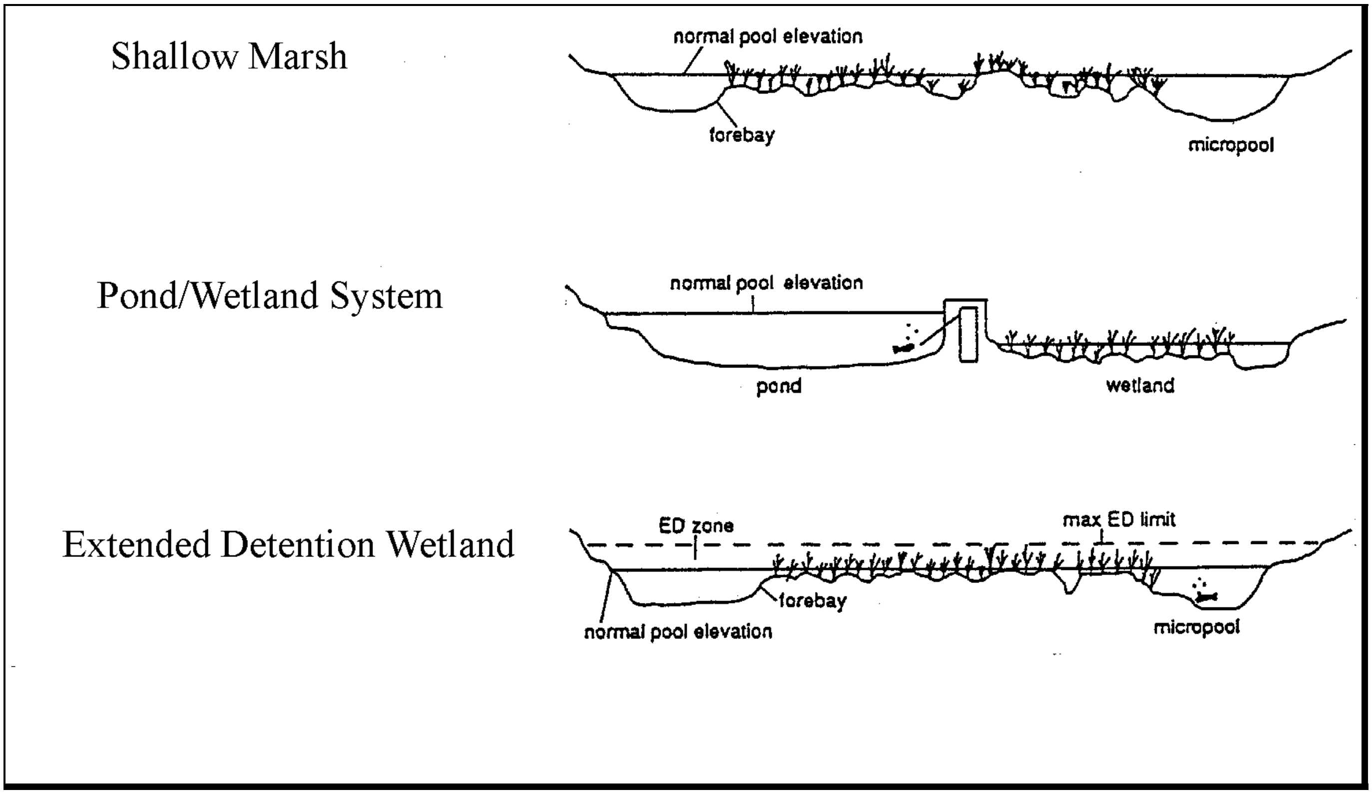
4. Wetlands

Stormwater wetlands are very similar to stormwater ponds, except that they are generally shallow and more extensively incorporate wetland vegetation into the design. The wetland plants remove pollutants by slowing runoff and through pollutant uptake. Extra design features need to be added to make wetland systems function. For example, shallow zones are needed in a wetland system to allow emergent wetland plants to grow. In cold climates, some modifications are needed to ensure the survival of these plants.

4.1 Types of Stormwater Wetlands

Three different types of wetlands are described in this chapter: shallow marshes, pond/wetland systems, and extended detention wetlands (Figure 4.1). The difference between the three types of wetlands is the area and storage allocated to the high marsh (<6" depth), low marsh (6" to 18" depth), extended detention and deep water zones (Table 4.1).

FIGURE 4.1 TYPES OF STORMWATER WETLANDS
(SOURCE: MODIFIED FROM SCHUELER, 1992)



In shallow marshes, most of the storage is in the high and low marsh areas, with the only deep water sections being the forebay and the micropool. This wetland type provides significant habitat value, but is the most space consumptive of the wetland treatment options.

The pond/wetland system has the most deep water of the stormwater wetland options: the deep pool is usually about half of the treatment volume. This option has less habitat value than the marsh option, but is effective because of the multiple treatment mechanisms (pond and wetland). It also saves space compared to the shallow marsh.

The extended detention wetland is the only option that provides extended detention in addition to settling and biological treatment. The extended detention zone must tolerate saturation, frequent inundation and fluctuating water levels.

TABLE 4.1 TREATMENT ALLOCATION FOR THREE MARSH TYPES

(SOURCE: SCHUELER, 1992)	Shallow Marsh	Pond/Wetland	ED Wetland
Treatment volume (Pool/Marsh/ED)	40%/60%/0%	70%/30%/0%	20%/30%/50%
Surface Area (Deep/Low Marsh/High Marsh)	20%/40%/40%	45%/25%/30%	20%/35%/45%

4.2 Base Criteria

Schueler (1992) outlines base design criteria for stormwater wetlands. These criteria, presented in Table 4.2, apply in both cold and moderate climates.

TABLE 4.2 FEATURES OF A STANDARD STORMWATER WETLAND

- Minimum wetland/watershed area of 0.01 (0.02 for shallow marsh)
- Minimum drainage area of 25 acres (10 acres for ED wetland)
- Minimum Length to width ratio of 1:1
- Maintenance to remove built up sediment
- Use of a forebay and micropool (forebay not required in the pond/wetland system)
- Non-clogging outlet
- Use of mulch, transplant or volunteer vegetation to propagate wetland plants
- Maintenance/ landscaping agreement.
- Wetland buffer between 25 and 50 feet.
- Use of high marsh wedges to increase the flow path
- Use of multiple cells within the wetland system

4.3 Cold Climate Modifications

Many of the cold climate modifications for wetlands are very similar to the modifications for ponds (Section 3). The reader is referred to Section 3 (Ponds) for some of these modifications. Modifications in this section relate to treatment allocation, based on depth zones, and wetland plant species choices.

4.3.1 Conveyance

The cold climate modifications to conveyance structures for wetlands are the same as the modifications to ponds. Refer to Section 3.3.1 for criteria on protecting inlet and outlet structures from cold climate challenges.

4.3.2 Pretreatment

First, the forebay, where used, should be increased to 0.25" per impervious acre. Second, a weir system to separate the forebay from the wetland further enhances the performance of the forebay. As in pond systems, the forebay prevents runoff "skating" over the top of the wetland system when frozen. An additional benefit of a forebay in wetland systems is that it can help dilute the chlorides in runoff, protecting wetland plants.

4.3.3 Treatment

The treatment modification options presented in this section are developed in response to ice build-up on the surface of wetland systems. These options, along with the regions where they apply and some of their drawbacks (see Table 4.3) are included in this section. Because wetlands are shallow systems, ice can take up almost all of the treatment volume during the winter season. The treatment modification options also address the concern of chlorides entering the wetland system, changing species composition.

TABLE 4.3 TREATMENT OPTIONS FOR WETLANDS

Option	Application	Restrictions/Drawbacks
25% Minimum ED Storage	Needed for January $T_{max} \leq 25°F$ Applicable in all cold climates	• Changes the wetland species.
At least 50% of storage in deep pool	Needed for January $T_{max} \leq 25°F$ Applicable in all cold climates	• Eliminates the use of shallow marshes
Use in combination with a grassed infiltration area	Applicable in all cold climates	• Space not always available

<u>Minimum Extended Detention Storage</u>

A minimum extended detention storage of 25% is recommended for cold climates, replacing some of the wet storage in wetlands with dry extended detention. The goal is to provide some treatment throughout the winter, when much of the permanent pool and marsh storage may be frozen. The same recommendation was made for pond systems.

<u>At least 50% of storage in deep pool</u>

This treatment option basically uses the pond/wetland system design option. If this option is used, the pond should use the modifications described in Section 3. The pond system dilutes chlorides before they enter the marsh, protecting wetland plants. In addition, the pond system may retain much of its permanent pool during the winter, while the shallow marsh may be completely filled with ice. (Figure 4.2).

<u>Use in Combination with a Grassed Infiltration Area</u>

Oberts (1994) proposes using a grassed infiltration area prior to a wetland system for meltwater treatment (Figure 4.3). In this system, runoff is spread over a grassy area before the wetland system, where some infiltration occurs. This method encourages infiltration of meltwater, and dampens the "shock" of chlorides entering the wetland system somewhat. This method should be used with caution, however. Although infiltration reduces the impact of chlorides on the wetland, the chlorides may still reduce the diversity of wetland plants. In addition, runoff with high salt concentrations may impact the grass species used to protect the wetland, increasing the maintenance requirements of the system.

FIGURE 4.2 POND/WETLAND SYSTEMS IN COLD CLIMATES
(SOURCE: FIGURES MODIFIED FROM SCHUELER, 1992)

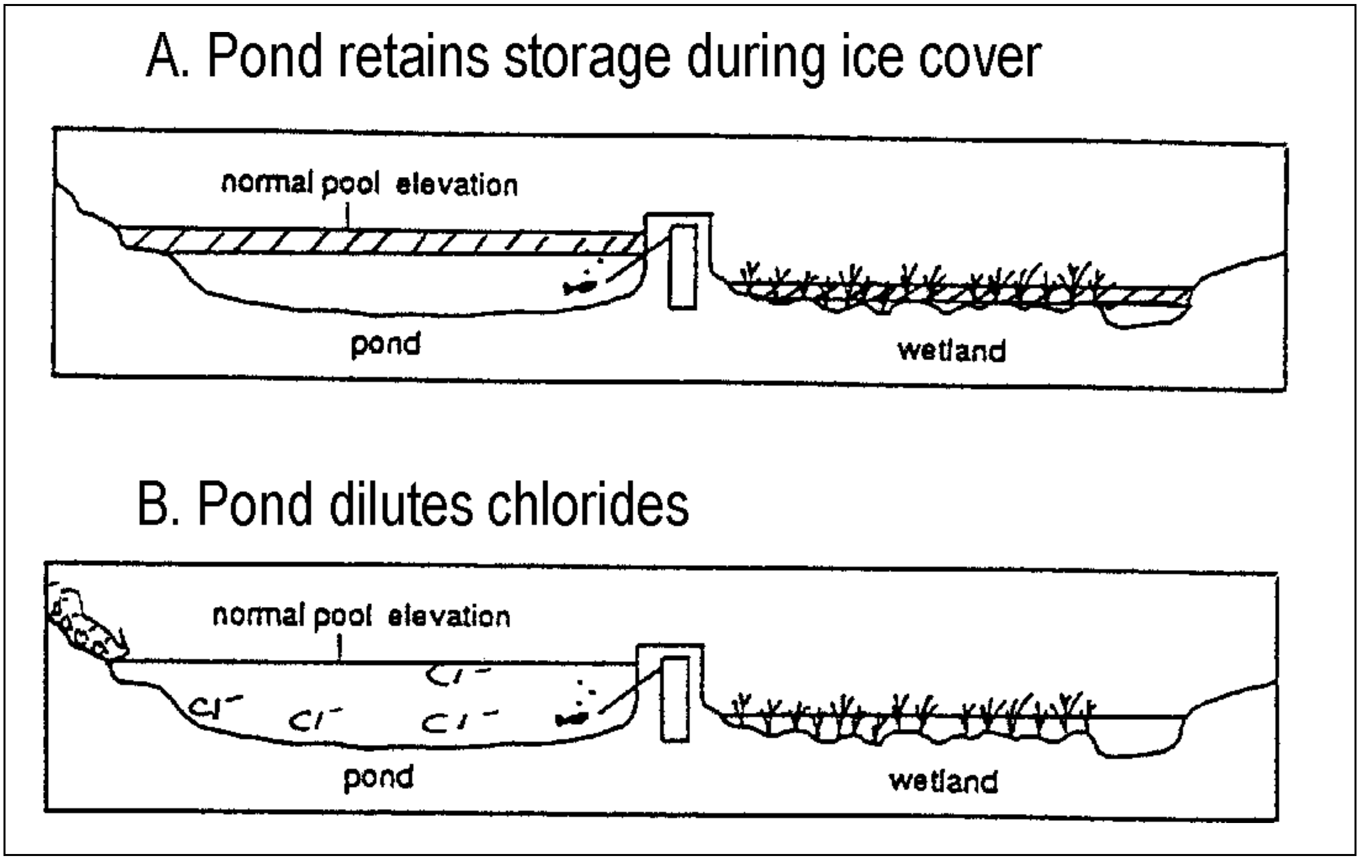
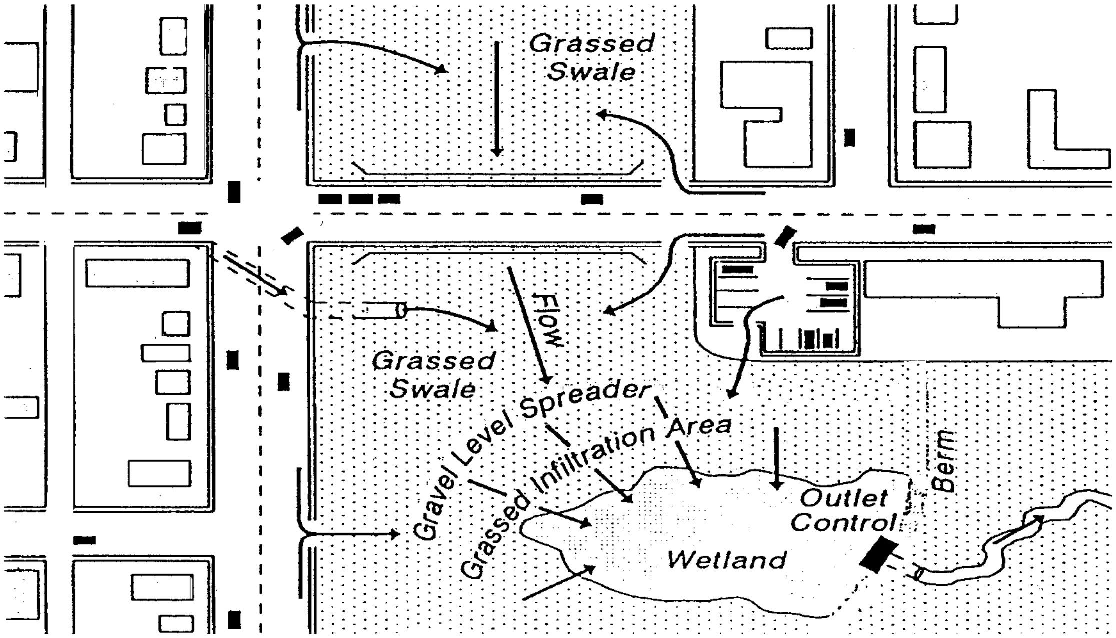


FIGURE 4.3 WETLAND/INFILTRATION SYSTEM
(SOURCE: OBERTS, 1994)


Grassed
Swale
Flow
Grassed
Swale
Gravel Level Spreader
Grassed Infiltration Area
Outlet
Control
Berm
Wetland

4.3.4 Maintenance.

The maintenance measures described in Section 3.3.4 apply to wetlands as well. Please refer to the pond section for this information.

4.3.5 Landscaping

Two characteristics of cold climates cause modifications to wetland landscaping. Short growing seasons modify the choice of wetland plant species, and also impact the planting schedule. In wetlands receiving runoff high in chlorides, species diversity is threatened.

A benefit of cold climates with a deep frost is that wetland creation or restoration can be undertaken during the winter season. This contrasts with moderate climates where both planting and replanting takes place during the spring.

Change the planting "window"

The window is the time period where it is feasible to plant wetland vegetation and other landscaping plants. In cold climate regions, the length of the growing season is reduced (Section 1). As a result, spring planting for both wetland and other plant species is delayed. In addition, there is less time before the fall frost. Thus, the "window" for seeding or transplanting wetland plants is reduced. Alternatively, fast-growing species can be used, especially grasses in the buffer region.

Pondscaping plans should specify dates when vegetation will be planted. More mature plants can be used, reducing the required growing season. Another option is to plant dormant rhizomes during the winter.

TABLE 4.4 WETLAND LANDSCAPING TECHNIQUES FOR COLD CLIMATES

	Application	Purpose(s)
Change the planting "window"	Growing season <5 months	• Ensure growth and survival of plants
Use appropriate vegetation	All cold climates	• Ensure growth and survival of plants • Wildlife value
Transplant frozen wetland blocks	Depth of freeze greater than 5' "Donor" wetland plants available	• Use of healthy, native vegetation • Cost savings measure

Use appropriate vegetation

In all climates, both wetland and upland plant species that are appropriate to the conditions of the area should be established. The "short list" of revegetation species is presented in Table 4.5 represents a cross section of plants available in cold climates. Local wetland nurseries or plant experts should be consulted whenever possible. In addition to using native plants, or those hardy in cold climates, salt tolerance should be taken into consideration. This is particularly true when road or parking lot runoff is directed to the wetland system.

TABLE 4.5A COLD CLIMATE PLANT SPECIES - SALT TOLERANT

Species	Moisture Regime	Habit	Comments
Arrowhead (*Saggitaria spp.*)	W	Emergent	Aggressive colonizer. High pollutant removal. Moderate wildlife value.
Phragmites spp.	W	Emergent	Fast-growing exotic that can become invasive.
Pickle weed (*Salicornia virginica)*	W	Emergent	Native to many cold climates, particularly in salt marshes.
Cord Grass (*Spartina spp.*)	W/F	Perimeter Grass	Prairie species native to much of the Midwest.
Switch grass *(Panicum virgatum)*	W/F	Perimeter Grass	Prairie species native to much of the Midwest.
Bulrush(*Scirpus spp.*)	W/F	Emergent	Aggressive colonizer. High pollutant removal.
Poplars (*Populus spp.)*	F/U	Woody Plant	High value for stream stabilization. Native throughout North America. Includes aspens and cottonwoods, among others. While most species can tolerate moisture, aspens prefer dry soils.
Creeping Bentgrass (*Agrostis palustris)*	U	Grass	Salt tolerant cover crop.

W: Soils always wet or underwater.
F: Frequently inundated with water. Plants should be able to tolerate wet soils and dry periods.
U: Upland plants. Soils generally well-drained.

TABLE 4.5B COLD CLIMATE PLANT SPECIES - NOT SALT TOLERANT

Species	Moisture Regime	Habit	Comments
Cattail (*Typha spp.*)	W	Emergent	Fast-growing, high pollutant removal. Exotic that can become invasive.
Rush (*Juncus spp.*)	W/F	Emergent	Native throughout North America with high wildlife value.
Sedges (*Carex spp.*)	W/F	Emergent	Native throughout North America with high wildlife value.
Smartweed (*Polygonum spp.)*	W/F	Emergent	High wildlife value. Native in prairie systems.
Pickerel Weed (*Pontederia Cordata)*	F	Perimeter Grass	Easily established wetland plant with moderate wildlife value
Willows (*Salix spp.)*	F	Woody Plant	Native throughout cold regions. Easily established.
Maple (*Acer spp.)*	F/U	Woody Plant	High wildlife value. Native throughout most of Eastern North America, with some species in the Midwest. Most are upland species, but Red Maples and Silver Maples moist conditions.
Ryegrass (*Lolium spp.)*	U	Grass	Easily established grass with some wildlife value.
Bluejoint (*Calamagrostis Canadensis)*	U	Grass	Midwestern wet meadow species.
Timothy (*Phleum pratense)*	U	Grass	Easily established, moisture tolerant grass.
Alpine grasses (e.g., Alpine Bluegrass)	U	Grass	Valuable in arid cold regions (e.g., Alaska or mountainous areas)
Oaks (*Quercus spp.)*	U	Woody Plant	Various species native to most of North America. High wildlife value; slow growing. Limited use in extremely cold climates.
Spruce (*Picea spp.)*	U	Woody Plant	Various species, particularly well adapted to cold climates.

W: Soils always wet or underwater.
F: Frequently inundated with water. Plants should be able to tolerate wet soils and dry periods.
U: Upland plants. Soils generally well-drained.

Transplant frozen wetland blocks

This method, initiated in Anchorage, AK (Barber-Wiltse, 1997), was initially used for construction of a pipeline through wetland systems. In its original application, the wetland plants were removed from a site, and then returned to the same site after construction. Here, it is presented as a tool for stormwater wetland construction. Wetland plants from a wetland site that is being “lost” during construction can be transplanted to another site and used as wetland vegetation. This procedure is only appropriate where frost penetrates at least 5' because the wetland blocks must be completely frozen. Specific steps to applying this method are described below.

1. Select a recipient and a donor site. In one case, described by Barber-Wiltse (1997a) part of the permit of the donor site required a moratorium on construction during a specified time period to allow wetland harvesting. (This was a form of wetlands mitigation). Ideally, the two sites should be within three miles of each other.
2. Complete the grading on the recipient site before the wetlands are transplanted. This reduces the time the wetland plants are left exposed to the elements. Take care to ensure that the excavation depth will be sufficiently wet to support wetland vegetation.
3. Remove snow from the donor site to encourage frost penetration. Use very light equipment to accomplish this task (e.g., a Bobcat)
4. Dig the blocks. Use light equipment that can cut a thin trench. A successful application included the use of a “ditch witch”. Also, cut the blocks in to manageable sizes (5 feet by 8 feet by 3 feet). At least three feet of peat depth is needed. Save the extra peat during this step.
5. Use a spatula-type arrangement to excavate the wetlands blocks. Transport on a flat-bed truck.
6. Place the wetlands blocks in the stormwater wetland. Use excess peat to fill the gaps between blocks.