wetlands is to prevent erosion from occurring at the construction site in the first place. Communities can prevent erosion by limiting the amount of clearing conducted at a site by encouraging site fingerprinting and construction phasing. Site fingerprinting (also known as site footprinting) minimizes clearing at a site by limiting disturbance to the necessary minimum to construct buildings and roadways. The limits of disturbance need to be clearly marked in the field and on the site plan. Construction site phasing is a process of disturbing land on a site in distinct phases. This is in contrast to the traditional construction sequencing where the entire site is cleared and graded at one time. Under construction site phasing, a portion of the site is cleared and graded, infrastructure is installed, and the disturbed soil is stabilized before work begins on the next phase. Since the amount of soil exposure is limited, this is a preventative approach to ESC.

Increase Frequency of Site Inspections

An important part of any ESC program is frequent inspections and enforcement. Surveys reveal that 16% to 50% of ESC practices specified in plans are never installed or are installed improperly (Paterson, 1994; Mitchell, 1993). These findings highlight the importance of bi-weekly inspections and/or inspections after certain sized storms. Communities can require more frequent ESC inspections within the drainage areas of sensitive wetlands. In order to avoid overburdening local ESC inspectors, communities can require contractors to hire an independent, certified erosion and sediment inspector to ensure proper installation and performance of ESC practices.

Prohibit Use of Natural Wetlands for Stormwater Treatment

Allowing natural wetlands to treat stormwater runoff increases the depth of temporary or permanent ponding in a wetland. Over time, the altered hydrology transforms a natural wetland into a stormwater wetland with the loss of biological diversity and functional value. To prevent this from occurring, communities should review their existing stormwater ordinances to makes sure they prohibit the use of natural wetlands for stormwater treatment.

Restrict Discharges of Untreated Stormwater to Natural Wetlands

Since wetlands are located at the low point in the landscape, stormwater outfalls may unintentionally be discharged to natural wetlands. To prevent this from occurring, communities can require treatment of stormwater from new and existing stormwater pipe outfalls that discharge directly to wetlands through a local stormwater ordinance. This allows removal of pollutants, such as sediment and nutrients, and dissipates the velocity of runoff into the wetland. In addition, communities may want to consider retrofitting existing stormwater outfalls that discharge to wetlands with some form of stormwater treatment.

Discourage Installation of Stormwater Treatment Practices within Wetland Boundaries

Wetland buffers are intended to connect the wetland with upland habitat areas and provide a transitional area of native vegetation that protects it from future disturbance or encroachment. As a general rule, communities should strongly discourage the location of large stormwater treatment practices, such as stormwater ponds or created wetlands, inside the wetland buffer. In some cases, the use of a filter strip may be desirable in the wetland buffer. This approach works well when the stormwater occurs as sheet flow or shallow concentrated flow. When the stormwater becomes more concentrated, a stormwater depression or bioretention area may need to be used at the buffer boundary to store and release the increased runoff volumes.

Discourage Constrictions at Wetland Outlets

Constrictions built below wetland outlets increase stormwater runoff to natural wetlands. Constrictions may be caused by downstream culverts, bridges, dikes, roadway embankments, stormwater embankments and other water control structures. Each type of constriction has the potential to back water up into the wetland - increasing ponding or the frequency of inundation. These hydrological alterations have strong influence on the wetland plant community, and can cause dieback for some woody species, and may impact other wetland dependent species. In order to avoid these impacts, communities should carefully evaluate the effect of any proposed constriction in or near a wetland, either as part of the preliminary site plan review process or as part of the local wetland permit review.

Encourage Progressive Stormwater Management Techniques

In situations where development is located near wetlands, communities should use progressive stormwater management techniques to prevent a direct discharge or fill into the wetland. These techniques use a combination of site design, source control, and stormwater treatment approaches (Hirschman and Kosco, 2008):

1. Reduce runoff through design - use site planning and design techniques to reduce impervious cover, disturbed soils and stormwater impacts.
2. Reduce pollutants carried by runoff - use source control and pollution prevention practices to reduce the exposure of pollutants to rainfall and runoff.
3. Capture and treat runoff - design stormwater practices to collect and treat the stormwater that is generated after applying the first 2

steps. This is accomplished through the use of small-scale, distributed practices close to the source of runoff (e.g. rain gardens and pervious parking) combined with conventional practices (ponds and filters).

4.

Additional information is found in (Hirschman and Kosco, 2008) and Wetlands & Watersheds Article 4.

Develop Special Sizing Criteria for Stormwater Treatment Practices

Local or state stormwater manuals or regulations outline the amount of stormwater runoff that needs to be managed for storm events of various sizes. These sizing criteria may involve recharge, water quality, channel protection, overbank flooding, and extreme flood control. Communities may adjust their existing stormwater sizing criteria to protect wetlands from the indirect impacts of stormwater runoff. They can also require additional information including a field investigation of any wetlands present at a development site to determine their sensitivity, delineate the drainage area to the wetland, and evaluate whether any additional runoff will be delivered to the wetland as a result of the proposed project.

This information can be used to determine special sizing criteria to protect sensitive wetlands. Components of special sizing criteria include the recharge volume, water quality volume, channel protection volume and hydroperiod standards. These special stormwater criteria are outlined in a model wetland ordinance that can be adopted by local communities.

Recharge volume criteria are designed to maintain existing groundwater recharge rates at development sites in order to preserve existing water table elevations and maintain wetland hydrology. Since many sensitive wetlands depend on groundwater to maintain their natural hydrology, communities may choose to require recharge to maintain predevelopment recharge rates within sensitive wetland drainage areas.

The water quality volume captures and treats runoff from about 90% of the rain events each year into a stormwater treatment practice. Communities should ensure that the water quality volume is fully treated before any stormwater is discharged to a down-gradient wetland. For sensitive wetlands such as bogs or calcareous fens, a higher level of stormwater treatment may be required.

The channel protection criteria is designed to prevent stream channel enlargement and stream habitat degradation due to the increased frequency of bankfull and sub-bankfull flows that follow urbanization (Schueler and Brown, 2004). Channel protection can be applied to protect wetlands where future development faces a headwater stream that leads directly to a wetland and where a large proportion of freshwater wetlands are located in or near headwater stream channels that are expected to be impacted by increased stormwater discharges.

Wetland hydroperiod refers to the extended duration of inundation and/or saturation of wetland systems. Small changes in wetland hydroperiod can have negative effects in sensitive wetlands. Communities can adopt hydroperiod standards into their existing stormwater management regulations in order to maintain the existing wetland hydroperiod in all sensitive wetlands.

Promote Effective Stormwater Treatment Practices to Protect Downstream Wetlands

The selection and design of stormwater treatment practices applied in the wetland drainage area is very important in protecting sensitive wetlands. Within wetland drainage areas, communities can review their stormwater design manuals to provide more guidance on the use of infiltration and filtering practices as well as encourage the following Better Site Design techniques:

- Disconnection of rooftops and other impervious surfaces from the stormdrain network
- Use of pervious areas to treat runoff close to the source through recharge and infiltration
- Use of swales rather than curb and gutters along streets wherever possible
- Conserve forests and other natural areas at the site to maintain predevelopment hydrology
- Replant open or turf areas to achieve greater site forest cover or other native vegetative cover
- Take care during clearing and construction to minimize the degree of soil compaction

For additional information on the use of specific stormwater treatment practices to protect wetlands refer to Wetlands & Watersheds Article 3 and Hirschman and Kosco (2008).

Conduct Illicit Discharge Surveys for all Outfalls to Wetlands

A storm drain that has measurable flow during dry weather containing pollutants is defined as an "illicit discharge." Sources of illicit discharges include cross-connections between the sewer system and the storm drain system, as well as land use activities that illegally discharge pollutants to the storm drain system. Storm drain outfalls can contribute a variety of pollutants to a wetland during both dry and wet weather. A discussion of the impact of urban stormwater pollutants to wetlands is provided in

Wetlands and Watersheds Article 1. To help protect wetlands from illicit discharges, communities can conduct illicit discharge surveys for all outfalls that discharge directly to wetlands or are located within wetland drainage areas. Brown et al. (2004) provides guidance on conducing illicit discharge surveys.

Actively Enforce Restrictions on Dumping in Wetlands and their Buffers

Illegal dumping is a problem in urban stream valleys and wetlands because these areas do not have obvious landowners, are not usually policed, and are often poorly lit (Figure 5.5). Even though most communities have ordinances that prohibit dumping, they are difficult to enforce. To combat this problem, communities should specifically identify wetlands and buffers as restricted dumping areas, post *No Dumping* signs, and make use of community groups or adopt-a-wetland groups as monitors, and clearly define enforcement penalties.

Figure 5.5. Illegal dumping in a wetland (Photo source: USFWS, no date)

Require Enhanced Nutrient Removal from On-site Waste Water Treatment Systems

On-site waste water treatment systems provide a means of treating household waste for those areas that do not have access to public sewer, or where sewer systems are not feasible. Traditional on-site waste water treatment systems are not designed to remove nitrogen from the waste water they discharge. Nitrogen from these systems leaches into groundwater, which can have major water quality implications for wetlands dependent on groundwater. To protect wetlands from these impacts, communities can require enhanced nutrient removal from these systems. Communities can define the desired removal efficiencies for these practices or in some cases it is driven by state regulations. Communities can encourage the use of enhanced nutrient removal systems by establishing more stringent performance criteria for waste water treatment, including higher nutrient removal efficiencies, and writing this into their local septic system design guidance and/or ordinances.

Require Regular Septic System Inspections

One of the biggest factors for septic system failure is lack of maintenance. Septic system failure has a huge impact on wetland water quality by releasing bacteria and other pollutants into groundwater. To combat this problem, local health departments must regularly inspect septic systems and take actions to fix or replace failing systems. Innovative approaches to local septic system management include charging homeowners a monthly fee that is used for inspection, maintenance, and education. Other communities have developed a revolving loan program to provide low-cost repair to failed systems.

Incorporate Wetlands into Watershed Education Programs

The general public is unaware of the benefits that wetlands provide and may have misconceptions about wetlands, including the idea that wetlands function only as breeding grounds for mosquitoes that carry the West Nile Virus. Communities have the challenge of educating the public to overcome these barriers and provide information on the benefits of wetlands. Key information that should be included in a wetland education program includes providing information on how the average citizen can reduce inputs of nutrients and other pollutants to wetlands, enhance or restore wetlands on their property, and provide input on the federal wetland permitting process and state or local programs, where applicable. Examples of wetland education resources include:

- USEPA Wetland Fact Sheet Series
- USACE - Recognizing Wetlands
- Digital Frog International - The Digital Field Trip to Wetlands
- Environmental Concern Wetland Information Website
- Ducks Unlimited
- University of Florida Wetland Extension

Post Signs to Identify Wetlands, Buffers, and Wetland Drainage Area Boundaries

An important companion to any new local ordinance or wetland protection program is a means of notifying the public of wetland values and/or new requirements. Signs are most commonly used to notify the public about ordinances that protect natural resources, such as wetlands and their buffers. Signs are posted to identify the boundaries of the protected area, to inform residents of restricted uses and penalties, and to educate residents as to why these areas are protected. Communities should post signs around protected wetlands and their buffers, and may even be used to identify the boundaries of sensitive wetland drainage areas (Figure 5.6).

Figure 5.6. Sign posted at conserved wetland (Photo source: www.landandfarm.com)

Manage Invasive Wetland Plants

In disturbed wetland ecosystems invasive plants may become dominant because they are tolerant of changes in hydrology and pollutant inputs. Common invasive plant species include purple loosestrife, phragmites, reed canary grass, cattails, kudzu, multiflora rose, Asiatic tearthumb, water hyacinth, and Eurasian watermilfoil. Invasive plant control methods vary with each species and can range from simple measures, such as mowing, to methods that require heavy equipment, herbicides, or burning. Most methods require repeat application and constant monitoring, and will never fully eradicate the species from a site. Therefore, communities should focus on the prevention of invasive species. Invasive plant removal can be prioritized in sensitive wetlands and include control of invasive plants with wetland restoration projects. Several resources for wetland invasive plant management are listed below.

- American Wetlands Campaign Kit 2001: Common Invasive Wetland Plants
- University of Florida: Center for Aquatic and Invasive Plants
- USACE Jacksonville District: Biological Control of Exotic Aquatic and Wetland Plants
- USACE: Aquatic Plant Control Research Program
- Aquatic Ecosystem Restoration Foundation

Establish Volunteer Wetland Monitoring and Adoption Programs

Communities can establish programs that engage citizen volunteers to monitor and "adopt" wetlands in the watershed. Adopt-a-wetland programs are similar in concept to the successful adopt-a-highway program - volunteers adopt a specific wetland and can perform a range of general maintenance such as trash removal, invasive species removal, and buffer plantings. These types of programs provide educational and research opportunities for residents and can lead to increased concern, understanding, and stewardship or wetlands. Another way to engage the community is through a wetland monitoring program that can range from simple, qualitative assessments to more advanced monitoring including surveys of invasive species, water quality, amphibians, and benthic macroinvertebrates. Volunteers can range from school children to scout groups to senior citizen groups.

Encourage Wetland Landowner Stewardship

There are several federal funded programs through the USDA to implement wetland conservation and restoration techniques on agricultural lands. These programs range from cost-sharing assistance to landowners for developing habitat for threatened and endangered species, and other wildlife to establishing and maintaining long-term conservation practices such as buffer plantings and cattle fencing (Figure 5.7). The USDA Natural Resources Conservation Service (NRCS) provides more information on federal programs for wetland stewardship. Communities can provide additional funding for projects on non-agricultural lands to encourage wetland landowners to establish buffers, monitor wetlands, or conduct restoration activities. Financial incentives can include financial assistance, such as estate or personal property tax credits, recognition by local government, and on-site technical assistance.

Figure 5.7. Before cattle fencing project (top) and after (bottom). (Photo Source: USFWS, no date).

Establish Partnerships for Funding and Implementing Wetland Projects

Communities should work with local land conservation and other non-profit groups to help implement wetland conservation and restoration projects recommended as part of a watershed plan. These groups can provide volunteers to monitor or maintain project sites or implement simple projects, such as wetland buffer plantings. Other groups, such as land trusts, can hold conservation easements or raise funds to acquire priority conservation lands. A list of example potential partners can be found in Wetlands & Watersheds Article 3.

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Attachment A: Assessment of Community Wetland Protection Needs

Assessment of Community Wetland Protection Needs

This questionnaire was developed for use by anyone with an interest in documenting the importance of wetlands in their community and compiles some basic information to support a local wetland protection effort that addresses the specific environmental concerns and regulatory drivers in the community.

The results of this questionnaire can be used to help gain support from decision makers for expanded local wetland protection, as outlined in the Wetlands-At-Risk Protection Tool (WARPT) provided online: www.wetlandprotection.org. The WARPT outlines a process to inventory and evaluate the functions provided by wetlands and to make decisions about how to protect these functions at the local level using regulatory and voluntary measures. Completing the questionnaire provides insight into which aspects of the WARPT will be most useful to your community.

To complete the questionnaire, answer the 12 questions below for your community and record your responses on this form. The form is designed so you can save your responses electronically in the pdf. It can be completed for a single jurisdiction, or responses from multiple jurisdictions within a single watershed can be compiled on one form for a watershed approach to wetland protection. Don't worry if you can't answer all the questions, just do the best you can and skip the ones that are not relevant. Some potential methods and data sources are provided to help you answer each question, and some background information is provided as well to help you make the case to your local leaders.

Questions

Wetland Services

1. What wetland services are you most interesting in harnessing and protecting?

☐ Flood protection. *Wetlands prevent or help abate flooding issues associated with coastal storm surges, river flooding, storm sewer capacity problems, and more.*

☐ Recreation. *Wetlands provide opportunities for recreation such as hunting, fishing, birdwatching, and hiking, which may be important to the local economy.*

☐ Drinking water quality. *Wetlands maintain streamflow and remove pollutants, protecting the quality of downstream water supplies.*

☐ Shoreline property protection. *Shoreline wetlands provide protection from erosion by stabilizing the soil and absorbing floodwaters.*

☐ Maintain stream baseflow. *Wetlands have significant storage and recharge capacity, and play a critical role in the hydrology of downstream waters. This may be particularly important in arid or semi-arid regions where water is scarce and withdrawals are permitted or where in-stream flow standards are in place.*

☐ Wildlife habitat and biodiversity. *Wetlands are some of the most diverse habitats on the planet, and provide refuge for both aquatic and terrestrial wildlife. They often provide habitat for plant and animal species that are rare, threatened, or endangered.*

☐ Commercial products from wetlands. *Certain wetland types are important for harvesting peat, timber, cranberries, rice, fish or shellfish, which may form a significant part of the local economy.*

☐ Reduce pollutants in streams and stormwater. *Wetlands transform nutrients, retain sediment, and remove other types of pollutants from surface runoff and streamflow, affecting the quality of waters downstream.*

☐ Other (list): ____

This question should be completed by local government staff that is familiar with the community programs and needs, if possible. Otherwise, it can be answered by consulting local environmental experts.

Regulatory Context

1. Check all that apply. My community:

☐ Contains waters that are on the 303(d) list, have a Total Maximum Daily Load (TMDL) study, and/or implementation plan.

Wetlands transform nutrients, retain sediment, and remove other types of pollutants from surface runoff and streamflow, affecting the quality of waters downstream. The WARPT can identify wetlands that provide these functions, and recommended wetland conservation and restoration activities can be included as part of a TMDL implementation plan.

☐ Is a permitted Municipal Separate Storm Sewer System (MS4) under federal/state discharge permitting programs.

An effective local stormwater management ordinance requires land use planning as the first BMP, meaning that developers who identify and protect significant natural resources on their *sites usually have reduced stormwater management requirements. The WARPT can help to support this type of ordinance by providing an inventory of important wetlands sites in advance of site plan submittal.*

☐ Has a flood protection program.

The WARPT can generate a map of sites important for flood protection to include in the community floodplain program.

☐ Has a wetland mitigation banking, wetland restoration, or off-site mitigation program.

The WARPT can provide a ready list of wetland sites as part of a wetland banking program.

☐ Has a transfer of development rights (TDR) or purchase of development rights (PDR) program

The WARPT can determine wetland areas to include in sending zones for a TDR program or high priority sites for a PDR program

☐ Has a comprehensive plan, watershed plan or other natural resource plan.

The WARPT can identify priority wetlands to incorporate into conservation planning for the community and/or watershed.

☐ Has a stake in the Clean Water Act (CWA) Section 404 permitting process.

*Having a wetland inventory that identifies important functions may help to provide greater predictability regarding CWA Section 404 jurisdictional determinations because these data can inform decisions about whether a "significant nexus" exists between the wetland and a jurisdictional waterbody. More importantly, this information is provided **in advance of site plan submittal** for the entire watershed or community and should be evaluated in the field.*

This question should be completed by local government staff that is familiar with the community programs and needs, if possible. Otherwise, the question can likely be found on your municipal website or by calling up the appropriate local department staff.

2. Is there a state statute, regulation, or program that protects waters of the state? ________

If Yes:

a) Does the state definition of regulated waters include wetlands of all sizes/types? ______________

b) Are there maps? __________

c) What activities are regulated?____

*The goal of questions 11 and 12 is not to determine precisely which wetlands are protected by federal, state or local measures, but rather to identify any existing regulations and programs that **may** directly or indirectly protect wetlands. This helps to give a general sense of the need for local wetland protection and can identify potential gaps that can be filled by local regulations or programs. The most effective protection for wetlands will likely be provided using a combination of approaches. Communities with no state or local protection for wetlands may get the greatest benefit from the WARPT. However, communities with state or local programs to protect wetlands may find that these do not protect all wetlands (or all significant wetlands) from all types of impacts, and may wish to fill these gaps using the WARPT.*

- Use the following resources to determine what level of protection exists for wetlands in your state:
  - State Wetlands Information Tool : http://www.cicacenter.org/swift.html
  - Association of State Wetland Managers' State Wetland Program website: http://aswm.org/swp/statemainpage9.htm
  - Environmental Law Institute's report *State Wetland Protection: Status, Trends & Model Approaches* (ELI, 2008)**:** http://www.elistore.org/reports_detail.asp?ID=11279
- Call your State's wetland program or other relevant agencies for additional (and the most up-to-date) information

3. Are there any local measures that protect wetlands? (check all that apply)

☐ wetland protection ordinance

☐ wetland buffer ordinance (could be part of a stream buffer ordinance)

☐ special protection zoning for wetlands

☐ special stormwater criteria for discharges to wetlands

☐ discharges of untreated stormwater to wetlands prohibited

☐ adopt-a-wetland program

☐ wetland-related outreach and education

If this information is not readily known, a quick review of your community websites, phone call to local staff and/or a review of your community's local codes, ordinances and programs can provide the necessary information.

Wetlands In Your Community

1. What is the current wetland acreage in your community? __________

This establishes the baseline for wetlands in your community and gives you an idea of how much effort may be needed to identify priority areas for protection. For example, if wetland coverage is very low, you might skip the prioritization process and adopt a program to protect all remaining wetlands. If wetlands are extensive, you'll need to determine which ones provide the most benefits so you can direct resources towards protecting them.

- Get estimate from an existing land use plan, watershed plan or natural resources plan for your community
- Use state or local wetland inventories to estimate wetland acreage
- If no state/local data available, use the NWI (see wetland mapping question)

2. How much wetland loss has occurred/is occurring in your community? ___________

If wetland losses from agriculture and urban development have been significant, it is likely that your community has also lost valuable functions provided by these wetlands such as flood storage or water cleansing. This information can help to make the case for protecting remaining wetlands. It can also be useful to find out the extent of permits issued under Section 404 so that you can provide input on these determinations. Historic wetlands maps can also be used to identify potential sites for wetland restoration.

- Consult the U.S. Fish and Wildlife Service Status and Trends reports for state or region-wide estimates of wetland losses: http://www.fws.gov/wetlands/StatusAndTrends/index.html
- Check local libraries or natural heritage agencies for regional or local historic wetlands maps
- Estimate using old U.S. Geological Survey maps or soil surveys

- Obtain statistics on acres and types of wetlands filled under Section 404 permits from your Army Corps District office: http://www.mvm.usace.army.mil/regulatory/information/Locations.htm
- Use Natural Resources Conservation Service wetland determinations (aka “Swampbuster” maps) to identify farmed wetlands (wetlands that have been drained for agricultural use)
- Use mapping data to develop a rough estimate of historic wetland coverage. For example, the West Eugene Wetlands Special Area Study assumed that all land below 400 feet in elevation with hydric soil was formerly a wetland (Lane Council of Governments, 1991). Tiner (2005) describes a process for identifying historic wetlands in the Nanticoke River in MD/DE using the NWI, soils and aerial photos.

3. Are there any locally or regionally significant wetland types? If yes, describe the types and why they are significant.

____

____

“Significant” is a relative term, but the idea here is to find out which specific wetlands or types of wetlands have already been identified as having value in your community (for wildlife, tourism, flood protection). You can get this information from the sources below or from other local sources or simply based on local knowledge of the area and community attitudes.

- Check with state or local plans to identify wetlands designated as significant: e.g., state wetlands conservation plans, watershed plans, Special Area Management Plans, green infrastructure plans
- Check with the state natural heritage program to identify rare wetland types or wetlands that provide habitat for rare, threatened, or endangered species in your community
- Use wetland maps to identify wetland types that are especially sensitive to land disturbance, such as bogs, fens, vernal pools, prairie potholes, pocosins, and sedge meadows (Cappiella et al., 2006)
- Use wetland maps to identify wetland types that are considered difficult to replace (DTR) aquatic resources by your local Army Corps District: http://www.mvm.usace.army.mil/regulatory/information/Locations.htm
- Check with the state to identify any wetlands designated as Outstanding Natural Resource Waters
- Use research studies and local knowledge to identify other wetlands that are of value to the community

4. Are there extensive "isolated" wetlands? If yes, estimate the extent and/or types.

____

____

There is no universal or legal definition of an "isolated" wetland but it generally refers to wetlands that may be unregulated under the Clean Water Act (CWA) due to their lack of apparent surface water connection to larger, navigable waterways. The question of whether these isolated wetlands are regulated under the CWA came about as a result of three Supreme Court rulings: <u>Solid Waste Agency of Northern Cook County v. United States Army Corps of Engineers</u>, 531 U.S. 159 (2001) (SWANCC)and <u>Rapanos v. United States</u> and <u>Carabell v. United States Army Corps of Engineers</u>, 126 S. Ct. 2208 (2006) (Rapanos). Since the SWANCC and Rapanos rulings, some states have made initial estimates of the extent of isolated wetlands, while scientists are documenting the values and extent of various types of wetlands that can be considered isolated. It is important to remember that even wetlands that are regulated under the CWA Section 404 are not automatically protected from impacts. Permits for wetland fills are issued all the time under this program and other activities that can degrade wetlands, such as discharges of stormwater, are not regulated under Section 404. However, communities with extensive isolated wetlands have an opportunity to provide much greater wetland protection at the local level.

- If you live in one of the following states, use the resources below for estimates of isolated wetland extent and/or values:
  - Illinois: http://www.nwf.org/wildlife/pdfs/CleanWaterActIllinois.pdf
  - Ohio: http://www.nwf.org/wildlife/pdfs/CleanWaterActOhio.pdf
  - Michigan: http://www.nwf.org/wildlife/pdfs/CleanWaterActMichigan.pdf
  - Montana: http://mtnhp.org/reports/Isolated_Wetlands.pdf
  - New Mexico: http://www.nwf.org/wildlife/pdfs/CleanWaterActNewMexico.pdf
  - New York: http://www.nwf.org/wildlife/pdfs/CleanWaterActNewYork.pdf
  - North Carolina: http://www.aswm.org/fwp/summary_of_headwater_wetlands_nc.pdf
  - Rhode Island: McKinney and Charpentier (2008)
  - South Carolina: http://sc.audubon.org/PDFs/atrisk.pdf
- Use the Figure 1 to see if any of the 19 types of geographically isolated wetlands identified by Tiner (2003) and Tiner et al. (2002) are located in your region (hatched areas on map). http://library.fws.gov/Wetlands/isolated.pdf
- Go to the Nature Serve website to download data on isolated wetland types by ecological divisions of the U.S. (from Comer et al., 2005): http://www.natureserve.org/publications/isolatedwetlands.jsp

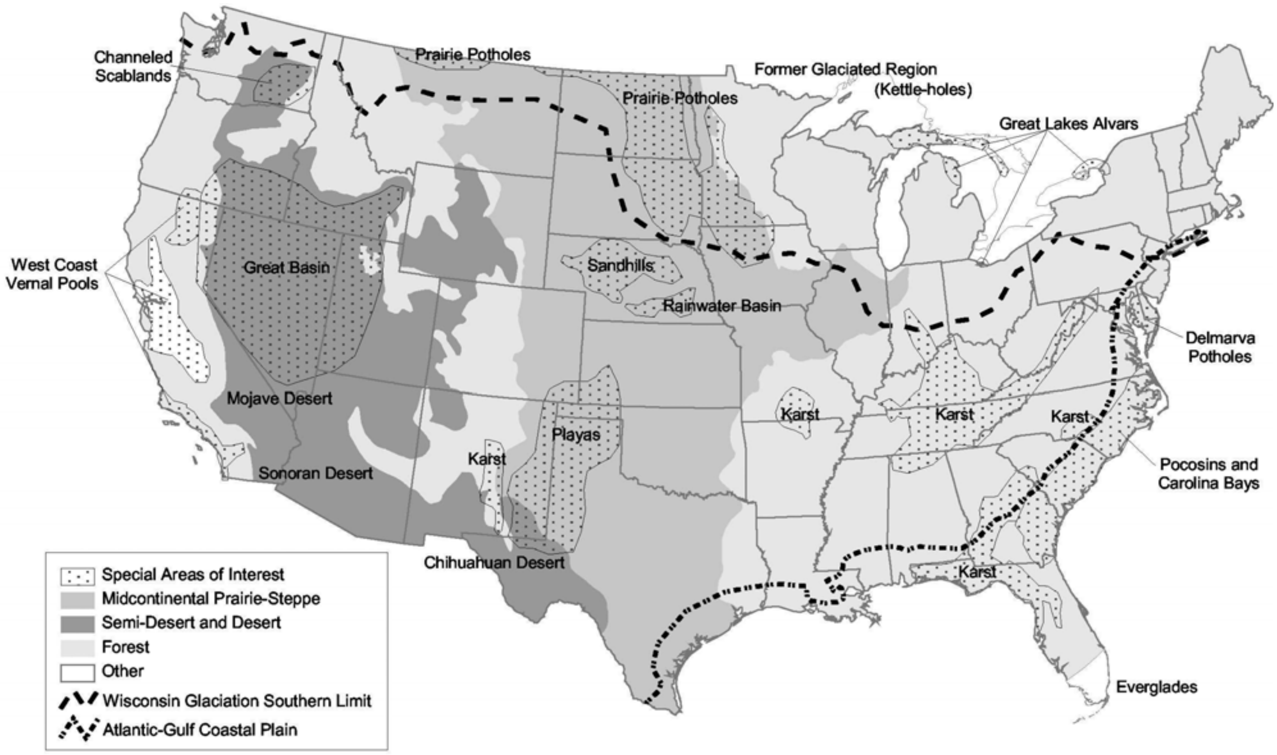

Figure 1. 19 types of geographically isolated wetlands (Tiner, 2003)

<u>Development In Your Community</u>

1. How much growth is anticipated in your community over the next 20-50 years? _________

This can be reported as population projections or increases in urban land, with the goal of getting a sense of the degree of development pressure on remaining undeveloped lands such as wetlands.

- Look at your community's comprehensive plan for growth projections, including population growth, urban growth boundaries, and acres of land planned for development.
- Use state or Census population projections: http://www.census.gov/population/www/projections/stproj.html

2. Where and how will this development occur?

____
____

Your comprehensive plan or zoning map should indicate not only where future development will be concentrated (or conversely, whether it will be widespread and sprawling), but also the types of development planned. You can compare this information with wetland maps to evaluate the relative risk of impacts to remaining wetlands, especially significant ones. The results of questions 8 and 9 can give you a sense of how urgent the need is for local wetland protection in your community.

- Look at your community's comprehensive plan and zoning map to identify areas with the most development pressure and determine the proposed development intensity. Specific elements to look for include: urban growth boundaries, priority areas for development, zoning categories and allowable densities, proposed sewer/water service areas, roads and existing infrastructure, and resource protection zones.
- Check with your state planning department for state or regional studies that evaluate development pressure.

3. What other planned activities (e.g., agriculture, forestry, mining, infrastructure projects) might adversely affect wetlands in your community? ________________________________

Wetland Mapping

1. What types of wetland maps are available? (check all that apply)

- ☐ National Wetland Inventory (NWI)
- ☐ State or local wetland inventory
- ☐ Maps of protected wetlands
- ☐ Wetlands associated with intermittent and ephemeral streams
- ☐ Wetlands less than 1 acre
- ☐ Geographically isolated wetlands

☐ Uncertain

If National Wetland Inventory (NWI) maps are the best available for wetland in your community, you may consider doing the WARPT as a way to update maps locally. The NWI is based on data from the 1980s, and tends to underestimate wetland coverage, specifically wetlands smaller than 3 acres and ephemeral wetlands. State or local wetland inventories generally have greater accuracy. If your state or local wetland inventory is very old or is based on low-resolution data, you may want to do an update. In general, if your wetland inventory includes wetlands less than 1 acre and wetlands associated with intermittent and ephemeral streams they are probably of sufficient detail to protect wetlands locally. If maps of protected wetlands or geographically isolated wetlands are available, they will be useful to identify priority wetlands as part of the WAPRT. It is much easier to protect wetland resources when you have good maps of their locations.

Resources

Cappiella, K., Kitchell, A., and T. Schueler. 2006. *Using Local Watershed Plans to Protect Wetlands.* Article 2 of the Wetlands and Watersheds Article Series. Center for Watershed Protection. Ellicott City, Maryland.

Comer, P., Goodin, K., Tomaino, A., Hammerson, G., Kittel, G., Menard, S., Nordman, C., Pyne, M., Reid, Sneddon, L., and K. Snow. 2005. *Biodiversity Values of Geographically Isolated Wetlands in the United States*. NatureServe. Arlington, VA.

Environmental Law Institute (ELI). 2008. State Wetland Protection: Status, Trends & Model Approaches. Washington, DC.

Lane Council of Governments. 1991. *West Eugene Wetlands Special Area Study. Draft Technical Report.* Lane Council of Governments, Eugene, OR.

McKinney, R.A., and M.A. Charpentier. 2008. Extent, properties and landscape setting of geographically isolated wetlands in southern New England watersheds. Wetlands Ecology and management 17(4): 331-344.

Tiner, R. 2005. Assessing cumulative loss of wetland functions in the Nanticoke River Watershed using enhanced national wetlands inventory data. *Wetlands*, 25(2):405-419.

Tiner, R. 2003. Geographically Isolated Wetlands of the United States. *Wetlands* 23(3): 494-516.

Tiner, R., Bergquist, H., DeAlessio, G. and M. Starr. 2002. *Geographically Isolated Wetlands: A Preliminary Assessment of their Characteristics and Status in Selected Areas of the*

United States. U.S. Department of the Interior, Fish and Wildlife Service, Northeast Region. Hadley, MA.

SA-WFC

1: GENERAL INFORMATION			
WATERSHED:	SUBWATERSHED:	UNIQUE WETLAND ID:	
DATE: ___/___/_____	ASSESSED BY:	CAMERA ID:	PIC#:
MAP GRID:	LAT ___°_____'_____" LONG ___°_____'_____"		LMK #
WEATHER CONDITIONS:			
Cowardin classification type from GIS or NWI:	Note specific field map(s) used as part of the assessment (e.g., GIS map of potential wetlands, aerial photos, etc.):		

2. PURPOSE OF FIELD CHECK (select all that apply)

- ☐ Quick check of presence of potential wetland identified in GIS (see Step 1 of the WARPT – update wetland maps)
- ☐ Confirm / verify Cowardin classification from GIS/NWI
- ☐ Confirm / verify changes in wetland condition (stressors, land use change) not detected in GIS
- ☐ Quick assessment of potential wetland functions
- ☐ Gather information on wetlands for planning / mapping of potential wetlands
- ☐ Gather preliminary information prior to more formal assessment
- ☐ Conduct a full wetland delineation using an appropriate method

3. PRESENCE OF WETLAND

- ☐ Wetland appears to be present in mapped location
- ☐ Wetland appears to be present, but mapped location is not correct.
- ☐ Wetland appears to be present, but condition is different than identified in GIS (e.g., stressors, land use changes)
- ☐ Wetland does NOT appear to be present

For wetlands confirmed as present:

- ☐ Cowardin classification from GIS/NWI confirmed
- ☐ Recommend change in Cowardin classification due to observed conditions (e.g., beaver dams, forest cover, clearing of vegetation, sedimentation, etc.). Recommended classification (see attached Cowardin tree):

____

4. PRESENCE OF WETLAND FUNCTIONS

Use Table 1 below to identify wetland functions associated with the wetland or watershed services relevant to your inventory or mapping effort. Based on these wetland functions, fill out the appropriate information in Table 2.

Table 1. Wetland Services and Functions

Wetland Services	Wetland Functions Associated with Services
Flood protection	• Surface water detention • Coastal storm surge detention
Recreation	• Provision of habitat for fish and other aquatic animals • Provision of waterfowl and waterbird habitat • Provision of other wildlife habitat
Shoreline property protection	• Shoreline stabilization • Coastal storm surge detention
Maintain baseflow in streams	• Streamflow maintenance
Wildlife habitat and biodiversity Commercial products from wetlands (e.g., peat, timber, cranberries, rice, fish, shellfish)	• Provision of habitat for fish and other aquatic animals • Provision of waterfowl and waterbird habitat • Provision of other wildlife habitat • Conservation of biodiversity
Maintain drinking water quality Reduce pollutants in streams and stormwater	• Nutrient transformation • Retention of sediments and other particulates

Table 2. Checklist for Probable Wetland Functions

Function (Tiner, 2003) – See Table 1	Wetland appears to provide function of interest? Check all that apply	Rate the ability of the wetland to perform the function of interest as High, Moderate or Low. Refer to Tiner (2003) for wetlands likely to provide the function at a significant level	Field observations to support function	Note any field conditions that are inhibiting the wetland's ability to provide the function of interest (e.g., adjacent land use, upstream impacts, etc.)
Surface water detention				
Streamflow maintenance				
Nutrient transformation and recycling				
Sediment and other particulate retention				
Coastal storm surge detention and shoreline stabilization (for coastal watersheds)				
Inland shoreline stabilization				
Provision of fish and shellfish habitat (coastal and inland)				
Provision of waterfowl and waterbird habitat				
Provision of other wildlife habitat				
Conservation of biodiversity				

Wetland ID:______________

5. NARRATIVE DESCRIPTION OF OBSERVATIONS

Describe relevant information about the wetland: unique features, impacts or indicators of stressors or degradation, influences from watershed, condition of downstream channel, etc.

6. SUMMARY OF FINDINGS & FOLLOW-UP ACTION

Wetland to be included in wetland map layer: ☐ Yes ☐ No

Classification of wetland from GIS/NWI:________________________

Recommended classification based on field visit (See Section 3): ________________________

Wetland should be confirmed and delineated as part of future regulatory or plan review process: ☐ Yes ☐ No

Other:____

7. SUPPORTING DOCUMENTATION

☐ Map with photo points identified

☐ Photo #s

☐ GPS Points

☐ Other:____

WETLANDS AND DEEPWATER HABITATS CLASSIFICATION

System: M - Marine

Subsystem	1 - Subtidal				2 - Intertidal			
Class	RB – Rock Bottom	UB – Unconsolidated Bottom	AB – Aquatic Bed	RF – Reef	AB – Aquatic Bed	RF – Reef	RS – Rocky Shore	US – Unconsolidated Shore
Subclass	1 Bedrock 2 Rubble	1 Cobble-Gravel 2 Sand 3 Mud	1 Algal 3 Rooted Vascular	1 Coral 3 Worm	1 Algal 3 Rooted Vascular	1 Coral 3 Worm	1 Bedrock 2 Rubble	1 Cobble-Gravel 2 Sand 3 Mud 4 Organic

System: E - Estuarine

Subsystem	1 - Subtidal				2 - Intertidal							
Class	RB – Rock Bottom	UB – Unconsolidated Bottom	AB – Aquatic Bed	RF – Reef	AB – Aquatic Bed	RF – Reef	SB – Streambed	RS – Rocky Shore	US – Unconsolidated Shore	EM – Emergent	SS – Scrub-Shrub	FO – Forested
Subclass	1 Bedrock 2 Rubble	1 Cobble-Gravel 2 Sand 3 Mud 4 Organic	1 Algal 3 Rooted Vascular 4 Floating Vascular	2 Mollusk 3 Worm	1 Algal 3 Rooted Vascular 4 Floating Vascular	2 Mollusk 3 Worm	1 Bedrock 2 Rubble 3 Cobble-Gravel 4 Sand 5 Mud 6 Organic	1 Bedrock 2 Rubble	1 Cobble-Gravel 2 Sand 3 Mud 4 Organic	1 Persistent 2 Non-persistent 5 *Phragmites australis*	1 Broad-Leaved Deciduous 2 Needle-Leaved Deciduous 3 Broad-Leaved Evergreen 4 Needle-Leaved Evergreen 5 Dead 6 Deciduous 7 Evergreen	1 Broad-Leaved Deciduous 2 Needle-Leaved Deciduous 3 Broad-Leaved Evergreen 4 Needle-Leaved Evergreen 5 Dead 6 Deciduous 7 Evergreen

System: R - Riverine

Subsystem: 1 - Tidal; 2 – Lower Perennial; 3 – Upper Perennial; 4* - Intermittent; 5** – Unknown Perennial

Class	RB – Rock Bottom	UB – Unconsolidated Bottom	SB*** – Streambed	AB – Aquatic Bed	RS – Rocky Shore	US – Unconsolidated Shore	EM – Emergent
Subclass	1 Bedrock 2 Rubble	1 Cobble-Gravel 2 Sand 3 Mud 4 Organic	1 Bedrock 2 Rubble 3 Cobble-Gravel 4 Sand 5 Mud 6 Organic 7 Vegetated	1 Algal 2 Aquatic Moss 3 Rooted Vascular 4 Floating Vascular	1 Bedrock 2 Rubble	1 Cobble-Gravel 2 Sand 3 Mud 4 Organic 5 Vegetated	2 Nonpersistent

* **Intermittent** is limited to the **Streambed** Class
** **Unknown Perennial** is limited to **Unconsolidated Bottom**
*** **Streambed** is limited to **Tidal** and **Intermittent** Subsystems

Classification of Wetlands and Deepwater Habitats of the United States, Cowardin *et al*. 1979

WETLANDS AND DEEPWATER HABITATS CLASSIFICATION

System: L - Lacustrine

Subsystem: 1 - Limnetic

Class	RB – Rock Bottom	UB – Unconsolidated Bottom	AB – Aquatic Bed
Subclass	1 Bedrock 2 Rubble	1 Cobble-Gravel 2 Sand 3 Mud 4 Organic	1 Algal 2 Aquatic Moss 3 Rooted Vascular 4 Floating Vascular

Subsystem: 2 - Littoral

Class	RB – Rock Bottom	UB – Unconsolidated Bottom	AB – Aquatic Bed	RS – Rocky Shore	US – Unconsolidated Shore	EM – Emergent
Subclass	1 Bedrock 2 Rubble	1 Cobble-Gravel 2 Sand 3 Mud 4 Organic	1 Algal 2 Aquatic Moss 3 Rooted Vascular 4 Floating Vascular	1 Bedrock 2 Rubble	1 Cobble-Gravel 2 Sand 3 Mud 4 Organic 5 Vegetated	2 Nonpersistent

System: P - Palustrine

Class	RB – Rock Bottom	UB – Unconsolidated Bottom	AB – Aquatic Bed	US – Unconsolidated Shore	ML – Moss-Lichen	EM – Emergent	SS – Scrub-Shrub	FO – Forested
Subclass	1 Bedrock 2 Rubble	1 Cobble-Gravel 2 Sand 3 Mud 4 Organic	1 Algal 2 Aquatic Moss 3 Rooted Vascular 4 Floating Vascular	1 Cobble-Gravel 2 Sand 3 Mud 4 Organic 5 Vegetated	1 Moss 2 Lichen	1 Persistent 2 Nonpersistent 5 *Phragmites australis*	1 Broad-Leaved Deciduous 2 Needle-Leaved Deciduous 3 Broad-Leaved Evergreen 4 Needle-Leaved Evergreen 5 Dead 6 Deciduous 7 Evergreen	1 Broad-Leaved Deciduous 2 Needle-Leaved Deciduous 3 Broad-Leaved Evergreen 4 Needle-Leaved Evergreen 5 Dead 6 Deciduous 7 Evergreen

MODIFIERS

In order to more adequately describe the wetland and deepwater habitats, one or more of the water regime, water chemistry, soil, or special modifiers may be applied at the class or lower level in the hierarchy. The farmed modifier may also be applied to the ecological system.

Water Regime			Special Modifiers	Water Chemistry			Soil
Nontidal	**Saltwater Tidal**	**Freshwater Tidal**		**Coastal Halinity**	**Inland Salinity**	**pH Modifiers for all Fresh Water**	
A Temporarily Flooded	L Subtidal	S Temporarily Flooded-Tidal	b Beaver	1 Hyperhaline	7 Hypersaline	a Acid	g Organic
B Saturated	M Irregularly Exposed	R Seasonally Flooded-Tidal	d Partly Drained/Ditched	2 Euhaline	8 Eusaline	t Circumneutral	n Mineral
C Seasonally Flooded	N Regularly Flooded	T Semipermanently Flooded-Tidal	f Farmed	3 Mixohaline (Brackish)	9 Mixosaline	I Alkaline	
E Seasonally Flooded/ Saturated	P Irregularly Flooded	V Permanently Flooded-Tidal	h Diked/Impounded	4 Polyhaline	0 Fresh		
F Semipermanently Flooded			r Artificial	5 Mesohaline			
G Intermittently Exposed			s Spoil	6 Oligohaline			
H Permanently Flooded			x Excavated	0 Fresh			
J Intermittently Flooded							
K Artificially Flooded							

Attachment C: Rapid Field Assessments of Wetland Function

Table 3c.2. Rapid Field Assessments of Wetland Function (derived from: Bartoldus (2000), Fennessey et al. (2004), and Hatfield et al. (2004))

Name	Geographic Applicability and Wetland Types Assessed	Functions Evaluated	Description	Source
Delaware Comprehensive Assessment Procedure	Tidal and non-tidal wetlands in DE	Hydrology, Water Quality, Habitat, Shoreline/Sediment Stabilization	Collects data that can be used to assess the condition of wetlands in relation to minimally disturbed sites. Variables are then combined into functions and an Index of Wetland Condition that provides an overall assessment of the ecological integrity of the site.	Jacobs et. al (2008)
Evaluation for Planned Wetlands	All wetland types nationally	Hydrology, Water Quality, Habitat, Shoreline/Sediment Stabilization	EPW is a simple procedure which documents and highlights differences between wetlands based on their capacity to provide six functions. The differences between wetlands are expressed in terms of individual elements, Functional Capacity Index, and Functional Capacity Units.	Bartoldus et al. (1994)

Table 3c.2. Rapid Field Assessments of Wetland Function (derived from: Bartoldus (2000), Fennessey et al. (2004), and Hatfield et al. (2004))				
Name	**Geographic Applicability and Wetland Types Assessed**	**Functions Evaluated**	**Description**	**Source**
Hollands / Magee Method	Non-tidal wetlands of the glaciated Northeast and Midwest	Hydrology, Water Quality, Habitat, Shoreline/Sediment Stabilization, Groundwater	Assesses wetland functions in the Section 404 regulatory program as well as other situations. Evaluates 10 wetland functions/values giving each functional indicator a numerical score. Output is a measure of function of a wetland site relative to the functional model mean score and/or scores for other wetlands in a defined area.	Hollands and Magee (1985)
MA Coastal Zone Management Method	Freshwater wetlands and salt marshes in the MA coastal zone	Habitat	Assessment based on 5 landscape indicators and 8 wetland quality indicators (indicators scored 0-6) with separate versions for freshwater wetlands and salt marshes. Total score calculated from sum of all indicators divided by total points possible.	Hicks and Carlisle, (1998)

Table 3c.2. Rapid Field Assessments of Wetland Function (derived from: Bartoldus (2000), Fennessey et al. (2004), and Hatfield et al. (2004))				
Name	**Geographic Applicability and Wetland Types Assessed**	**Functions Evaluated**	**Description**	**Source**
MT Wetland Assessment Method	All wetlands in MT	Hydrology, Water Quality, Habitat, Shoreline/Sediment Stabilization, Groundwater	Regulatory method to evaluate sites where proposed impacts may occur, especially from highway projects. Evaluates 12 functions and assigns wetlands overall ratings to facilitate avoidance priorities (e.g., based on uniqueness or high value, disturbance and replacement potential)	Berglund (1999)
Guidance for Rating the Values of Wetlands in NC	Non-tidal freshwater wetlands in NC and SC	Hydrology, Water Quality, Habitat, Shoreline/Sediment Stabilization	Designed to rate freshwater wetlands when making decisions regarding 401 Water Quality Certifications. Also provides a tool for evaluating wetland acquisition, restoration, and mitigation banks. Six wetland values are addressed.	NCDENR (1995)
OH Rapid Assessment Method	Freshwater wetlands in OH, may be applicable to	Habitat, Hydrology	Used for regulatory and condition assessment purposes. Easy to use and provides overall quality rating based on 6 metrics (presence or absence of	Mack (2001)

Table 3c.2. Rapid Field Assessments of Wetland Function (derived from: Bartoldus (2000), Fennessey et al. (2004), and Hatfield et al. (2004))				
Name	**Geographic Applicability and Wetland Types Assessed**	**Functions Evaluated**	**Description**	**Source**
	throughout the Midwest		disturbance indicators and ecological condition). Used to place wetlands into three management categories. Method includes some value added measurements. With regard to reference, the user is directed to score the assessment wetland in comparison to wetlands of the same type. While the definition of reference wetlands is simple and not explicit, the method scoring is supported by the IBI data.	
Penn State Stressor Checklist	Freshwater wetlands in PA		Tabulates number of stressors present and accounts for ameliorating effects of buffer. Weights all stressors the same, but overall score lowered if buffer is impaired (outfalls or encroachment). Requires	Brooks et al. (2002)

Table 3c.2. Rapid Field Assessments of Wetland Function (derived from: Bartoldus (2000), Fennessey et al. (2004), and Hatfield et al. (2004))				
Name	**Geographic Applicability and Wetland Types Assessed**	**Functions Evaluated**	**Description**	**Source**
			landscape analysis prior to fieldwork.	
WA State Wetland Rating System (Western)	Freshwater wetlands in western WA	Hydrology, Water Quality, Habitat	Categorizes wetlands into four categories based on their sensitivity to disturbance, their rarity, our ability to replace them, and the functions they provide. The "rating" categories are intended to be used as the basis for developing standards for protecting and managing the wetlands to reduce further loss of their value as a resource.	WA Dept of Ecology, (1993)
WA State Wetland Rating System (Eastern)	Freshwater wetlands in eastern WA	Hydrology, Water Quality, Habitat	Categorizes wetlands into four categories based on their sensitivity to disturbance, their rarity, our ability to replace them, and the functions they provide. The "rating" categories are intended to be used as the basis for developing standards for protecting and managing the	WA Dept of Ecology, (1993)

Table 3c.2. Rapid Field Assessments of Wetland Function (derived from: Bartoldus (2000), Fennessey et al. (2004), and Hatfield et al. (2004))				
Name	**Geographic Applicability and Wetland Types Assessed**	**Functions Evaluated**	**Description**	**Source**
			wetlands to reduce further loss of their value as a resource.	
Wetland Rapid Assessment Procedure	Freshwater wetlands in FL	Hydrology, Water Quality, Habitat	Provides a consistent, timely regulatory tool for evaluating freshwater wetlands that have been created, enhanced, preserved, or restored through FL's regulatory programs and permit process. Cannot use to compare different wetland types.	Miller and Gunsalus (1997)

All methods are rapid (1 day or less per site). All require field visits. Methods that require development of regional models are not included. Most can evaluate isolated wetlands based on the description of wetland types assessed, but this should be confirmed with the protocol documentation. Methods with poor documentation were eliminated. All methods result in quantitative scores and, if they evaluate multiple functions, have the ability to generate separate scores for each function. Methods evaluating social values or biological condition only (e.g., site-specific values) were eliminated. Methods designed solely for mitigation sites were not included. It is unclear from a cursory review of the literature on these methods, whether use of a reference site is required. This should be verified before deciding on a method. Some methods may also have the ability to evaluate condition, restoration potential or social factors but this information was not considered in selection of the methods presented here. Most assessments require wetland delineation and many of these methods use HGM as the wetland classification system.

Attachment D: Case Studies

CASE STUDY - Wood County, Ohio

Wood County, Ohio is located in Northwestern Ohio, south of the City of Toledo. After the last glacier retreat 20,000 years ago, the majority of Wood County, Ohio (the County) was left as the Great Black Swamp (Figure 1.3). Over time the swamp was drained though aggressive ditching efforts to create rich and fertile agricultural land. Today, most of the County is in agricultural production with an extensive, well-maintained ditch network that drains to local waterways. Through a partnership with the Center for Watershed Protection, the County conducted an update of its local wetland map using a Geographic Information System (GIS).

The County currently uses the National Wetlands Inventory (NWI) data, which is often outdated and doesn't include smaller wetland systems (i.e. less than one to three acres) that provide important functions, such as water quality and habitat. Updating the wetland mapping data provided the County with more accurate data to locate and protect wetlands.

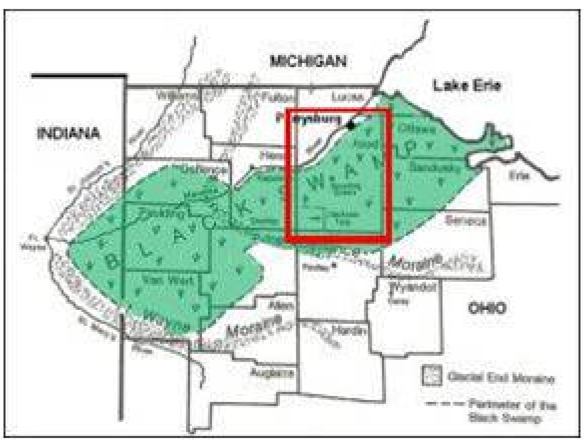

Figure 1.3. Great Black Swamp (Wood County is outlined in red)

In addition to using the NWI data as known locations of wetlands, the County utilized the following wetland indicator layers to help identify potential wetlands in addition to the NWI data:

- Hydric Soils data from NRCS Soil Survey Geographic (SSURGO) Database - Soils that are saturated, flooded, or ponded for a long enough period during the growing season to develop anaerobic conditions in the upper horizons.
- 100 yr FEMA floodplain data - May contain riverine or riparian wetlands.

- Forest layer from Wood County, OH - Wetlands encompassed the entire County before it was developed, and therefore it is assumed that any land that is currently forested is still a wetland.

In addition, a Digital Elevation Model (DEM) was used to identify the locations of 'sinks' (or depressional areas) in the County that may indicate the presence of wetlands. This analysis wasn't successful due to the minimal topographic relief within the County; as the greatest elevation change within the County is approximately 10 feet. Therefore, the DEM wasn't used as a wetland indicator layer in this analysis.

Each wetland indicator layer was assigned a numerical weight based on the data layer's known accuracy for indicating wetlands and best professional judgement. For example, hydric soils were provided a higher weight because they are one of the main indicators of wetlands, whereas floodplains were provided a lower weight. A score was then assigned to each data layer that represents the likelihood of wetland presence. Table 1.4 provides a summary of the weights and scores assigned to each wetland indicator layer.

Table 1.4. Scoring System for Wood County Wetland Indicators

Indicator Layer	Weight	Score	Highest Possible Score
Hydric Soils	3	Hydric = 15 Dominantly Hydric = 10 Partially Hydric = 7 Urban Complex Hydric = 5	45
Floodplain	1	Location within Floodplain = 25	25
Forests	2	Location within Forests = 15	30
		Total Possible Score:	**100**

After the scores were assigned, all of the data layers were intersected using GIS, which resulted in a new shapefile that contains all of the wetland indicator data and the assigned scores. The sum of all of the scores for each polygon in the shapefile was calculated - the higher the score, the more likely that a wetland is present in that location. The wetland indicator layers and resulting scores are shown in Figure 1.4, with the areas in red representing the highest total score of 100 and the areas in orange representing a score of 85. The County plans to field verify the accuracy of the data and use it to make future decisions through a local wetlands information committee.

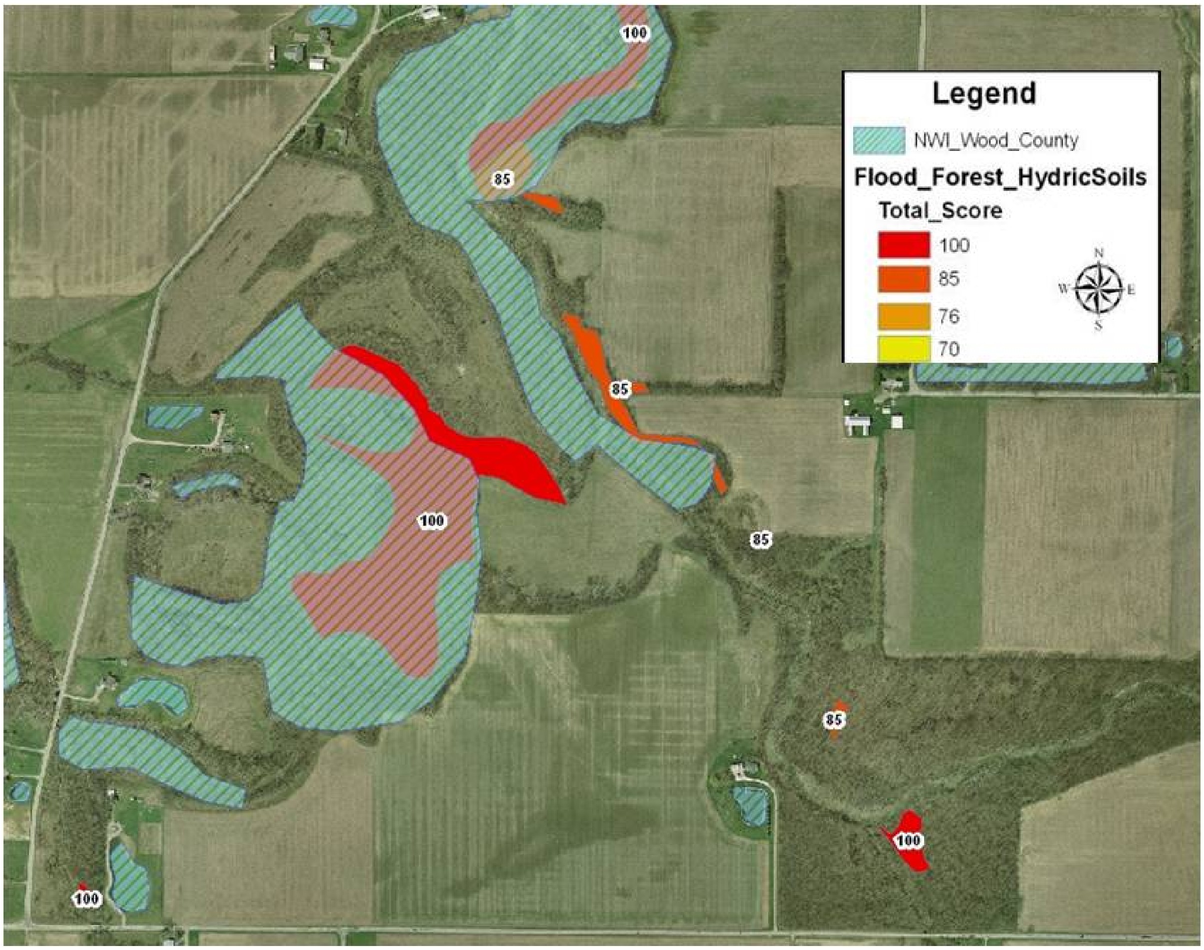

Figure 1.4. Results of Potential Wetland Indicator Mapping (blue striped = NWI, red = score of 100, orange = score of 85).

For additional information, contact Robert Heckman, GIS Analyst II at Wood County Engineer's Office - rheckman@co.wood.oh.us.

CASE STUDY - Seven Mile Creek Watershed in Minnesota

Seven Mile Creek is a 36.8 mi^2 agricultural watershed located in south-central Minnesota in the Minnesota River Basin. The watershed is dominated by flat agricultural fields with numerous small depressions. As of 2002, 81% of the watershed land use was cropland. A study was conducted to determine the extent of wetland loss to cropland, engineered surface and sub-surface drainage modifications, and general cropping system shifts by analyzing aerial photos from seven different time periods dating back to 1938.

Public land surveys were also available from 1854 and combined with digital elevation models and soil surveys to provide insight on pre-settlement conditions. Changes in land use, specifically wetland, grassland, pasture, and forest loss were digitized in GIS. The results show that about 50% of the watershed was once covered by wetlands during the pre-settlement time period. Of those wetlands, approximately 88% have been converted to cropland. This analysis is a valuable tool to help educate watershed residents and policy makers about the importance of restoring wetlands and their functions. For additional information, refer to Kuehner (2004).

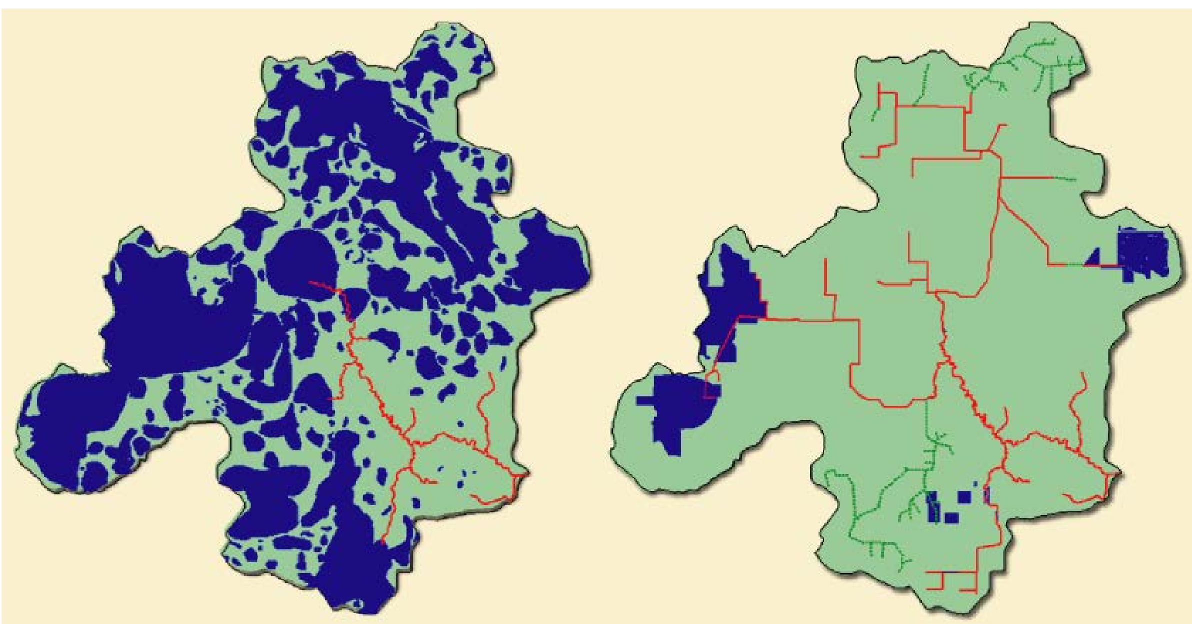

Figure 2.1. Historic (1854) and present-day (2003) wetland coverage in the Seven Mile Creek watershed in Minnesota (Source: Cottonwood Water Quality Board - http://mrbdc.wrc.mnsu.edu/org/bnc/wetlands.html).

CASE STUDY - Wetlands and Deepwater Habitats of the Nanticoke River Watershed

The Nanticoke River watershed is a tributary to the Chesapeake Bay, located in Delaware and Maryland and is approximately 2,070 km^2 in size. The two states worked cooperatively to develop a watershed-based strategy for wetland conservation and restoration. The goal was to produce an inventory and analysis of historic wetlands and their functions for the

Nanticoke River watershed and to compare those findings to present-day conditions.

Tiner (2005) derived the distribution and extent of pre-settlement wetlands from soil survey data from the NRCS and the Delaware Department of Natural Resources and Environmental Control (DNREC), as well as USGS orthophotomaps. Hydric soils were the primary source used to identify historic wetlands and were compared with existing NWI data to identify possible large wetland complexes that were not recorded as historic wetlands based on soil mapping. The assumption was that if the area was a large wetland today, it was likely a wetland at the time of settlement. Orthophotos were used to locate "lost" estuarine wetlands that are now shallow water.

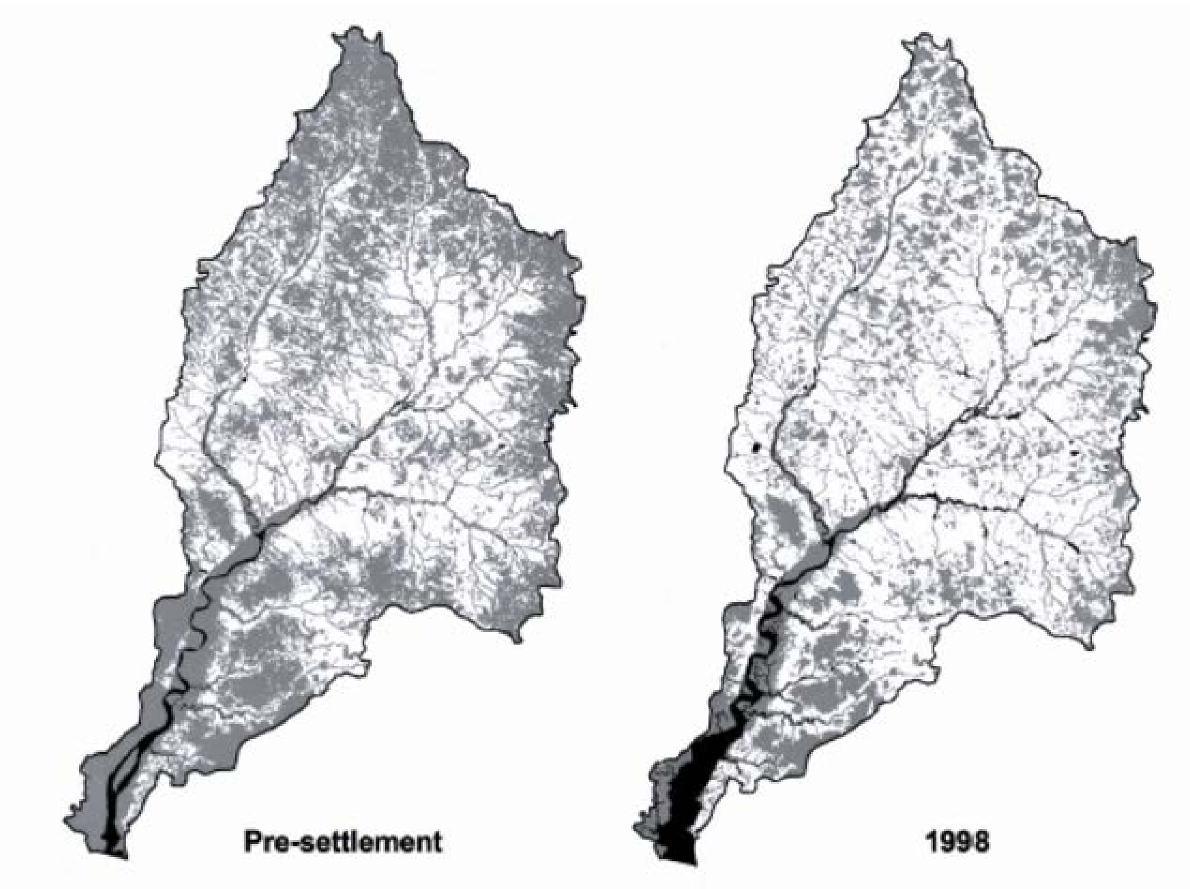

Figure 2.2. Nanticoke River watershed's wetlands and deepwater habitats at pre-settlement and in 1998 from Tiner (2005). Black areas are deepwater habitats; gray areas are wetlands (including ponds).

After pre-settlement wetlands were identified, they were classified according to Cowardin et al. (1979). In addition, a preliminary assessment of wetland function was conducted by assigning descriptors for landscape position, landform, water flow path, and waterbody types. The results of the analysis show that by 1998, the extent of wetlands in the watershed had been reduced by 62% of the original pre-settlement conditions. The principal causes of wetland loss were sea-level rise and wetland conversion to farmland. Based on the functional assessment, the watershed lost over 60% of its original capacity for streamflow maintenance and over 35% for surface-water detention, nutrient transformation, sediment and particulate retention, and wildlife habitat. For additional information, refer to Tiner (2005).

CASE STUDY - Wetlands of Cape Cod and the Islands, Massachusetts

Wetlands in Massachusetts were among the first to be inventoried as part of the National Wetland Inventory (NWI) program based on data from the mid-1970s. However, this original mapping is no longer relevant for most areas due to development and changes within the region. Tiner (2010b) describes the process for updating the NWI for the Cape Cod region as well as the addition of descriptors for landscape position, landform, water flow path, and waterbody type (LLWW).

NWI data were viewed with on-line U.S. Geological Survey topographic maps to identify wetlands along streams and general slope characteristics and aerial imagery was used to determine waterbody types. Based on the LLWW descriptors, wetlands and ponds were evaluated for the performance of 11 functions: surface water retention, streamflow maintenance, nutrient transformation, sediment and other particulate retention, coastal storm surge detention, shoreline stabilization, provision of fish and shellfish habitat, provision of waterfowl and waterbird habitat, provision of other wildlife habitat, conservation of biodiversity, and carbon sequestration. Wetlands in the region totaled nearly 53,500 acres, representing 12 to 16% of the land area of the Cape Cod region. Estuarine wetlands were the most abundant, followed by palustrine wetlands. Through the preliminary assessment of wetland functions, over half of the wetlands were found to perform nine of the eleven functions evaluated at significant levels. More than 90% of the wetlands were found to be important for surface water detention and retention of sediments, while more than two-thirds were projected to serve as coastal storm surge detention areas, fish and shellfish habitat, and waterfowl and waterbird habitat.

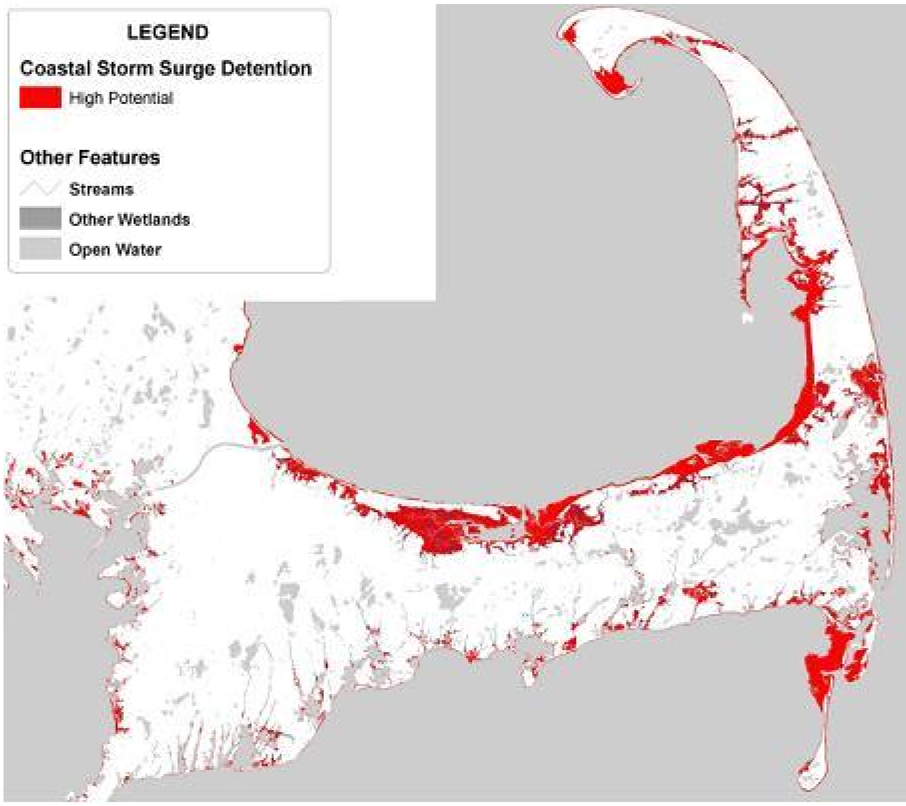

Figure 3a.2. Wetlands with high potential to provide coastal storm surge detention based on a preliminary assessment of wetland function in the Cape Cod region of Massachusetts. Source: Tiner (2010b).

For additional examples of the preliminary assessment of wetland function, please visit the publications page of the U.S. Fish and Wildlife Service.

CASE STUDY - Frederick County, Maryland

Frederick County is located in western Maryland and is the largest county in the state (Figure 3a.3). The land use and landscape is quite varied and includes agriculture, large forest tracks, mountains and rolling hills, and urban/suburban development. In recent decades, development has increased significantly as development pressure from the Washington DC and Baltimore, MD metropolitan areas has increased. Because of this development pressure, it is important for the County to identify wetlands and their functions that are most vulnerable to development.

Two components of the WARPT process were tested in Frederick County, MD.

Step 1. Update Wetland Maps
Step 3a. Assess Wetland Functions (desktop)

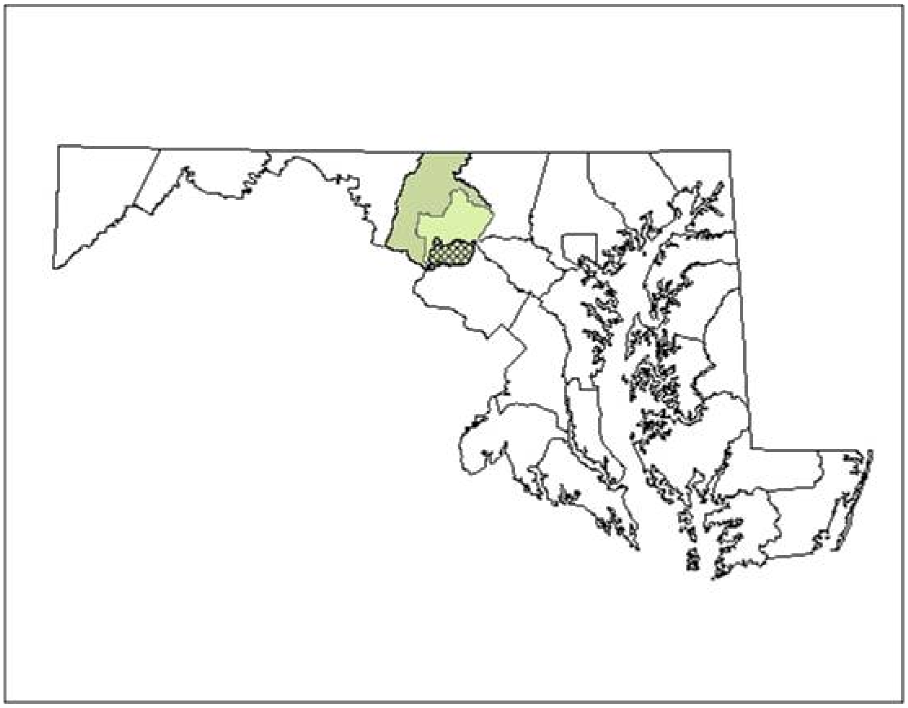

Figure 3a.3. Frederick County, Maryland (the Lower Monocacy watershed is in lighter green and the Bennett Creek watershed is in black hatch).

Step 1. Update Wetland Maps

County staff currently relies on wetland maps from the Maryland Department of Natural Resources (DNR) and the National Wetlands Inventory (NWI). These maps were published in 1998 and because of development and subsequent land use changes; the county has a need for updating its wetlands maps. Using a similar process as was used in the Wood County, OH case study, wetland indicator layers were utilized to indicate areas where unmapped wetlands could potentially exist. The following wetland indicators layers were used for this process:

- Hydric soils data from NRCS Soil Survey Geographic (SSURGO) database - Soils that were both hydric and partially hydric were included in this layer.
- Sinks greater than 0.1 acres - These are depressions or areas of low elevation where water running off the surrounding landscape is most likely to collect. They were derived from the County's Digital Elevation Models (DEMs) which are a 3-D representation of the landscape's terrain.
- Buffered headwater streams - The majority of the wetlands in Frederick County are associated with streams, seeps, or springs. However, the County's existing stream layer only includes perennial streams. Headwater streams provide a better indication of where the water table is close to the surface, increasing the likelihood of a

wetland. The headwater streams were derived from the County's DEMs and then buffered by 50 ft.

- Vegetation from the USGS GAP Analysis Program - This Program maps vegetative associations that can be used to facilitate planning and management of biological diversity on a regional and national scale. Classes of vegetation that may contain wetland vegetation were selected from the dataset.
- 100 yr FEMA floodplain - May contain wetlands associated with streams and rivers.

Figure 3a.4. Areas of overlap between the various wetland indicator layers. Each wetland indicator layer was assigned a score. Areas with the greatest number of overlapping indicator layers received higher overall scores and are therefore more likely to be wetlands (Figure 3a.4). This process was piloted in the Bennett Creek watershed, which is located in the southern portion of Frederick County (Figure 3a.5).

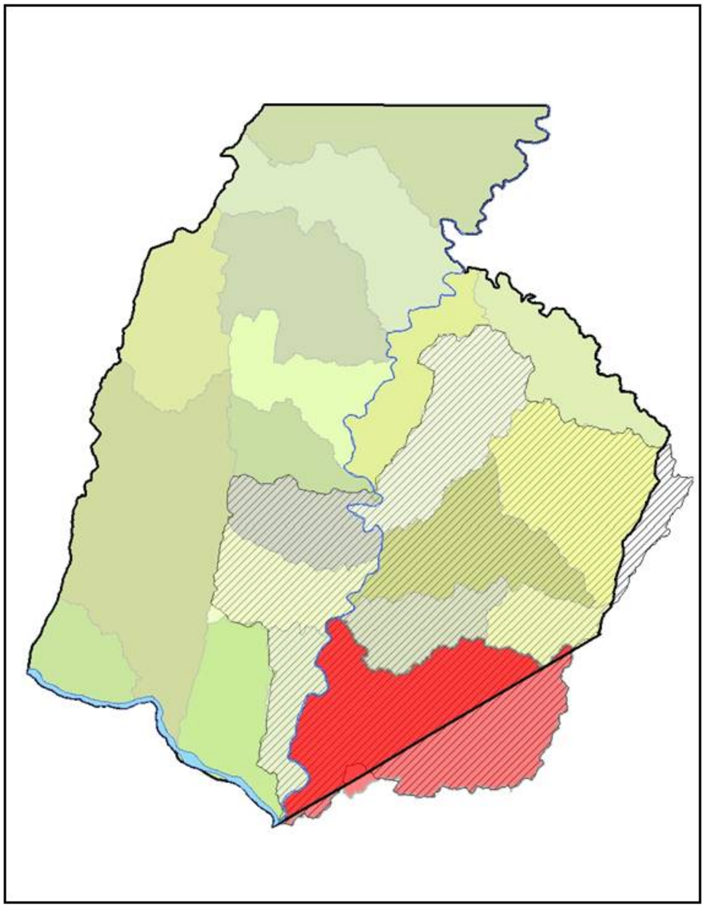
Figure 3a.5. Frederick County's 20 subwatersheds (Bennett Creek watershed highlighted in red).

Table 3a.5. Scoring System for Frederick County Wetland Indicators		
Indicator Layer	**Score**	**Highest Possible Score**
Hydric Soils	Hydric = 20 Partially Hydric = 10 Non-Hydric = 0	20
Sinks	Hydrologic Sink = 10	10
Headwater Streams	Location within headwater stream buffer = 10	10
Vegetation	Contains wetland vegetation = 10	10
Floodplain	Location within floodplain = 10	10
	Highest Possible Score:	**60**

Within the Bennett Creek watershed, 296 potential wetlands were mapped using the wetland indicator layers above with a high score of 40. Based on best professional judgment, it was determined that those wetlands with scores of 30 or higher should be included in the updated wetland layer as potential wetlands. Cowardin classifications (system, class, and subclass) for the potential wetlands were assigned using Frederick County's orthophotography. Fifteen potential wetlands were selected for field verification, thirteen were actually visited, and three were confirmed as wetlands. Based on field conditions, two of the three confirmed wetlands had recommended changes to the Cowardin classification. The three confirmed wetlands all had the same wetland indicator layers: hydric soils, floodplain, and vegetation. All but one of the mapped potential wetlands that ended up not being wetlands once field verified had the same wetland indicator layers: hydric soils, vegetation, and headwater streams. This leads staff to believe that the headwater streams indicator layer might be leading to an overestimation of wetland presence. County staff intends to select another sample of wetlands for field verification to test this hypothesis. Based on the findings, it's possible that the scoring for the different indicator layers will be adjusted. After the mapping technique and indicator layers have been refined, staff will complete the effort countywide.

Step 3a. Assess Wetland Functions (desktop)

The County has not completed the desktop wetland function analysis on the newly mapped potential wetlands in the Bennett Creek watershed. However, the LLWW toolbar was run on the existing mapped wetlands within the Bennett Creek watershed. Forty-four different Cowardin classifications are used, which included a total of 1,214 wetland polygons, to classify the wetlands in the Bennett Creek watershed with the majority classified as some variation of palustrine shrub/scrub, palustrine forested, or palustrine emergent. The toolbar ranked all of the wetland polygons with high, moderate, or null (N/A) rankings for 10 different wetland functions.

Table 3a.6. Number of Wetlands Ranked by Function in the Bennett Creek Watershed

Wetland Functions	Number of Wetlands with Ranking Function		
	High	Moderate	Null (N/A)
Bank & Shoreline Stabilization (BSS)	159	0	1055
Carbon Sequestration (CAR)	153	582	479
Coastal Storm Surge Detection (CSS)	0	0	1214
Fish & Aquatic Invertebrate Habitat (FAIH)	2	5	1207

Nutrient Transformation (NT)	156	582	476
Other Wildlife Habitat (OWH)	15	722	477
Streamflow Maintenance (SM)	0	162	1052
Sediment & Other Particulate Retention (SR)	163	349	702
Surface Water Detention (SWD)	15	339	860
Waterfowl & Waterbird Habitat	9	2	1203

This data will be used by County staff to prioritize areas for restoration or protection during a Green Infrastructure (GI) Planning Process that is currently underway.

For additional information, contact Jessica Hunicke, Project Manager, Frederick County Watershed Management Section, jhunicke@frederickcountymd.gov.

CASE STUDY - Assessment of Wetland Condition: An Example from the Upper Juniata Watershed in Pennsylvania

Wetland condition was evaluated by Wardrop et al. (2007) in the Upper Juniata Watershed in central Pennsylvania using a multi-level approach. The Upper Juniata watershed is one of the three subwatersheds of the Juniata River, which is the largest tributary to the Susquehanna River. The watershed is almost 1,000 mi^2 in size and contains 1,770 miles of streams, 76% of which are first and second order. Land cover in the watershed is 70% forested, 27% agriculture, and 3% urban.

A landscape assessment was conducted through a GIS analysis that used forested land cover as a reference condition because it is the historic land cover. Wetland sites were determined using the National Wetlands Inventory (NWI) data combined with a map of probable wetland sites. A generalized random tessellation stratified (GRTS) design was used to generate a random sample of wetland sites. Forested land cover was overlain with the wetland data layer to calculate each wetland's percentage of forest cover. The resulting scores ranged from 0% to 100% with 100% forested being the highest condition.

A rapid assessment was then conducted to refine the results of the landscape assessment and to account for the influence of stressors and the benefits of buffers. Field sampling was conducted for each site identified by GRTS and involved assigning an HGM class and type, as well as the number of stressor indicators present. Sites with a higher number of stressors had a lower influence from the forest cover. Wetland buffer influence was evaluated based on the type and width of the buffer.

The study found that a total of 5,246 acres of wetlands exist in the watershed, consisting of slope wetlands (74%), riverine wetlands (20%), and lacustrine fringe and depressions (less than 7%). Using the landscape assessment, over half of the wetlands were rated in the highest or high condition. In comparison, the rapid assessment showed a 38% decrease in the highest and high condition wetlands and four time increase in low condition wetlands. The rapid assessment was shown to be better at gauging factors important to wetland condition. This information can be used to prioritize sites for restoration, conservation or protection.

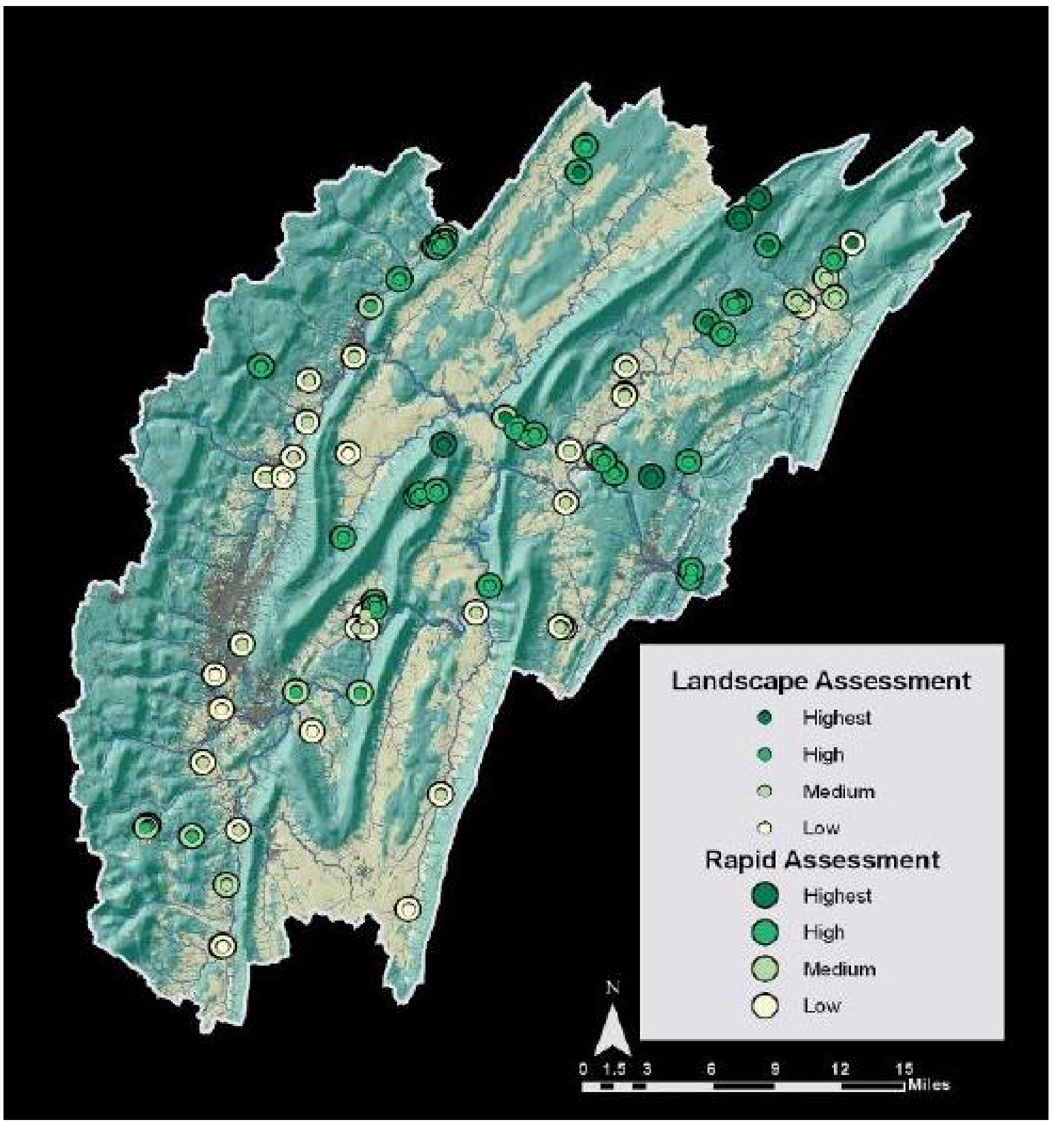

Figure 3c.1. Spatial distribution of sites by landscape and rapid assessment category in the Upper Juniata watershed. (Source: Wardrop et al. (2007))

CASE STUDY - New Jersey Natural Resource Valuation Study

The New Jersey Department of Environmental Protection (NJ DEP) worked with researchers from the University of Vermont to be the first state to assess the economic value of all of New Jersey's natural resources. The natural resources inventories included wetlands, forest, riparian buffers, farmland, urban parks, open fresh waters, beaches/dunes, marine waters and mines and quarries. The total acres for each type of natural resource were calculated using state geographic information system data. Monetary values were then assigned to the goods and services provided by each type of natural resource using data from peer-reviewed journals and analysis conducted by the authors. The results of the study reported an annual value of approximately $20 billion/year for the total ecosystem services and values of New Jersey. Of this amount, freshwater wetlands and marine ecosystems provide the highest eco-service values. The NJ DEP intends to use this data to generate a statewide dialog to inform rulemaking, land acquisition priorities, and decisions with regional and local planning organizations.
For additional information refer to NJDEP (2007).

CASE STUDY: Lake County, IL Advanced Identification (ADID) Study

Located in the Chicago suburbs, Lake County, Illinois was facing development pressure and experiencing unwanted wetland loss. In order to protect the existing wetlands in the County, a partnership with federal, state and local agencies was developed to complete an Advanced Identification (ADID) study. The ADID study provides an inventory of high quality wetland resources in the County that were defined as wetlands that provide the following functions; habitat quality, stormwater storage, and water quality mitigation. The data from the study provides upfront information on the location of wetlands designated for protection which allows more predictability in the wetland permitting process. The study is used at the federal level as an advisory document during federal 404 wetland permit reviews, at the local level to inform local land use decisions, identify potential mitigation/restoration sites, and identify potential sites for acquisition.

Source: Dreher, Elston, and Schaal (1992)

CASE STUDY: A Model Local Ordinance to Protect Wetland Functions

Wetlands & Watersheds Article 4 presents a model wetland drainage area protection ordinance available for use by local governments to protect wetland functions. The model ordinance aims to protect wetlands from indirect impacts not addressed under the Section 404 permit program. The model ordinance uses the following concepts and principles for protecting wetlands: identifying sensitive wetlands, addressing wetland contributing drainage areas, and applying wetland protection criteria.

CASE STUDY: Eightmile River Watershed, Connecticut

The lower Connecticut River is home to internationally recognized tidal marsh communities, exceptionally intact forest blocks and tributaries, and a multitude of creatures, including six kinds of plants and animals that are rare or endangered worldwide. The Nature Conservancy (TNC) has protected more than 4,000 acres in the Lower Connecticut River region since 1960. A key component of TNC's Lower Connecticut River Program is community partnerships, particularly in East Haddam, Lyme and Salem, the three towns through which the Eightmile River flows. This tributary of the Connecticut has remarkably high water quality, and is surrounded by large blocks of undeveloped forest. Despite more than 350 years of settlement, the area today is more than 80 percent forested. It comprises a variety of habitats, from its cold, fast-flowing headwaters to the freshwater tidal marshes where it meets the Connecticut.

Local government partners have been working with TNC to protect the Eightmile River watershed by acquiring key parcels of land and conservation easements. In October of 2004, the town of Lyme and TNC protected the town's highest conservation priority, the 480-acre Jewett property. A total of 434 acres were purchased, while conservation easements protected the remaining 46 acres for a total of $3,270,500. It was one of the three largest unprotected parcels in the Eightmile River watershed, and includes more than a mile of high quality tributaries of the Connecticut River. The land links a 1,000-acre block of protected open space to the south with a 3,000-acre block to the northeast, forming more than 10 miles of open space predominantly along the Eightmile River. The cost of the acquisition was split by TNC and the town of Lyme. A portion of the town's funding came from the state Department of Environmental Protection Open Space and Watershed Protection grant program.
Source: TNC (no date)

CASE STUDY: Washington State Wetlands Rating System

Washington State Department of Ecology developed a rating system for wetlands based on functions, values, sensitivity to disturbance, rarity, and replacement difficulty. Local management decisions that are based on this rating include: the level of impact avoidance required, width of buffers necessary to protect from adjacent development, mitigation acreage and replacement ratios, and permitted uses in wetlands. The wetlands rating system includes four categories, ranging from the highest quality, rare wetland types (Category I) to the smallest, and least diverse wetlands (Category IV). Category I wetlands include Natural Heritage wetlands and

bogs, and require a buffer width of 215 feet, while only a 50 foot buffer is required for Category IV wetlands.
Source: WADOE (1993)

CASE STUDY: King County, Washington Critical Areas Ordinance

King County, Washington's Critical Areas Ordinance states that an increase in buffer width of 50 feet may be required for certain wetland types if located within 300 feet of priority habitat areas, as defined by the state. Alternatively, the developer may provide a relatively undisturbed vegetated corridor at least 100 feet wide between wetlands and all priority habitat areas located within 300 feet of the wetland, provided this corridor is protected by easement.
Source: King County, Washington (2005)

CASE STUDY: The Villages of Thomas Run

When originally proposed, the Village of Thomas Run in Harford County, Maryland consisted of 450 single-family homes on individual lots. The plan required extensive filling of wetlands and five stream crossings. When the County rejected the proposal, citing adverse impacts on wetlands, the developer hired a local planning and engineering consultant to redesign the site. The revised plan called for townhomes to be clustered on upland portions of the site. Careful designing of the site allowed nearly half of the site to be preserved as open space, reduced the number of stream crossings, and greatly minimized the impact to wetlands.
Source: ULI (1994)

CASE STUDY: King County, Washington Erosion Control Guidance

The King County Department of Development and Environmental Services (DDES) has written guidance for contractors regarding construction site controls needed during the "wet" season of October 1 through April 30. In certain designated areas of the county, no clearing and grading work can occur during the wet season unless the site infiltrates 100% of its runoff or the applicant submits and obtains approval for a "Winterization Plan" from DDES. This plan must identify the areas where work is to be performed, describe the techniques that will be used to mitigate erosion, and include the name and number of a 24-hour contact who has demonstrated ability in erosion control.

Source: King County, Washington Erosion and Sediment Control for Construction Sites

CASE STUDY: Mecklenburg County, North Carolina ESC Ordinance

Mecklenburg County, North Carolina has incorporated construction site phasing into its erosion and sediment control ordinance. The County encourages contractors not to disturb more than 20 acres at any one time. When an area larger than 20 acres is disturbed, the corresponding ESC plan must contain five additional measures to ensure that soils are exposed for the shortest amount of time possible. Included among these measures is construction sequencing and construction phasing to "justify the time and amount of exposure."

Source: Mecklenburg County, North Carolina (2002)

CASE STUDY: Puget Sound Wetland Guidelines

Washington State Department of Ecology's Storm Water Management Manual specifies that discharges to wetlands must maintain the hydrologic conditions, hydrophytic vegetation, and substrate characteristics necessary to support existing and designated beneficial uses. To provide guidance for developers on how to meet this requirement, the Puget Sound Wetlands and Stormwater Management Research Program developed criteria for determining the maximum allowed exceedances in alterations to wetland hydroperiods. The resulting Puget Sound Wetland Guidelines are summarized below.

In order to determine if the proposed development will impact the wetland hydroperiod, designers must first determine the existing hydroperiod of the wetland using simulation models or actual measurement over a period of time. Next, they must forecast the future hydroperiod of the wetland using simulation models or impervious cover (IC) estimates and relationships between IC and water level fluctuations (WLF) (Chin, 1996; Horner et al., 1997). The future hydroperiod of the wetland must meet the following standards:

- Mean annual WLF shall not exceed 20 cm
- The frequency of stage excursions of 15 cm above or below pre-development stage shall not exceed an annual average of six
- The duration of such stage excursions shall not exceed 72 hours per excursion
- The total dry period shall not increase or decrease by more than two weeks in any year
- Alterations to watershed and wetland hydrology that may cause perennial wetlands to become vernal shall be avoided

For priority peat wetlands (e.g., bogs, fens), the duration of stage excursions above the pre-development stage shall not exceed 24 hours in any year. For wetlands inhabited by breeding native amphibians during breeding season, the magnitude of stage excursions above or below the pre-development stage shall not exceed 8 cm, and the total duration of such excursions shall not exceed 24 hours in any 30-day period.

If the analysis forecasts exceedance of any of the hydroperiod standards, then the designer must consider reducing the level of development, increasing the runoff storage capacity, using selective runoff bypass, or increasing runoff infiltration, where feasible. After development, wetland hydroperiod must be monitored continuously to determine if applicable limits are exceeded.

Source: Horner et al. (1997)

CASE STUDY: Nags Head North Carolina Septic Health Initiative

The Town of Nags Head began a Septic Health Initiative in late 2000 designed to develop strategies and programs to improve the performance of septic systems in the Town. The programs developed were based on the work of the Town of Nags Head Septic Health Committee. This committee is composed of a cross-section of Town citizens sharing a deep concern for the protection of water quality within and around the Town. The goals of the Septic Health Committee in developing the Initiative were to improve septic systems performance while maintaining acceptable surface and ground water quality, as well as controlling the density of developed land by promoting the use of on-site waste systems. The Septic Health Committee developed a series of four programs designed to improve the performance of septic systems while gathering information about septic systems in the town. The four programs are:

- Septic Tank Pumping and Inspection Program
- Water Quality Monitoring Program
- Education Program
- Decentralized Wastewater Management Plan

Click here for additional information.

CASE STUDY: Oakdale, Minnesota Adopt-A-Wetland Program

The City of Oakdale, Minnesota
established an adopt-a-wetland program for community groups, homeowner associations, businesses, or other interested parties who want to help with the improvement and upkeep of a particular Oakdale wetland, pond, lake or stream. Volunteers can select their own water body or have the City suggest one for them, and choose from the following list of activities:

- Trash removal

- Invasive plant removal (e.g., buckthorn, purple loosestrife)
- Native buffer planting
- Water quality monitoring
- Wetland data collection
- Wetland monitoring
- Community education

Volunteers can conduct the activity as frequently as they wish, and have officially "adopted" the wetland after having completed one activity. Volunteers receive an Adopt-A-Wetland certificate, and a sign commemorating the volunteer group may be installed at the site. The City has created an Adopt-A-Wetland How-To Kit, which contains instructional materials and resources for adopting a wetland. This kit is available on the City's website.

Source: City of Oakdale, Minnesota (no date)

CASE STUDY: Wetland Restoration in the San Francisco Bay Estuary

The San Francisco Bay Estuary is the Nation's second largest and perhaps the most biologically significant estuary on the Pacific Coast. It has also suffered the most extensive degradation of any estuary in the nation. Many years of filling, pollution, and alien species invasions have taken a great toll on the ecosystem. Despite these losses, however, the San Francisco Bay Estuary is now a major center for a vibrant habitat restoration movement.

The Bay Estuary's ecological value lies mainly in the wetlands along its edge, and in the riparian habitats of streams and rivers feeding into it. These habitats are essential to the health of the myriad fish and wildlife populations of the region. Millions of shorebirds and waterfowl stop by during their annual migrations between Alaska and South America. The Western Hemisphere Shorebird Reserve Network has designated the San Francisco Bay Estuary as a site of "Hemispheric Importance" (its highest ranking), and the North American Waterfowl Management Plan has listed it as one of 34 waterfowl habitats of major concern in North America.

Over the past two decades, the San Francisco Bay Joint Venture (SFBJV) has made significant progress to protect what remains and to begin restoring as much as possible of what was lost. This partnership of public agencies, environmental organizations, the business community, local governments, the agricultural community, and landowners works cooperatively to protect, restore, increase, and enhance wetlands and riparian habitat in the San Francisco Bay watershed.

The SFBJV helps partners put habitat restoration, acquisition and enhancement projects on the ground by connecting partners with the

funding opportunities, information and resources they need to make projects happen. Over the past few years, the San Francisco Bay Joint Venture (SFBJV) partners have completed 22 wetland protection, restoration, or enhancement projects involving over 11,100 acres, with another 31,400 acres in progress. Working with the SFBJV, Ducks Unlimited staff has created a comprehensive, yet user-friendly habitat project tracking system that will help the SFBJV with their facilitation role and help the partnership track regional progress towards their restoration goals.
Source: http://www.sfbayjv.org/