



New York State
Department of Environmental Conservation

Division of Fish, Wildlife and Marine Resources
Division of Mineral Resources

Technical Guidance for Creating Wetlands As Part of Unconsolidated Surface Mining Reclamation

February 1997



GEORGE E. PATAKI, Governor

JOHN P. CAHILL, Acting Commissioner

Preface

This document provides technical guidance for creating functional, persistent wetlands as part of the reclamation of unconsolidated surface mining operations. Much of the material presented is not precise, because it is intended to serve as a framework. There is no standard "recipe" for creating a wetland, for no two wetlands and no two situations are alike. The hydrogeomorphology, soil types, and functions vary from site to site. Successfully creating a persistent, functional wetland involves adapting the design to the conditions and opportunities present.

Figure 1-4 courtesy of Richard B. Newton, University of Massachusetts.

Figure 5,6 from Marble, A.D. 1992. A Guide to Wetland Functional Design. Lewis Publishers. Chelsea, MI. 222 pp.

I. INTRODUCTION

Wetlands are transition areas between aquatic and terrestrial communities and exist where the ground is saturated or inundated with water for extended periods during the growing season. Many, but not all, may be flooded for the entire year. The presence and duration of water in the soil influences the type and characteristics of the soils present. Conversely, the soils may influence how long and how deeply an area is saturated or inundated. The hydrology and soil in turn influence the plant and animal communities that live and thrive at the site. Many plants cannot survive with their roots continually wet while others have developed adaptations that allow them to survive in wet conditions. Certain animals also depend on the water and plant communities present in wetlands in order to feed, breed or raise young.

This document presents technical guidance for developing wetlands as part of the reclamation of unconsolidated surface mining operation. It is intended to help establish the conditions so that a functional wetland will develop and persist. Wetlands change over time. The goal is to establish a wetland that will persist and adapt to the conditions present over time. As the site matures, the plant and animal communities present will probably become more diverse and adapted to the site.

A few basic steps must be followed in designing a wetland:

- 1)** Determine the goals and objectives for creating the wetland. What does the landowner want out of the wetland? Are there regional wetlands goals that the project might help support? These may be general goals, such as improving aesthetics on the property, or very precise goals, such as providing habitat for ducks and swallows.
- 2)** Determine the hydrology of the site. What is the source of water? (Groundwater? Surface run-off?) What are the elevations throughout the year? (Will there be sufficient water to keep the wetland wet, or is there too much, resulting in a pond?)
- 3)** Determine the soils present at the site. Are they sufficient to allow the proper permeability? Are they rich enough for plant development? Can the plants' roots get established?
- 4)** Design the size, shape and plant community and consider any other unique issues using Steps 1 - 3.

Once these points have been determined, decisions about methods of planting, maintenance schedule, and wildlife considerations can be made.

II. WETLAND HYDROLOGY

The long-term viability of a created wetland depends on establishing the appropriate hydrology. The hydrology will determine the type and functions of the wetland that will develop.

Sites of shallow water will support a greater variety and diversity of plants. Deeper water supports fewer, but often different, species of plants and animals. Water depth and inundation also affect soil composition.

Wetlands hydrology can be categorized in a number of different ways. Novitzki's (1979) hydrological classification system for wetlands combines topography, surface water and groundwater parameters and establishes the four wetland classes listed here. Most wetlands created on unconsolidated surface mining sites will be either surface water depression or ground water depression wetlands.

SURFACE WATER DEPRESSION WETLANDS result from water pooling in shallow basins. Hydrology depends on precipitation and overland flow. Water permanence and basin depth determine whether the impoundment is a pond, a marsh, or a seasonal wetland (**Figure 1**). To prevent infiltration, soils generally must be fine textured, impermeable silt clay, or bedrock that extends beyond the planned depth of the wetland basin.

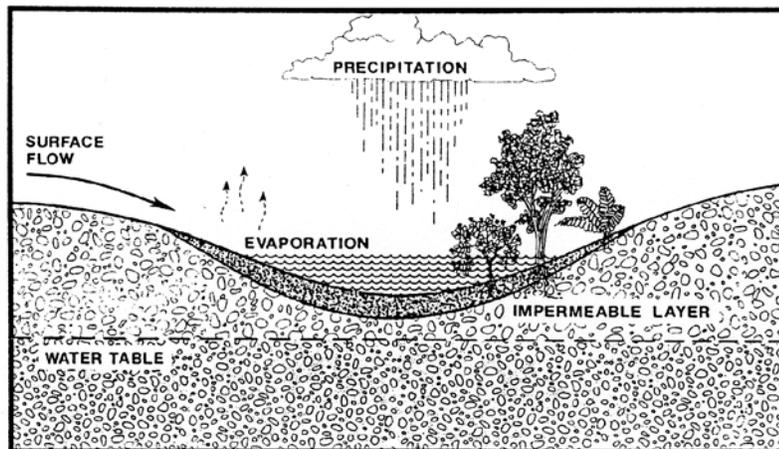


Figure 1. Surface Water Depression Wetlands.

SURFACE WATER SLOPE WETLANDS are located along pond, lake, and stream margins. Hydrology depends on fluctuating water depths caused by surface water flooding (**Figure 2**). The source may be either surface or ground water. Soils should be permeable sands or loams that allow subsurface flow.

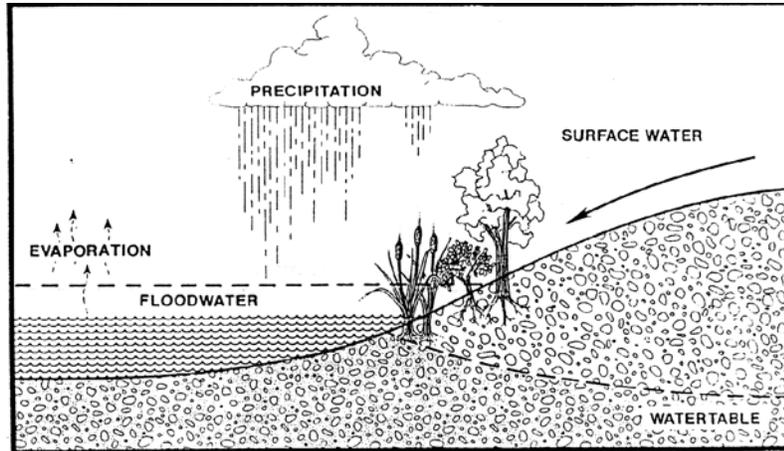


Figure 2. Surface Water Slope Wetlands.

GROUND WATER DEPRESSION WETLANDS intercept the water table (**Figure 3**). Hydrology input results from precipitation and surface runoff. These wetlands often lack surface drainage away from the site and water levels fluctuate with the ground water levels. Ground water depression wetlands are common on Long Island and are often the result of sand mining. Unless precise, long-term groundwater levels have been monitored, it is not safe to rely on ground water alone. It is better to design for surface water input as well. This will help establish a more reliable water source.

To help determine water levels, test holes can be dug in the planned wetland basin. Levels in the test holes at different times of the year will give an indication of expected levels in the wetland after construction. Soils should be a permeable layer of sand and gravel that extends into the water table.

CAUTIONS: This type of wetland is frequently difficult to create and maintain. Accurate measurements of water table fluctuations throughout the year and careful planning are important to any created wetland of this class.

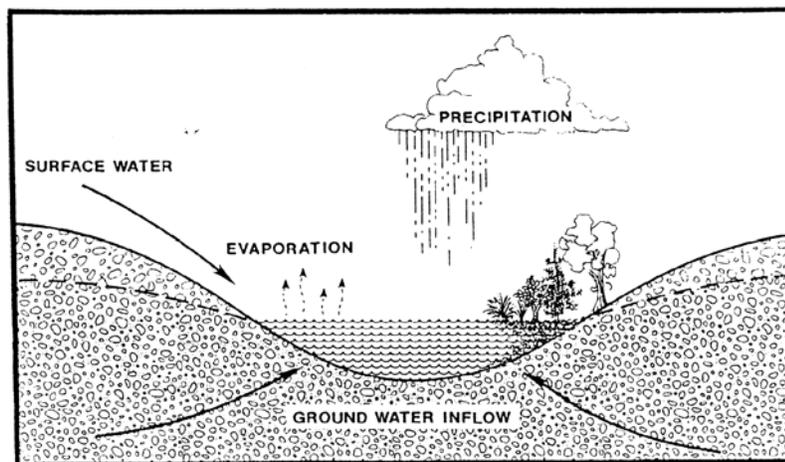


Figure 3. Ground Water Depression Wetlands.

GROUND WATER SLOPE WETLANDS are also known as hillside seeps. They exist where surface or subsurface conditions cause groundwater to discharge as springs or seeps flowing down slope away from the site (**Figure 4**). They frequently are found at the headwaters of streams or on hillsides where geological conditions force or allow percolation. These sites tend to be seasonal, responding to groundwater levels near the surface. To create a permanently flooded wetland in association with a groundwater slope wetland will require constructing a dike to hold the water. This wetland type requires permeable soils at the discharge site and impermeable silts and clay in the basin. Water permanence may be maintained on impermeable soils if the slope carries below the water table.

CAUTIONS: This complex hydrology makes it difficult to plan for the creation of this type of wetland. Where proper conditions exist, however, creation has been successful.

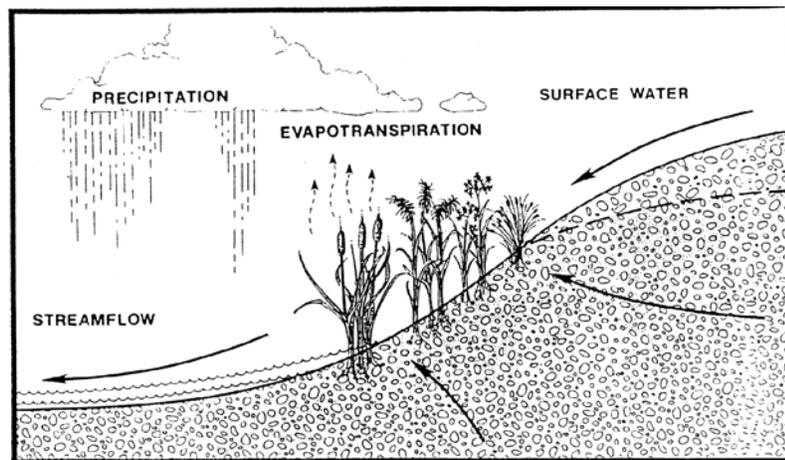


Figure 4. Ground Water Slope Wetlands.

A. Hydrologic Regimes

Hydroperiod is defined as the periodic or regular occurrence of flooding and/or saturated soil conditions (Marble, 1992). The two most common hydroperiods that may be designed as a part of the project include:

- 1) Permanently Flooded - Water covers the land surface throughout the year in all or most years (it may be difficult to ensure the presence of water during drought years). This is probably the hydroperiod most landowners will want to design. Excavate to a depth below the seasonal low water table. Shallow, permanently flooded wetlands are dominated by emergent vegetation. Relatively few woody species thrive in permanently flooded conditions.
- 2) Seasonally Flooded - Surface water is present for extended periods, especially early in the growing season, but is absent by the end of the growing season in most years. When surface water is absent, the water table is often near the land surface. Excavate the site to an elevation between the seasonally high and normal water table levels. This type of wetland frequently supports woody plant communities.

Hydroperiods that persist under the greatest range of water level fluctuation are the easiest to create thus permanently flooded wetlands -- which can fluctuate a few feet -- are the easiest to create. Seasonally flooded wetlands are difficult to create because of the very narrow hydrologic regime. However, most wetlands will naturally have a range of hydroperiods present with the center of the basin wettest (permanently flooded) and the fringes gradually becoming seasonally flooded or saturated.

B. Determining Water Levels in the Wetland

Wetlands With a Groundwater Source

Knowing the elevation and seasonal fluctuations of the water table is particularly important for wetlands dependent on groundwater. This information will help with determining mining depth at the wetland site. In many situations where a site has been or is being mined, groundwater or surface water measurements have been taken or investigated. These will be critical in designing the desired wetland.

Wetlands With a Surface Water Source

Wetlands depending on surface water usually receive input from two principal sources: overland flow, or an existing permanent or seasonal stream. The information listed above can help in determining existing hydrology at the site. The wetland can then be designed to respond to the site conditions to obtain the water levels desired in the wetland. An existing stream channel can be used by excavating, as shown in **Figure 5**. Water levels in the designed wetland will depend on the depth of excavation and base flows in the stream. For a permanently flooded wetland, an earthen embankment usually must be constructed across the stream channel (**Figure 6**). Permits may be needed to modify the waterway. Off-site effects of flooding, safety, fish migration, and downstream uses of the stream will need to be considered.

Engineering formulas exist for determining the minimum drainage basin required for each foot acre of storage in a wetland. For wetlands depending on surface run-off for the main water source, appropriate calculations should be made; a good rule of thumb, however is a minimum of 20 acres of drainage basin to each foot acre of storage. The following data sources also may be useful:

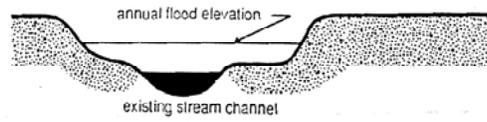
County Soil Surveys - Information for specific soil series can be obtained from county soil survey maps. The description of the soil series at the site will indicate the depth of the seasonal high water table during average conditions. Depth to bedrock and soil permeability rates also can be obtained from soil surveys.

Soil Boring Logs - If available, soil boring logs for adjacent highway projects taken nearby can be interpolated for the site. This is useful only if the site is immediately adjacent to the right-of-way and if the soils and geologic conditions are similar.

Location of Adjacent Wetlands - The elevation of nearby existing wetlands with a groundwater source can be useful. This assumes that the water table for the site of creation is the same as for the adjacent site and, therefore, must be used with some caution. Underlying soils and geologic conditions must be similar.

Streambed Elevations - If present, nearby perennial streams may provide an indication of the adjacent water table elevation. Stream profile elevations can be tied into other sources of data to establish the ground water contours throughout the site.

(a) Existing stream channel cross section



(b) Stream channel cross section modified with wetland basin

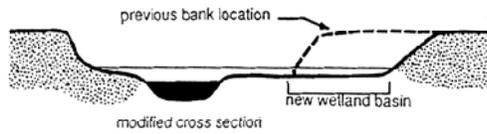


Figure 5. Creating Wetland by Excavating Streambeds.

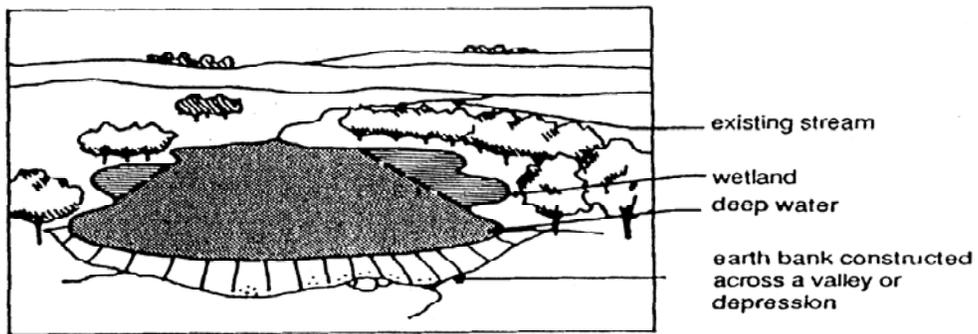


Figure 6. Creating Wetlands by Impounding Stream Flow.

III. SOILS

The soil types at the wetland site and in the watershed are important to the success of the project. Many created ponds and wetlands with ideal hydrology fail for lack of proper soils. Soils should be evaluated for composition, distribution, and depth. County soil surveys, which describe the infiltration rate in inches per hour can be used to evaluate soils at the site. Four infiltration rates have been classified by the National Cooperative Soil Survey:

Very low - Soils with infiltration rates of less than 0.1 inches per hour; soils in this group are very high in percentage of clay (Marble 1992).

Low - Infiltration rates of 0.1 to 0.5 inches per hour; most of these soils are shallow, high in clay, or low in organic matter.

Medium - Infiltration rates of 0.5 to 1.0 inch per hour; soils in this group are loams and silts.

High - Rates of greater than 1.0 inch per hour; these are deep sands and deep well-aggregated silt loams.

For wetlands dependent on overland flow, impermeable soils need to be present at the wetland site and in the watershed for flow to go into and stay in the wetlands basin. For wetlands dependent on a combination of surface and groundwater, impermeable soils are needed in the watershed to channel water into the wetland. Permeable soils, such as sandy loams would be necessary where groundwater infiltration occurs.

IV. WETLAND VEGETATION

There are many ways to establish wetland vegetation, including seeding, planting nursery stock, transplanting vegetative cores, spreading wetland soils or natural re-vegetation. Each has been used with various levels of success. Successfully establishing the desired plant community depends on: planting method, the health of the planting stock, weather, stock source, species selected, and a diligent monitoring and maintenance regime in the early years. Most projects will likely include a combination of methods for creating the desired plant community.

1) Seeding

Seeding can be successful where muddy flats occur in the late spring because many plants need moist soil for germination. Seed are available from many nurseries, but it is best to obtain seeds collected from a local source because local plants are adapted to local climatic conditions, thereby improving the chances for success. Seeding should involve 10 -15 species of plants to maximize diversity.

CAUTIONS: Wet, exposed soils also are ideal for the germination of purple loosestrife which is an undesirable, invasive plant. Mudflats should be monitored closely during planting and germination. If purple loosestrife is present in the immediate area, contact your DEC regional biologist for assistance with controlling this plant.

2) Planting Nursery Stock

Wetland plants can be obtained commercially from plant nurseries located throughout the Northeast. Nursery grown plants are supplied as bare root seedlings, potted plants, or bagged rootballs. The USDA Soil and Conservation Service document, "A Partial List of Commercial Sources and Costs of Wetland Plants (1993)" is available to assist with locating planting stocks. Purchasing nursery stocks offers many advantages. Nursery stocks can be ordered to fit into a planting schedule. Nurseries can deliver large quantities of plants at one time, something that is not always possible when obtaining plants non-commercially. Potted plants and bagged rootballs survive the shock of transplanting better than bare root plants.

There are also disadvantages associated with planting nursery stocks. Care should be taken to avoid restricting wetland planting to only those species available through a chosen supplier, which may be limited. If local supplies of species are limited, it may be necessary to supplement with other planting methods. Wetland planners should try to select a local nursery or a nursery with similar soil and climate conditions to minimize transplant shock.

3) Transplanting Cores of Wetland Vegetation

Cores, also known as plugs, contain plants and propagules (seeds, roots, tubers, and rhizomes). Use cores 10-12 cm in diameter and 15-25 cm deep (Hammer 1992). The cores need to be transported and stored in a cool, dark, and moist environment. Emergents should be planted in one foot of water within 48 hours after digging. Plant in the spring or early fall. Emerson (1961) recommends the fall for harvesting and planting underground reproductive structures of perennial emergents. The water is shallower and warmer than in the spring.

Local sources of wetland vegetation should be used if they are available because wild plants obtained locally have developed an ability to thrive under local soil, weather, and hydrologic conditions. Cores may be obtained through agreements with landowners who possess wetlands. This can be a cost effective technique, depending on the agreement under which cores are obtained.

Under Article 24 of the State's Environmental Conservation Law, harvesting the natural products of a wetland is exempt from regulation. Digging cores of wetland plants is considered a harvesting practice.

CAUTIONS: Wetlands where exotic or invasive plants are present should not be used, for supplying cores. These plants include: purple loosestrife (*Lythrum salicaria*), Eurasian milfoil (*Myriophyllum spicatum*), and common reed (*Phragmites australis*). In addition cattails (*Typha latifolia* and *T. angustifolia*), and willows (*Salix* sp.) should be limited during initial plantings because they are aggressive and invasive plants that can dominate entire wetlands and are very difficult to control.

4) Spreading Wetland or Organic Soils

Wetland soils usually contain seeds or propagules of wetlands species which can help establish vegetation. Organic soils provide the greatest benefit in wetlands underlain by impermeable clay soils, hardpan, rocky soil, and silt. The soil provides a medium in which roots can grow.

CAUTIONS: The excavation of wetland soils is regulated by the Army Corp of Engineers, the Adirondack Park Agency, or, if the wetland is greater than 12.4 acres, by the DEC under Article 24. Soils might be obtained by applying for a permit with the DEC or APA; and with the Army Corp of Engineers; through arrangements with the landowner of a wetland being altered under an existing permit; or from a farmer who owns converted wetland that is exempt from regulation due to current agricultural use.

5) Vegetation By Natural Processes (wind dispersal and animal movements)

Vegetation can become established naturally within a few growing seasons. The rate at which this occurs depends on the proximity of the created wetland to naturally occurring wetlands and any land barriers that may impede the natural processes affecting seed dispersal. This method does not provide the same level of species richness after 3-5 years that planting does, but it does not involve any time or financial commitment on the part of the landowner. It usually is not a preferred method to use alone.

V. TRANSITION ZONE & UPLAND VEGETATION

This zone is an important transition area that buffers the wetland from disturbances in the adjacent upland. A minimum of twenty feet should be designated as a transition zone between the planned wetland edge and the upland habitat. Given the dynamic nature of wetlands, this zone is needed to allow for fluctuations in the water level. A few suggestions to consider include:

- ! Grade to a slope of 10:1 or greater.
- ! DO NOT mow; allow to develop naturally after planting.
- ! Manage only to maintain the desired plant species.
- ! Plant as quickly as possible after the wetland is excavated to control erosion and limit sediment loading from upland activities.
- ! May be planted with tree, shrub, or grass species, depending on site goals.

VI. DESIGNING THE WETLAND

1) **Establish the goals and objectives for the wetland.** Probably the single most important step in the process, this will determine or influence all subsequent decisions and will be important in monitoring and in evaluating project success. Goals should be related to wetland function. For example: Create breeding habitat for tree frogs.

Objectives step down from the goal, and become increasingly specific and measurable. To create tree frog habitat, an objective might be to create three acres of emergent marsh (identify species) in 12 to 18 inches of water, at 50 percent interspersion, by the next growing season.

2) **Determine the hydrology necessary to meet the goals.** For example, permanent water is not necessary for tree frog breeding habitat. However, permanent water may be necessary to meet some other associated goal (improve site aesthetics).

Using the appropriate data and goals, the necessary design can be determined. Additional excavation may be necessary, or contouring of slopes may be desirable. If an embankment wetland is to be created, consult the USDA Soil Conservation Service handbook #590 Ponds - Planning, Design, Construction for specifications on building a dike.

3) **Determine whether soils are appropriate.** Basic site conditions must be met but can be improved by spreading organic soils over the substrate. Mining operators also might consider backfilling with clean fines settled out from the mining operation. This should not be undertaken where groundwater discharge is occurring or where high soil permeability is necessary. However, in surface water depression wetlands, backfilling with fines can improve slopes, increase microtopography, and provide a finer soil substrate for plant establishment.

4) **Design the other variables of the wetland.**

A. Wildlife

Here are some tips for considering wildlife:

! Created wetlands should be designed to resemble natural systems. The shape should be irregular to maximize shore area, an important ecological zone for wildlife.

! Logs or large rocks in shallow areas can provide perches for birds and sunning spots for turtles. Trees and shrubs along the shore can provide perches for kingfishers, ospreys, and other species of birds that feed on fish, and for insect feeding birds.

! Nest boxes can be placed to attract wood ducks, swallows, and other cavity nesters.

! An interspersion of open water and emergent plants in a fifty-fifty balance is optimal for many species of waterfowl.

! The number of nesting pairs of waterfowl increases when the pairs are visually isolated. The construction of one or more small islands or a peninsula will help achieve visual isolation. Islands can be approximately twenty feet in diameter or an oval (20 x 40 feet) with a settling height of two to six feet above the water level.

! Wetlands of at least five acres with gradual shorelines (with a slope of 5:1 or greater) and water depth of 18 to 24 inches are the most successful waterfowl brooding sites.

! Many species of wildlife find a series of water areas in close association more attractive than a single isolated pond or marsh.

CAUTIONS: Mowing around the wetland will increase use by geese, which can be a nuisance, especially in the spring.

B. Aquatic Diversity and Abundance (Marble 1992)

The overall diversity of the aquatic system in a wetland will improve its stability and the abundance of other plants and animals that depend on the aquatic system. Here are some tips for designing for the aquatic community:

- ! The aquatic community includes more than fish. It also includes the amphibians and invertebrate populations.
- ! Design for interspersed vegetation and open water.
- ! Vegetation which is attractive to aquatic invertebrates will aid in sustaining an abundance of fish species dependent on those invertebrates.
- ! Partially submerged wetland plants provide an optimal environment for most aquatic invertebrates and juvenile fish communities.
- ! Avoid very dense vegetation; it is not conducive to most species.
- ! Design for a shallow fringe of wetland surrounding a pond, and avoid creating a steep-sloped pond.
- ! Diversity in water depth will improve plant and animal species diversity.
- ! Deep pools help keep water temperatures low during summer months. If the wetland is dependent on surface runoff, ensure that the deeper soil layers are impermeable.
- ! Most wetlands support bullhead, bass, perch, sunfish, and in larger areas, pickerel.

C. Aesthetics

A wetland can be designed for aesthetic purposes without sacrificing other functions.

- ! Design the wetland to incorporate existing landforms whenever possible.
- ! Vegetation around the wetland can be planted to reflect on the water surface with a variety of colors. Blue flag (*Iris versicolor*), red osier dogwood (*Cornus sericea*), elderberry (*Sambucus canadensis*), swamp rose (*Rosa palustris*), and red chokeberry (*Aronia arbutifolia*) are a few of the species that can be planted to attract the human eye.

Interspersed plants and varying textures, forms and heights offer more interesting views.

VII. PROJECT MONITORING

It is absolutely critical that created wetlands be monitored and that contingency plans exist to correct any problems. After construction and planting, there should be annual evaluations during and at the end of the growing season for five years. Monitoring should be focused on evaluating the success at meeting the goals stated prior to construction. Other aspects to address include: water permanence, wetland size, water quality, vegetative cover (as a percentage) and composition, species diversity, and presence of undesired plants or animals. Modifications might include: replanting or removing unwanted species. Fixed point photographs should be taken as a part of the annual monitoring.

WHERE TO GO FOR HELP

NYS Department of Environmental Conservation. Division of Fish and Wildlife regional Biologists may assist with setting goals, designing for wildlife and how to control nuisance species of plants and animals.

Contact your regional DEC office

US Fish and Wildlife Service

May assist with designing the wetland.

Contact: US Fish and Wildlife Service
3817 Luker Road
Cortland, NY 13045
(607) 753-9334

County Soil and Water Conservation District

May provide soil maps and assist with soil determinations.

Check your local listing for your county office.

U.S.D.A. Natural Resources Conservation Service (formerly Soil Conservation Service)

May assist with designing the wetland. They have many different publications available to the public to assist with various aspects of this project (pond creation, planting to attract wildlife, and others).

Contact: Resource Planning
441 South Salina Street
5th Floor - Suite 354
Syracuse, NY 13202
(315) 477-6537

Adirondack Park Agency

May provide information and assistance with created wetlands within the Adirondack Park.

Contact: Adirondack Park Agency
PO Box 99
Ray Brook, NY 12977
(518) 891-4050



NEW YORK STATE DEPARTMENT OF ENVIRONMENTAL CONSERVATION

Regional Offices

DEC - Bldg. 40, SUNY at Stony Brook, Loop Rd.
Stony Brook, NY 11790-2356
Bureau of Wildlife (516) 444-0305

DEC - 1 Hunter Point Plaza
4740 21st Street
Long Island City, NY 11101-5407
Bureau of Wildlife (718) 482-4941

DEC - 21 South Putt Corners Road
New Paltz, NY 12561-1696
(914) 256-3000

DEC - 1150 North Westcott Road
Schenectady, NY 12306-2014
(518) 357-2066

DEC - Route 10, Jefferson Road, HC01
Stamford, NY 12167-9503
(607) 652-7364

DEC - Route 86, PO Box 296
Ray Brook, NY 12977-0296
Bureau of Wildlife (518) 891-1291

DEC - Hudson St., Box 220
Warrensburg, NY 12885
(518) 623-3671

DEC - State Office Building
207 Genesee Street
Utica, NY 13501
(315) 793-2554

DEC - 1285 Fisher Avenue
Cortland, NY 13045-1090
(607) 753-3095

DEC - 6274 E. Avon-Lima Road
Avon, NY 14414-9519
(716) 226-2466

DEC - 128 South Street
Olean, NY 14760-3632
Bureau of Wildlife (716) 372-8678

DEC - 270 Michigan Avenue
Buffalo, NY 14203-2999
(716) 851-7200

DEC - State Office Building
317 Washington Street
Watertown, NY 13601-3787
Bureau of Wildlife (315) 785-2261

WETLAND PLANNING CHECKLIST

1. WHAT FUNCTIONS WILL BE ADDRESSED?

	Open space and aesthetic values
	Fish Habitat
	Wildlife Habitat
	Recreation
	Water Supply
	Water Quality
	Other

2. HYDROLOGY ISSUES

	Is the watershed of sufficient size to supply the system?
	Is the groundwater flow sufficient to supply the system?
	Have hydroperiods been considered for desired functions?
	Will the water quality have a negative effect on achieving the desired functions?

3. SOIL ISSUES

	Are substrate materials consistent with project needs? <input type="checkbox"/> Impermeable for surface water basins <input type="checkbox"/> Permeable for groundwater basins
	Is soil type and fertility beneficial to plant establishment?

4. VEGETATION ISSUES

	Can local plant species be obtained in sufficient quantities at the appropriate time for successful planting? <input type="checkbox"/> Soil Cores <input type="checkbox"/> Seeds or root stocks
	Are nursery stocks available?
	Will vegetation occur naturally from nearby wetlands?
	Could exotic or noxious plants create problems in the future?

5. HAS LANDOWNER BEEN CONSULTED ABOUT:

	Potential permit needs?
	Future land regulations?
	Ability to complete the work?
	Willingness to carry out midcourse corrections and active wetland management?
	Impacts of future landuse?