Wetlands

&

Water Quality

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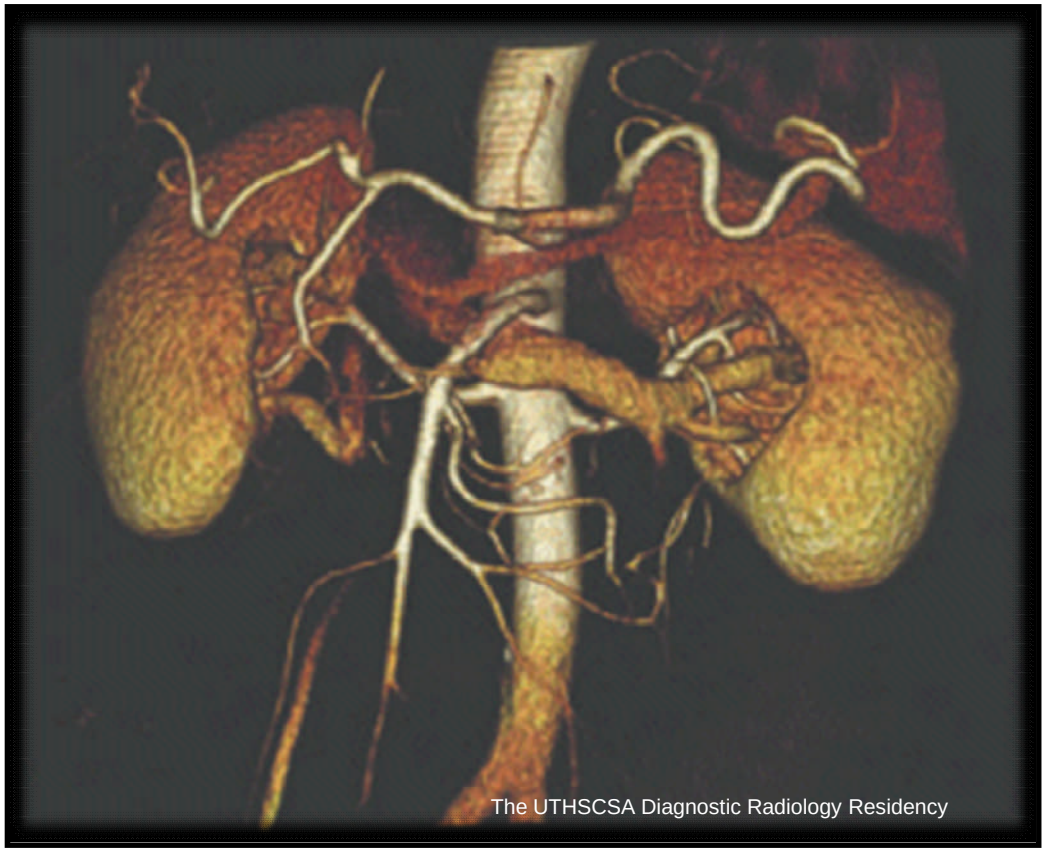
Wetlands
Kidneys of the Water System

One hectare of tidal wetland can perform $123,000.00 worth of state of the art waste water treatment

Wetlands are natural filters that remove sediment, fertilizers, and contaminants found in animal waste, waste water, and storm water.



Loss of wetlands has resulted in decreased water quality in lakes, streams, rivers, and oceans.

The loss has affected drinking water supplies along with the fishing and tourism industries.

Wetland loss affects plants, animals, and humans.

What is a Wetland

A wetland is an area that is predominantly wet during the growing season. The level of saturation of the soils is sufficient enough to prevent the growth of upland plant species and allow the growth of hydorphyte plant species

What is a Wetland

USEPA & USACE –
Those areas that are inundated or saturated by surface or groundwater at a frequency and duration sufficient to support, and under normal conditions do support, a prevalence of vegetation typically adapted to life in saturated soil conditions. Wetlands generally include swamps, marshes, bogs, and similar areas.

What agencies regulate and have jurisdiction over wetlands?

- Environmental Protection Agency (EPA)
  (Clean Water Act)

- US Army Corps of Engineers
  (Section 404 permitting)

Concurring Agencies include:

- US Fish and Wildlife Service
- Bureau of Land Management
- Bureau of Indian Affairs
- General Land Office
- US Forest Service
- Natural Resource Conservation Service
- Many other state Natural Resource/Land Management offices and departments.

Wetland Must Haves

- **Hydrology**
  - Standing water or very shallow groundwater during growing season
- **Hydric Soils**
  - Inundated Soils or Poorly Drained Soils
  - Soils Capable to Support Plant Life
- **Hydrophytic Vegetation**
  - During growing season

What three indicators are necessary to consider when assessing if an area is a wetland?

Soil Indicators

- **Hydric Soils** - as identified by the National Resource Conservation Service (RCS)
  - Soil Consists predominantly of decomposed plant material
  - Soil has a bluish gray or gray color below the surface or can be dark brownish black to black and dull.
  - Soil has a “rotten” or mold smell
  - Soil has dark stains or streaks of organic material in the upper layers

Vegetation Indicators

- Obligate and Facultative species- Aquatic **(hydrophytic) vegetation** (5,000 species in the US, bald cypress, sedges, rushes, moss, cattails, etc.)
- Plants physical characteristics (shallow root system, swollen trunks, roots on the ground surface)

Hydrology Indicators

How the water moves across the land during flooding or soil saturation

- Standing or flowing water is observed on the area during the growing season
- Soil is waterlogged during the growing season
- Water marks are present on trees or other erect objects showing that water periodically covers the area to the depth shown on the objects
- Drift lines are present on contours showing the extent of flooding in the area
- Thin layers of sediments are deposited on leaves or other objects

All three of these characteristic indicators must be present at some point during the growing season for an area to be a wetland.

Indentifying wetlands can be very technical and will require a professional evaluation

How can people identify possible wetlands?

Wetlands Checklist
(easily identifiable features)

- ✓ Standing or ponded water
- ✓ High water marks on trees or objects
- ✓ Observed or close proximity to streams, rivers, ponds, and lakes
- ✓ Area shown as a floodplain on maps
- ✓ Wetland vegetation present or a change in vegetation
- ✓ Drainage observed (requiring BMP’s)

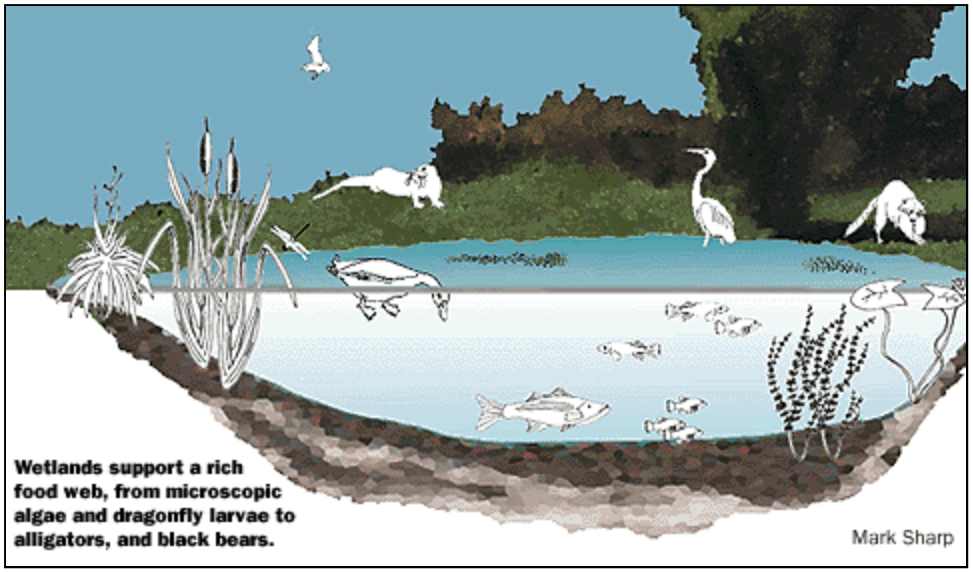
If you observe any of the items on the checklist please contact your EHS Representative .

Wetlands Provide

Photo courtesy of USDA NRCS

Provides Water Storage & Regulates Flow:

- Flood Control
- Ground Water Recharge



Provides Habitat &
Plant & Biodiversity

Provide for Ecotourism

Provide for Industry including Fishing & Shrimp Industries

Wetland Loss

Cause & Effect

- Hydrologic Alterations
- Development
- Agriculture Development
- Mineral & Energy Resource Development
- Pollution

- More Severe Flooding
- Reduced Water Quality
- Increase sediment transportation
- Increased water flows
- Increases damage from tidal surge
- Decrease biodiversity
- Decrease wildlife

Reasons for Wetland Loss

How much wetland has been lost:

US: over 50 %

Europe: over 50 %

Asia: 27 %

South America: 6 %

Africa: 2 %

World Wide: 26 %

A coastal town built on Louisiana wetlands on Atchafalaya Bay (Photo by Maitri)

Humans cause wetland loss by draining , dredging, and filling wetlands. They alter the hydrology by stream chanalization, stream diversion, and groundwater withdrawal. They can also release pollution into wetlands. Theses activities are performed for residential, industrial, agricultural, mineral, and energy development.

Natural Causes include: storm surge, hurricanes, drought, naturally occurring erosion, subsidence, and sea level rise.

Reasons for Wetland Loss: Agricultural Development

Wetlands historically have been thought of as wasted lands for breeding mosquitoes that carried harmful disease. Most of the wetlands that were destroyed in the United States were plowed over by farmers needing to expanding crops to feed a growing population. Wetlands that were drained often had very fertile soils.

In 1849 Congress passed the first of the Swamp Land Acts, which granted all swamp and overflow lands in Louisiana to the State for reclamation it was latter expanded to other states. The Federal Government assisted in draining and filling of wetlands through the 1940s.

If the wetlands are not diverted where will farmers find the land to expand to feed a growing nation?

Effects of Wetland Loss

Photo courtesy of USDA NRCS

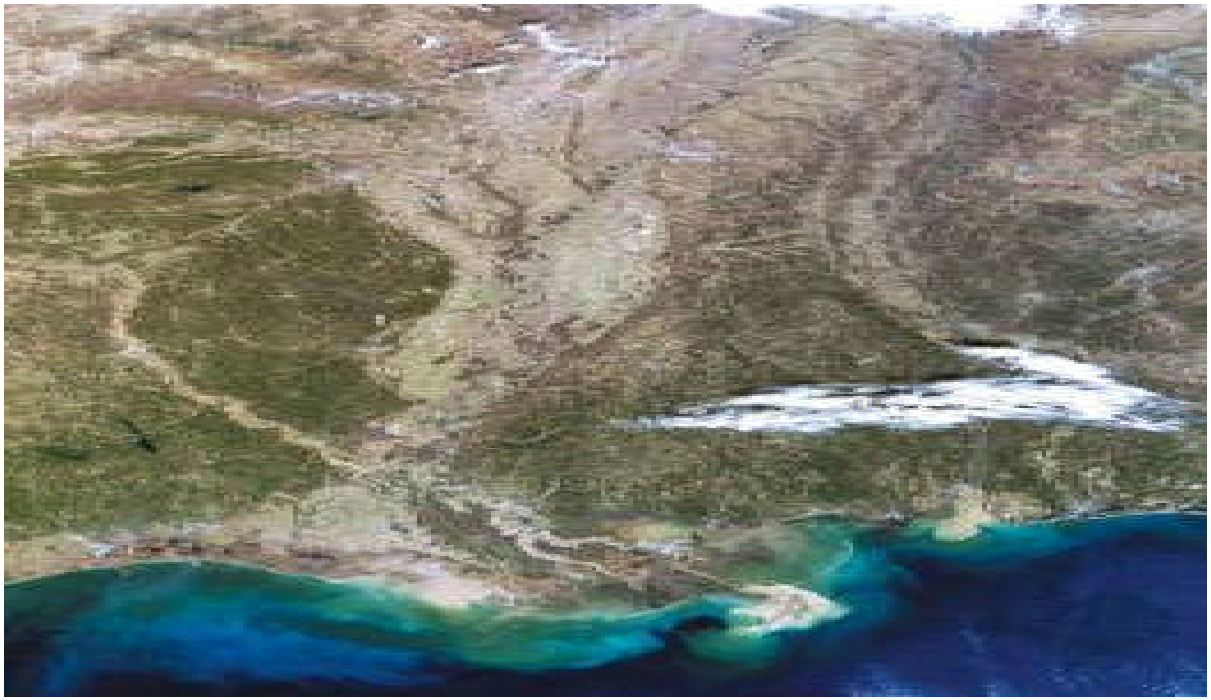
Wetlands assist in removal of contaminant and nutrients by letting sediment settle acting like a filter and using plant uptake to remove nutrients.

Wetlands assist in flood control and ground water recharge by acting like a sponge, slowly releasing the water. One acre of wetland can store 1 – 1.5 million gallons of flood water.

Wetlands provide habitat. Approximately 50% of North American Bird Species nest or feed in wetlands. Wetlands are also home to 31% of all US plant species.

Wetlands provide for both the ecotourism industry and the fishing industry. Approximately 71% of the fishing industry is dependant on wetland dependent fish. Wetlands generate millions of dollars every year from ecotourism and $79 billion annually from the fishing industry.

Effects of Wetland Loss: Dead Zones



Satellite image of the northern Gulf of Mexico / Mississippi Delta, dead zone in light blue, January 2003
Source: Jacques Descloitres, MODIS Land Rapid Response Team, NASA/GSFC, and UNEP

Dead Zones caused by nutrient overload could possibly be prevented with wetlands. Dead Zones can happen in local waters as well as the ocean.

In the Gulf of Mexico the Dead Zone is caused by a complex chain of events including the loss of nutrient filtration provided by wetlands.

When nutrients from fertilizers runoff into the Mississippi River Basin and into the ocean they promote the growth of phytoplankton in the gulf. When the phytoplankton die they fall to the sea floor and are digested by microorganisms. The digestion process removes oxygen from the bottom water and creates a low oxygen, hypoxic zone. Most fish cannot survive in hypoxic zones. Over 50% of the wetlands in the Mississippi River Basin have been destroyed.

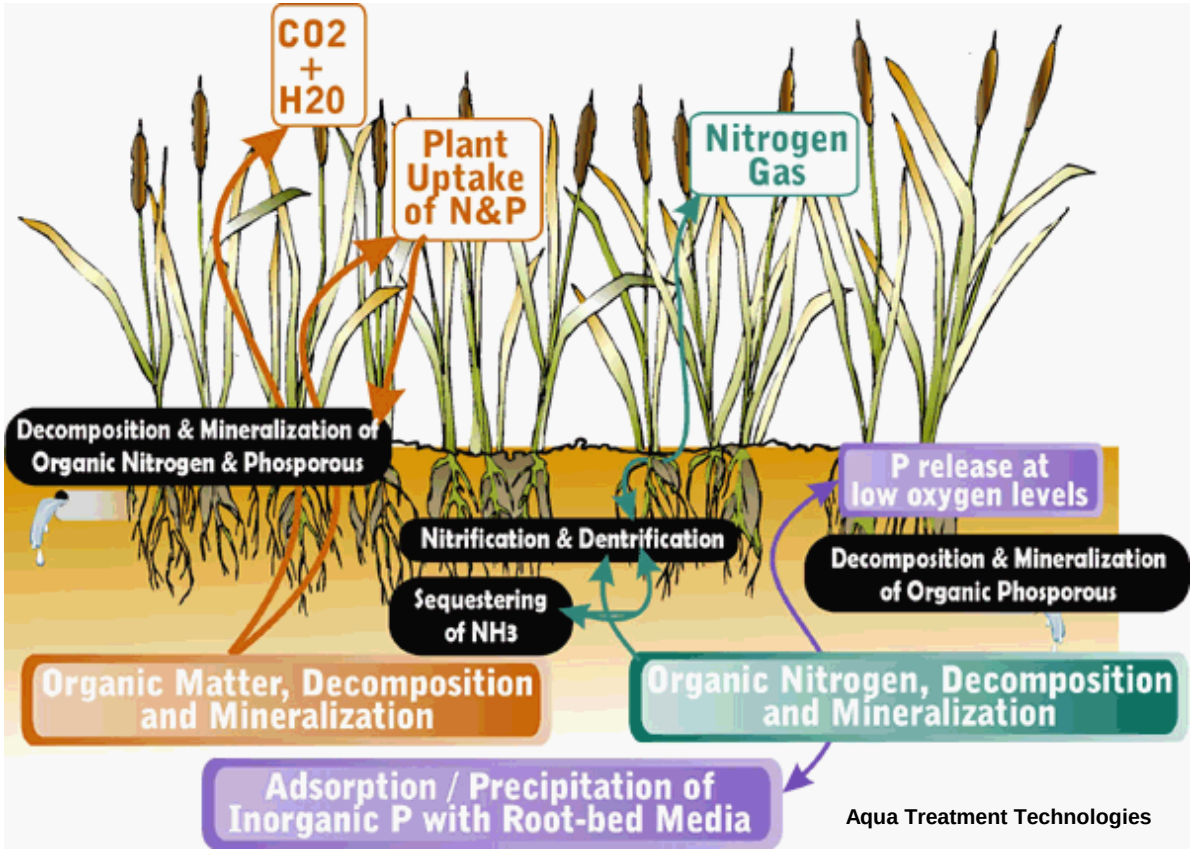
Storm Water & Waste Water Treatment

As water moves through a wetland, it is slowed down. This allows pollutants and sediments carried by the water to settle and fall out. In this way wetlands act like a filter releasing cleaner water than what was brought in.

One acre of wetland can store 1 – 1.5 million gallons of water releasing it over a period of time.

As long as the plant species do not become overloaded with contaminants, they will assist in the water treatment process.

How Waste Water Treatment Works



Physical, chemical, and biological processes combine in wetlands to remove contaminants from waste water. Theoretically, treatment of waste water within a constructed wetland occurs as it passes through the wetland medium and the plant rhizosphere. Decomposition of organic matter is facilitated by aerobic and anaerobic micro-organisms present. Microbial nitrification and subsequent denitrification releases nitrogen as gas to the atmosphere. Phosphorus is co-precipitated with iron, aluminum, and calcium compounds located in the root-bed medium. Suspended solids are filtered out as they settle in the water or are physically filtered out by the plant medium within the wetland cells. Harmful bacteria and viruses are reduced by filtration and adsorption by biological films on the sand. (Lloyd Rozema's, Aqua Treatment Technologies, http://www.aqua-tt.com/howitworks/index.html)

Storm Water Treatment

Studies indicate wetlands on average are the most effective storm water management practice at reducing pollutant levels.

How Wetlands Remove Pollutants

Pollutant removal mechanism	Pollutants
Sedimentation and filtration	Total suspended solids, floating debris, trash, soil-bound phosphorus, some soil-bound pathogens
Adsorption to soil particles	Dissolved metals and soluble phosphorus
Microbial processes (including nitrification and denitrification)	Nitrogen, organics, pathogens
Plant uptake	Small amounts of nutrients including phosphorus and nitrogen
Exposure to sunlight and dryness	Pathogens

(Adapted from Brix, 1993)

Pollutant Removal Percentage

Pollutant	Number of samples	Median pollutant removal percentage	Range
Total suspended sediment	35	78%	-29% to 99.5%
Soluble phosphorus	15	40%	-34.5% to 75%
Total phosphorus	35	51%	-9% to 99.5%
Ammonia (as NH_4)	19	43%	-55.5% to 72%
Nitrate-nitrogen	30	67%	-100% to 90%
Organic nitrogen	12	1%	-31% to 43%
Total Khedjahl nitrogen (TKN)	10	14.5%	-10.3% to 81%
Total nitrogen	22	21%	-25% to 83%
Copper	10	39.5%	2% to 84%
Lead	17	63%	23% to 94%
Zinc	16	53.5%	-73.5% to 90%

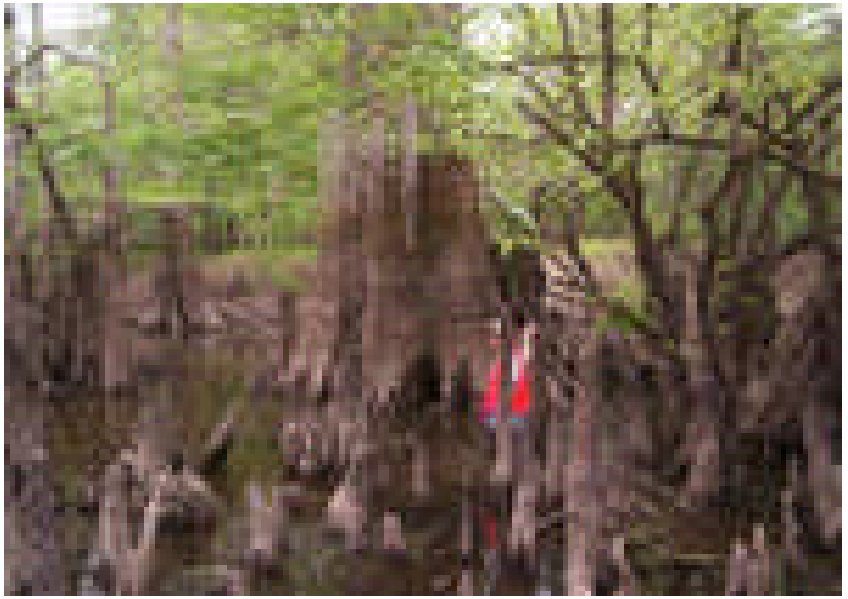
(Adapted from Brown and Schueler, 1997)

From: Designing Stormwater Wetlands for Small Watersheds (2000), North Carolina State University, College of Agriculture and Life Sciences

Government Response

United States:
On Earth Day 2004 President Bush changed the policy to attain an overall increase in the quality and quantity of wetlands. The president set a goal of 3 million acres in 5 years.
According to the US Fish and Wildlife Service, between 1998 & 2004 prior to Hurricanes Katrina and Rita there was a net gain of over 191,000 acres of wetlands. Estuarine and marine wetlands are still declining

Piney Woods Mitigation Bank, Texas

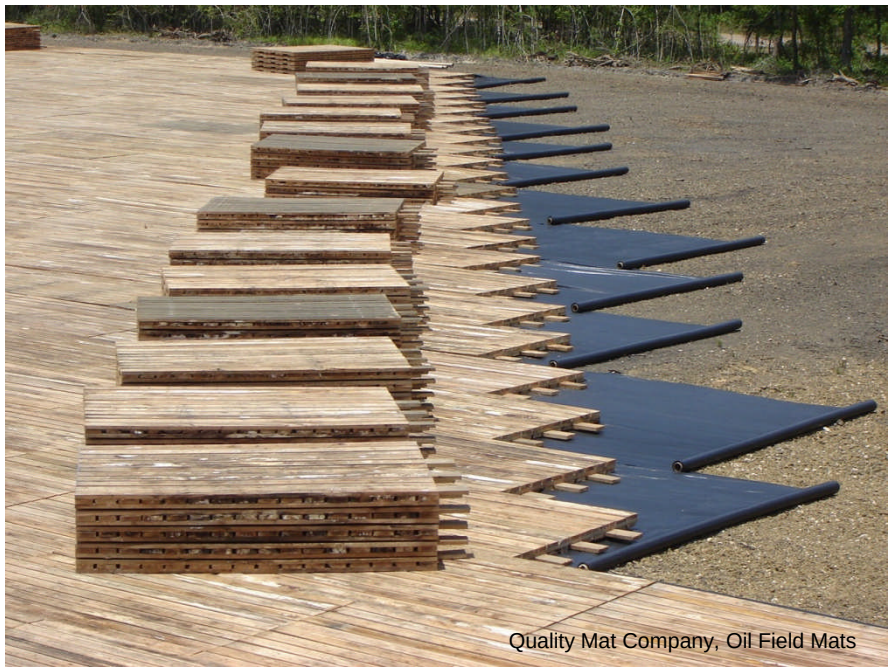


Piney Woods Mitigation Bank, Texas

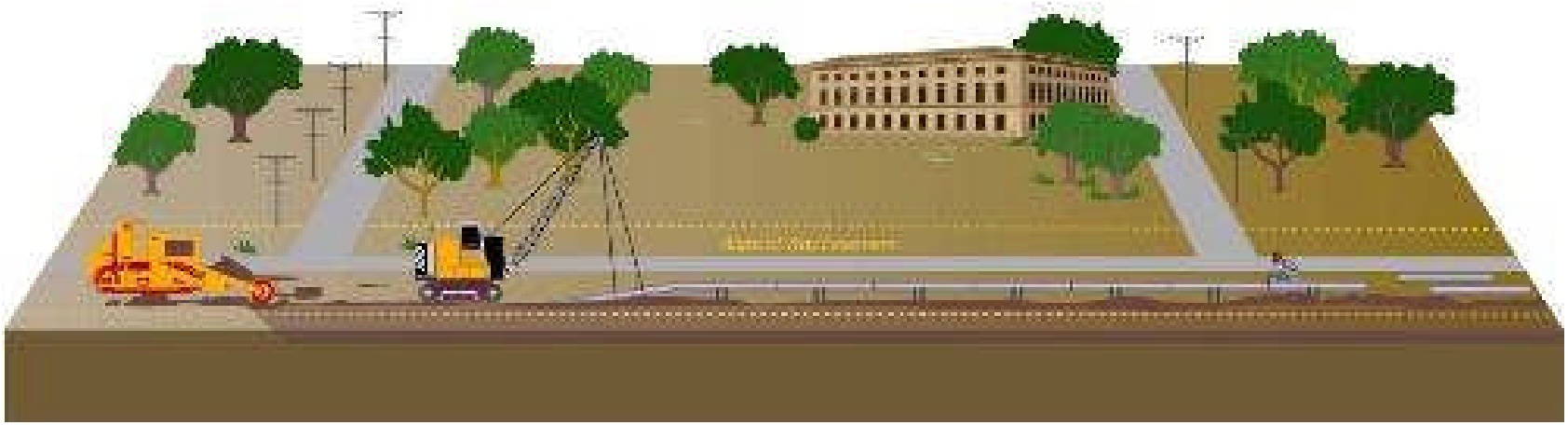
Ramsar Convention:
The Convention on Wetlands, signed in Ramsar, Iran, in 1971, is an intergovernmental treaty which provides the framework for national action and international cooperation for the conservation and wise use of wetlands and their resources. There are presently 159 Contracting Parties to the Convention, with 1838 wetland sites, totaling 173 million hectares, designated for inclusion in the Ramsar List of Wetlands of International Importance. Wetlands listed on the Ramsar List of Wetlands of International Importance are protected under international treaty. There are 24 wetland areas in the United States that encompass over 1.3 million hectares. Caddo Lake in Texas is a Ramsar listed wetland.

How to avoid wetland loss

- Adjust project
  - Move pad location
  - Adjust road path
- Bore pipelines beneath wetlands and creeks

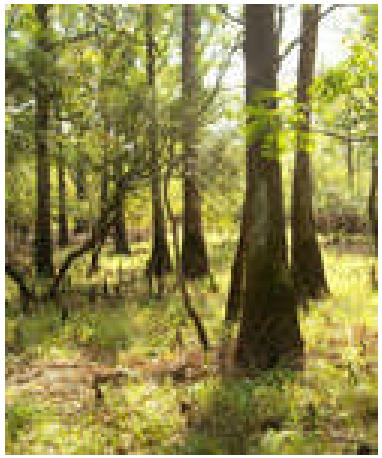


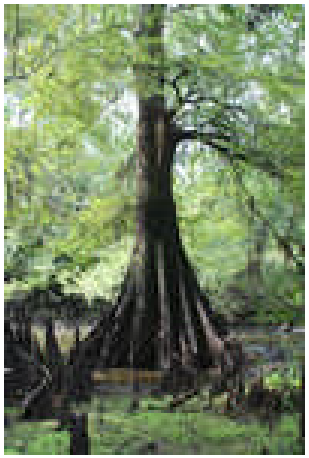
- Use temporary matting when necessary

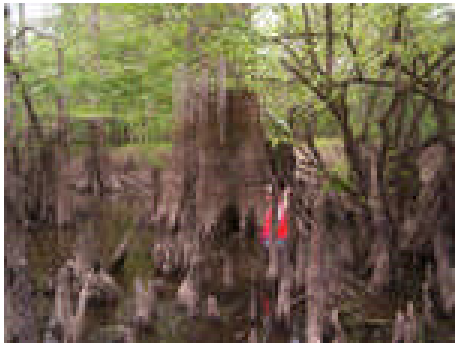


AskChesapeake.com, Pipeline Construction

Mitigation Banks







Wetland area that has been restored, established, enhanced, or preserved for the purpose of providing compensation for impacts on wetlands

Piney Woods Mitigation Bank, Texas

Constructing & Restoring Wetlands

Wetlands can be enhanced for a particular function; however, often enhancing the function of a wetland is at the expense of another function. For example, cutting down of trees to increase flood conveyance capacity may result in reduced pollution control, habitat, and wildlife diversity.

Creating wetlands is often used to transform upland areas into wetlands. It is very difficult to get the hydrology right and may require significant maintenance. There has not been significant long-term research on the viability of entirely man-made wetlands.

Usually restoration of wetlands may be performed more easily and less expensive than creating a wetland. The hydrology and / or soils are usually in place or easily diverted or returned. Wetland restoration may only require the redirection of water or removal of fill material.

Difficulties in Constructing Wetlands

VI a. Hydrology

VI b. Soils

VI c. Vegetation

Hydrology

Geologic conditions which favor wetland development include areas with thick fine textured surficial soils with low hydraulic conductivity that can store water. Areas with impermeable bedrock near the land surface may favor wetland hydrology development.

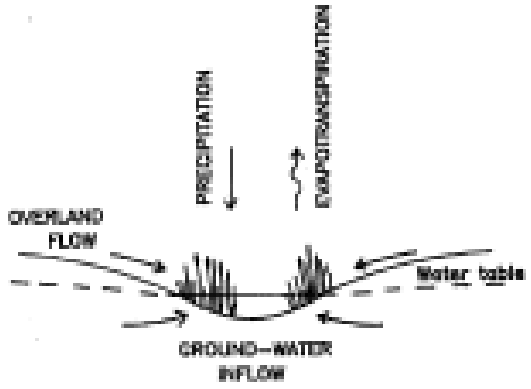
Timing and availability of groundwater can change significantly over short distances; therefore moving a wetland a short distance could require a significant change in the hydrology of the new location.

Identifying Water Sources:
This can be problematic especially when working in an area where the hydrology and groundwater table is not well known or easily seen at the surface. Usually requires the identification of vegetation, digging shallow groundwater wells or pits for monitoring and modeling.

Measuring Water Flow
Historically Darcie's Law has been used to measure groundwater. Darcie's Law relates groundwater to the hydraulic gradient and the materials hydraulic conductivity. Due to uncertainties of hydraulic conductive in sediments Darcie's Law may underestimate groundwater.

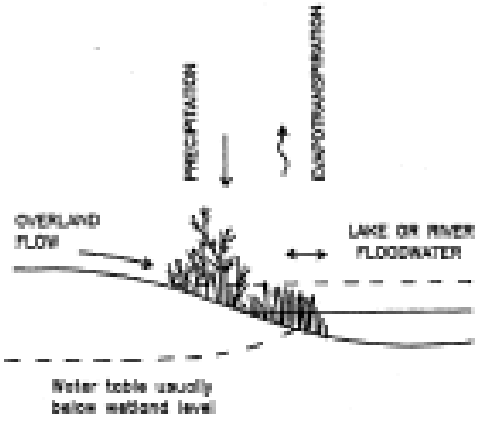
Other Techniques: isotope mass balance, temperature profile modeling, and numerical mass balance

Figure 2.4 - Groundwater depression wetland



Adapted from Novitski, 1979.

Figure 2.5 - Surface water slope wetland



Adapted from Novitski, 1979.

Soils

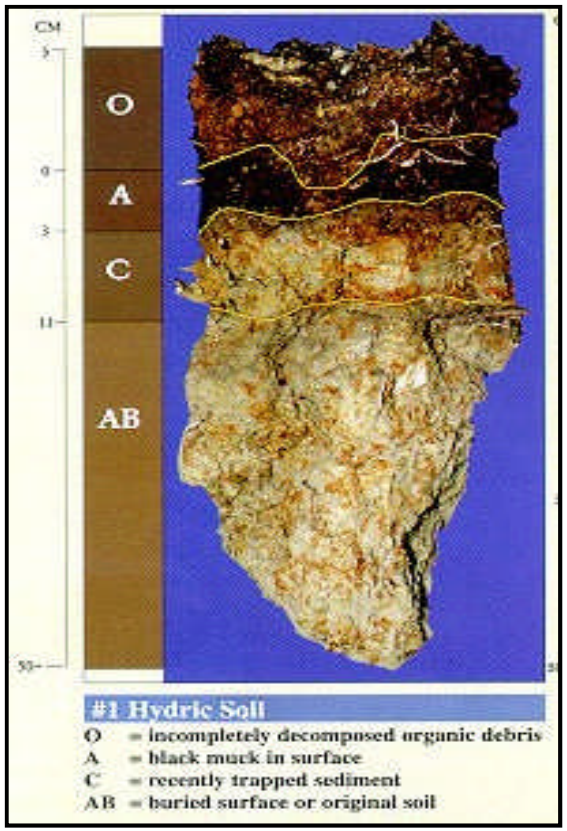
Soil structure can affect holding capacity of water, nutrients, pH and vegetative growth.

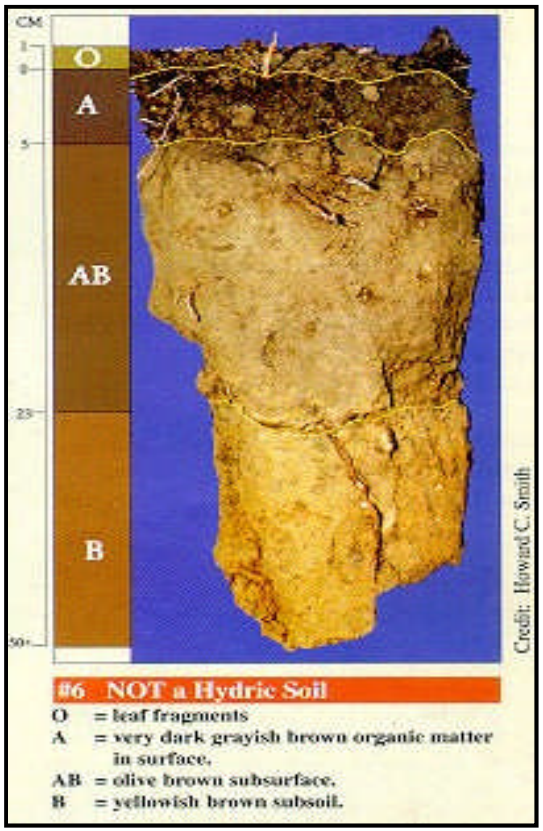
When creating a wetland or restoring a wetland it is important to mimic the type of wetland you want.

Newly created man-made wetlands usually are created with more sand and less organics, resulting in less material available for plant growth, increased drainage and decreased holding capacity of water

Mineral breakdown, plant types, and future soil structure can be affected by pH.

Mineral needs like salinity should be determined in deciding the type of wetland and plants that are to be incorporated.





Vegetation

When determining plant structure for a wetland, consideration should be given to the functionality of the wetland to be created and the plant species to be placed in the wetland.

Plant structure can affect the biological activity, nutrient availability, and water flow.

Care must be taken to determine the viability of species to each other and the nutrients available for plant growth.

Additionally, care should be given when using non-native, ornamental, and exotic species. These species may become invasive and could ultimately push out other plant species and change the functionality of the wetland.

Research Needed on

Wetland Resources Inc.

Wetland Resources Inc.

- How the functionality of wetlands are created
- The evolution of wetlands
- How wetlands affect the surrounding upland ecology
- How replacement of small wetlands with large mitigation banks affect the watershed and local areas

General wetlands

Include:

- Swamps
- Potholes
- Marshes
- Bottomland Forests
- Bogs
- Tidal Marshes
- Wet Meadows
- Intermittent Wetlands
- Other Wetlands

Associated with:

- Streams

  -Perennial

  -Intermittent

  -Ephemeral
- Relatively Permanent Waters
  - Lakes, some ponds
- Other Wet Areas

Swamps

Potholes

Marshes

Bottomland Forests

Bogs

Tidal Marshes

Wet Meadows

Perennial Streams

Intermittent Streams

Ephemeral Streams

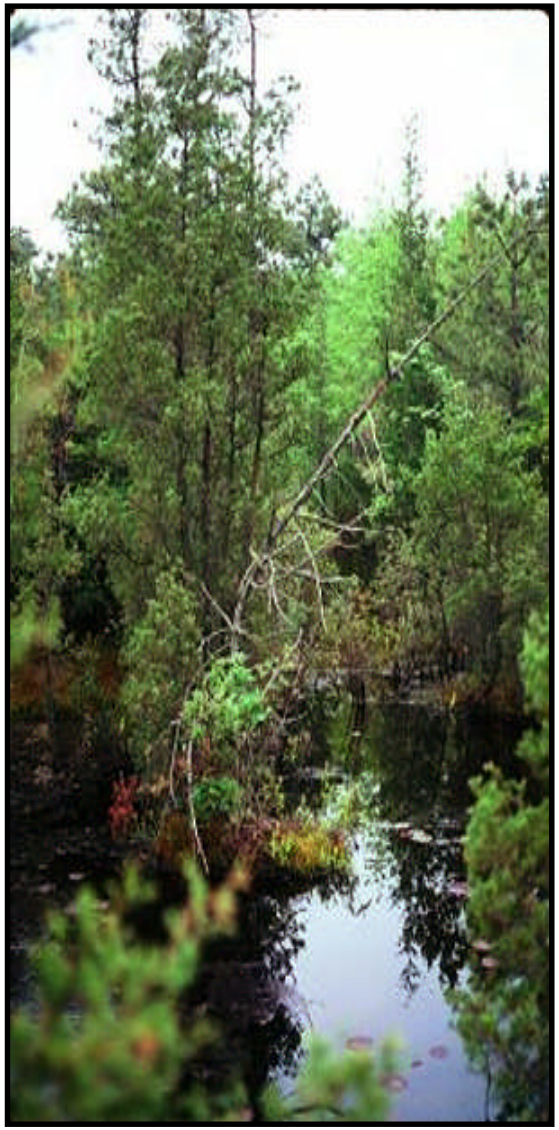
Relatively Permanent Waters

Lakes

Some Ponds

Links

Association of State Wetland Manager, Inc.	http://www.aswm.org/
NCSU Stormwater Engineering Group	http://www.bae.ncsu.edu/stormwater/pubs.htm
NRCS – Wetland Science	http://www.wli.nrcs.usda.gov/
Ramsar Convention on Wetlands	http://www.ramsar.org/
US Army Corps of Engineers – Regional Supplements to the Corps Delineation Manual	http://www.usace.army.mil/cecw/pages/reg_supp.aspx
US Army Corps of Engineers – Wetlands Research Technology Center	http://el.erdc.usace.army.mil/wetlands/
US Fish and Wildlife Service – National Wetlands Inventory	http://www.fws.gov/wetlands/
US. EPA - Wetlands	http://www.epa.gov/wetlands/
USGS – National Wetlands Research Center	http://www.nwrc.usgs.gov/index.html



Credit: Dave Davis, pine barrens, New Jersey

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