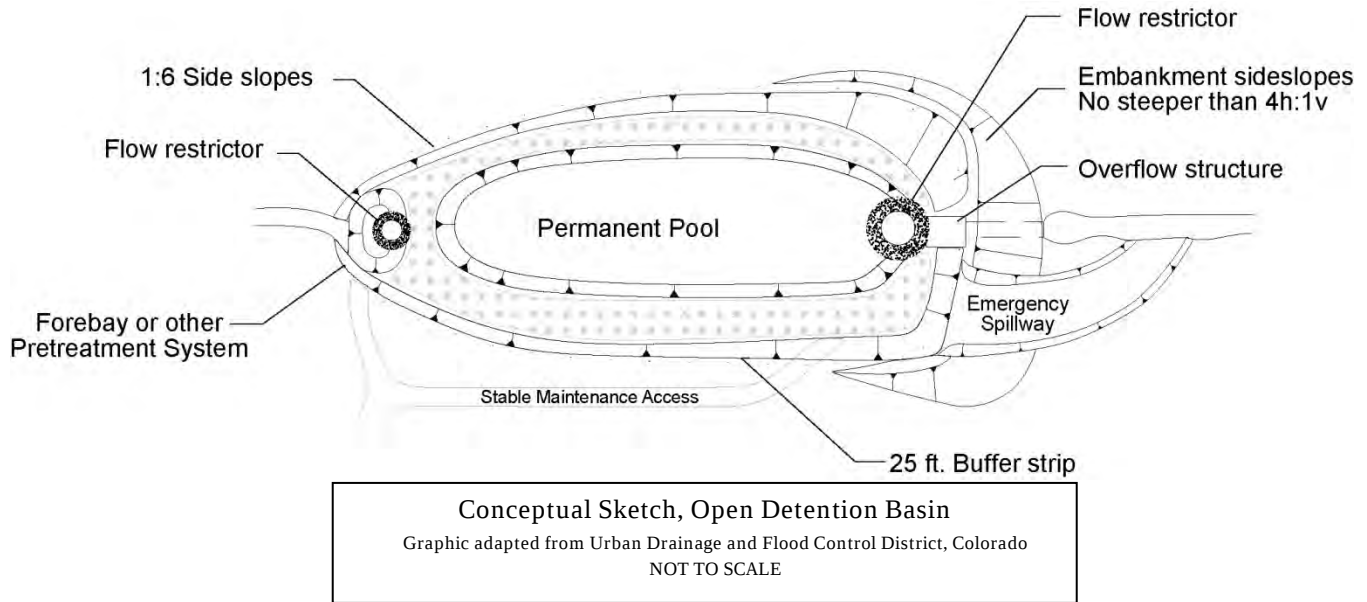


8.1.1 Open Detention Basins



Open detention basins are man-made surface waters designed to temporarily detain storm water runoff to control peak flow rates and provide for pollutant removal through settling and plant uptake. There are two types of open detention basins traditionally used in Wayne County:

- Traditional detention basins, which detain storm water runoff for an extended period of time in a permanent pool and remove sediment and other pollutants via settling.
- Constructed wetlands, where over 50% of the surface area typically is covered by wetland vegetation. Permanent wetland pool depths may vary between 0.5 and 3.0 feet, depending on vegetation type.

Design Standards

Open detention basins must be sized to detain the required storage volumes (both the bank full and flood control volumes). Design standards specific to open detention basins include the following:

- A forebay or other pretreatment system is required at each inlet to the detention basin. Pretreatment systems trap sediment before entering the detention basin, reduce the incoming runoff velocities, and spread runoff evenly over the detention basin to create sheet flow conditions. Section 8.2 of this manual

provides detailed information and design criteria for pretreatment systems.

- All closed conduits entering or exiting an open detention system should have an end treatment and adequate soil erosion protection, as described in Section 8.3.1. Some enclosures should also be covered with a grate to prevent children and animals from entering the enclosure.
- Open detention basins must have a restricted outlet that limits outflow for the bank full flood and for the maximum allowable release rate from the development site.
- Flow restrictors, overflow structures, and emergency spillways are required for all open detention basins. Section 8.1.4 provides design criteria for outlet structures associated with forebays and open detention basins. Flow restrictors must be placed near or within the embankment of the detention basin to provide ready maintenance access.
- Open detention basins must include a minimum four (4) foot deep permanent pool that allows for removal of urban pollutants through settling and biological uptake. The volume of the permanent pool does not satisfy any portion of the required flood control storage volume.

- The design water level of an open detention basin must not exceed five (5) feet above the permanent pool water level.
- A minimum of one (1) foot of freeboard is required above the design water level of an open detention basin.
- Providing a safe design is a primary consideration for all storm water management systems. Side slopes for open detention basins must not be steeper than 1:6. Further safety measures (e.g., aquatic benches or safety shelves, vegetative and barrier plantings) may be warranted depending on the type of development.
- Although use of terraced side slopes generally is discouraged when other alternatives exist, terraced side slopes may be approved for open detention basins in certain, limited circumstances at the discretion of Wayne County. The overall slope of a terraced side of an open detention basin should not be steeper than 1:3. An example detail for terraced side slopes is provided in Appendix E-3.



Photo courtesy Environmental Consulting & Technology (ECT)

- Open detention basins may not be located within pre-existing surface waters.
- Plant vegetation is required for all types of open detention basins to control erosion and enhance sediment entrapment. A landscaping plan is required for open detention basins, due to the importance of the vegetation to the function of the entire system. Use of a registered landscape architect with experience in storm water management system design and native landscaping is encouraged.
- In constructed wetlands, a diversity of depth zones throughout the basin should be used to meet the unique growing requirements of divergent wetland plants. Use of a qualified

professional with specific expertise in hydrology and wetland plant ecology is recommended for design and construction of these systems.

- A buffer strip must be provided around all surface waters such as open detention basins. Except as noted below, the buffer strip must be at least 25 feet wide measured from the minimum freeboard elevation of the surface water or basin. Of the minimum 25 ft width, a minimum of 15 feet of the buffer strip should be exterior to the pond perimeter defined by the top of bank. The slope of the buffer strip should be 1:6 or flatter. These provisions ensure that there is sufficient room along the top of the basin to provide access to the basin for maintenance. The right side of the figure “Required Buffer Strip for Forebays, Open Detention Basins, and Retention Basins” provided in Attachment C to this section illustrates a typical buffer strip associated with an open detention basin.
- In the following situations, the minimum width of the buffer strip around open detention basins is 15 feet measured from the minimum freeboard elevation of the basin:
 - When an open detention basin has a drainage area 5 acres or less; or
 - When an open detention basin has a drainage area greater than 5 acres and no storm water from areas outside of or within the buffer strip enters the basin via direct sheet flow (See the right side of the figure “Required Buffer Strip for Forebays, Open Detention Basins, and Retention Basins” provided in Attachment C to this section).

Preferred Design Elements

- Open detention basins should be designed to maximize sheet flow across the open water portion of the facility.
- The shape and configuration of open detention basins will vary considerably based on detention type and storage requirements, local topography, land availability, hydraulic considerations, and other site-specific constraints. Generally, a rectangular configuration is preferable, with an approximate length to width ratio of 3:1. Inlet and outlet pipes should be placed at opposite ends.

- If a terraced side slope is approved by Wayne County for use in a detention basin, the materials proposed for use in its construction should be approved by the local community.
- Baffles may be used to increase the flow path and maintain the topography.
- If aerating devices are used as part of a storm water management system, they should be designed to minimize disturbance of bottom sediments. For example, open detention basins may need to have a deeper permanent pool if an aerating device is used. Bubbler systems are the preferred type of aerating device as they have been found to be more efficient at providing aeration. The manufacturer's recommendations should be followed in regards to design and maintenance.
- The locations of any mechanical structures/devices necessary for pond operation should be identified on the plans. The location should include a description of whether the structure/device is above ground or below ground.
- When discharge is within a watershed where thermal impacts are a primary concern, deep wet ponds with bottom draw may be required.

Vegetation Specifications

- A landscaping plan is required for open detention basins due to the importance of the vegetation to the function of the entire system. Vegetation should be specified for each zone within the detention basin as follows:
- Pond zone (permanent water depths from 0 to 3 ft deep): Vegetation in the pond zone is entirely or partially submerged and should consist of a combination of native plant plugs and bare-root stock.
- Edge zone (permanent water elevation to bank full elevation): Vegetation in the edge zone must withstand periods of inundation and drought. This vegetation also stabilizes the side slopes of the facility.
- Upland zone (bank full elevation to 100-year flood elevation and beyond): Vegetation in the upland



Bulrush
(Photo courtesy ECT)

zone may have little or no inundation by storm water, and must withstand periods of drought. This vegetation also stabilizes the side slopes of the system. Note that the buffer strip lies within the upland zone.

The landscaping plan for open detention basins should identify the following items:

- Existing site conditions and vegetation (e.g., trees 6-in caliper and larger) that may be affected by the project;
- Plan view of the open detention basin, including one foot grading contours;
- Elevations in the open detention basin, including detention basin bottom elevation, permanent water elevation, bank full storm elevation, 100-year storm elevation, and freeboard elevation;
- Area in square feet of each of the three planting zones (pond zone, edge zone, and upland zone);
- Seed mixes and wetland plugs/bare root stock in each of the three planting zones;
- Plant spacing and applicable depths, based on industry standards; and
- If the construction plans include any mechanical structures/equipment necessary for pond operation, use of evergreen trees (or other trees/shrubs recommended for the appropriate pond zone) around the mechanical structure should be considered if visual screening of the equipment is appropriate for the location.

All plant material and planting applications should meet all guidelines set by the American Standard of Nursery Stock. All plant stock should be grown by suppliers or nurseries certified by the Michigan Native Plant Producers Association (see "References and Additional Resources" on page 8-6).

The type of vegetation used for open detention basins is dependant on site-specific conditions, such as soil types, amount of sunlight, and other factors. Vegetation for open detention basins should be composed of a mixture of species that will provide temporary cover (e.g., quick growing species such as annual rye grass (*Lolium multiflorum*)) and species which will provide the permanent cover (e.g., seed oats).

Use of native plants and “no mow zones” is encouraged. Native plants are adapted to the local climate and conditions, and have numerous short-term and long-term advantages.

Vegetation for open detention basins should be specified in the following categories:

- **Seed mixes** – Many species can be successfully established from seed mixes, including grasses, sedges and rushes; and forbs (herbaceous plants, other than grasses, that commonly grow in fields or meadows). Forbs are used for re-vegetation, wild flower gardens, prairie and detention basin planting and roadside plantings.
- **Bare-root stock** – Plants received with very little, if any, soil around the roots. Bare-root stock generally is wrapped in Hessian cloth or plastic to prevent the roots from drying out.
- **Plugs** – Plants raised as individual plants, each in a small container about the size of an ice cube. The cube of greenhouse soil (“plug”) can be pried from the tray, containing an individual plant up to 6 inches tall. Using a digging stick, the plants are plugged into the soil.

Additional specifications for designing the planting areas in each zone of an open detention basin are appended to the end of this section as Attachment A. The specifications recommend native plant species for each zone of open detention systems built in Wayne County.

Local community requirements for vegetation should also be consulted.



Photo courtesy Environmental Consulting & Technology (ECT)

Construction

Proper construction techniques, particularly installation of vegetation, are important to the successful functioning of open detention basins, especially for constructed wetland-type open detention basins in order to establish a dense and diverse emergent wetland plant community.

General guidelines for vegetation installation include:

- If emergent plant stock is proposed in the pond zone, the supplied plug material must have sufficient vegetative growth extending out of the water once planted.
- Seed must be planted above the permanent water elevation.
- All seeded areas should be properly stabilized with a mulch blanket pegged in place.
- Depending on the type of vegetation, barriers may be required for one year to protect the plantings (e.g., snow fence or netting to deter wildlife, prevent mowing).
- Additional guidance on seed and sod specifications and installation is provided in Section 8.5.1 of this manual.

For constructed wetland-type open detention basins, preparation of the wetland bed prior to planting is crucial to success. Good results can be achieved through the five-step process shown in Attachment B to this section.

Maintenance

Maintenance activities for open detention basins are listed below. These activities must be identified in the maintenance plan that the applicant must submit with an application for storm water construction approval. Additionally, provision for maintenance access should be shown on the plan; it is recommended that the maintenance access to the storm water management system be a minimum of 15-feet wide. The landscape plan should be designed to prevent obstruction of the access by trees and shrubs.

- Inspect and clean the storm sewer system and catch basins upstream from the detention basin (every five years or as needed).
- Inspect for sediment accumulation at the inlet pipes and remove sediment which may be

impeding flow (semiannually and after rain events).

- Inspect inlets, outlets, and appurtenances (e.g., grates) annually for structural integrity.
- Check the outlets regularly for clogging and clean when necessary, especially after large storm events.
- Inspect the stone around riser-type outlet structures semiannually and after rain events. If stone has accumulated sediment, vegetation and/or debris to an extent that water is not flowing through the stone and out of the pond as originally designed, then the stone should be replaced.
- Check for floatables and debris and remove as necessary.
- Remove dead vegetation that obstructs flow (early spring).
- Check banks and bottom for erosion, and regrade or reshape as necessary (annually).
- Remove sediment when accumulation reaches 6 – 12 inches or if resuspension is observed.
- Reseed banks near inlet/outlet and stabilize eroded banks as necessary.
- Inspect detention basin and buffer strip zone for invasive species such as purple loosestrife, phragmites, buckthorn (common & glossy), honeysuckle and autumn olive that out-compete native vegetation (annually - July).
- Have a professional selectively remove invasive species (annually, July-August). Purple loosestrife flower heads can be clipped off to reduce seed production until plant removal may be achieved. If woody debris is cut, the cut should be four inches above the ground surface and the stumps should be treated with herbicide immediately after cutting, and monitor for sucker growth. Use of chemicals within the pond (e.g., for control of algae or invasive species) requires a permit from the MDEQ.
- Plantings must be monitored for two years after establishment. Replacement will be necessary as determined by the agency having jurisdiction over the system.
- During the first two growing seasons, all areas planted with native prairie seed mix should be mowed three times at a height of 6-8 inches in order to control weeds. Beginning in the third year, a burning or mowing regimen should be

instituted, either burning or mowing once in spring, or once in the fall.

- Except as described herein, ensure that no mowing, chemical application, or construction has occurred in the buffer strip (annually). If it has, take corrective action to ensure these activities do not occur in the future.
- Except as described herein, ensure that chemicals are not applied to any aspect of the open detention basin, including the bottom, side slopes or buffer strip.
- If the outlet is pumped, then only a licensed electrician or company that provided the pump system should conduct maintenance.

References and Additional Resources

- Alliance of Rouge Communities, Maintaining Your Detention Pond: A Guidebook for Private Owners in Southeast Michigan, revised 2009. Available from link on webpage <http://www.allianceofrougecommunities.com/documents.html>
- Article 5.02.1, “General Landscaping Requirement, Storm Water Detention Basins”, Zoning of the Code of Laws and Ordinances, Charter Township of Canton, July 11, 2006.
- Michigan Association of Conservation Districts. <http://www.macd.org>
- Michigan Department of Environmental Quality, Guidebook of Best Management Practices for Michigan Watersheds. http://www.michigan.gov/deq/0,1607,7-135-3313_3682_3714-118554--,00.html
- Michigan Native Plant Producers Association. <http://www.MNPPA.org>
- Oakland County Water Resources Commissioner, Engineering Design Standards for Storm Water Facilities, revised July 8, 2014. Available from link on webpage http://www.oakgov.com/water/Pages/standards_specs.aspx
- Southeast Michigan Council of Governments, Low Impact Development Manual for Michigan, 2008. Available from link on webpage <http://www.semcong.org/Plans-for-the-Region/Environment/Green-Infrastructure>
- Washtenaw County Water Resources Commissioner, Rules and Guidelines – Procedures and Design Criteria for Stormwater

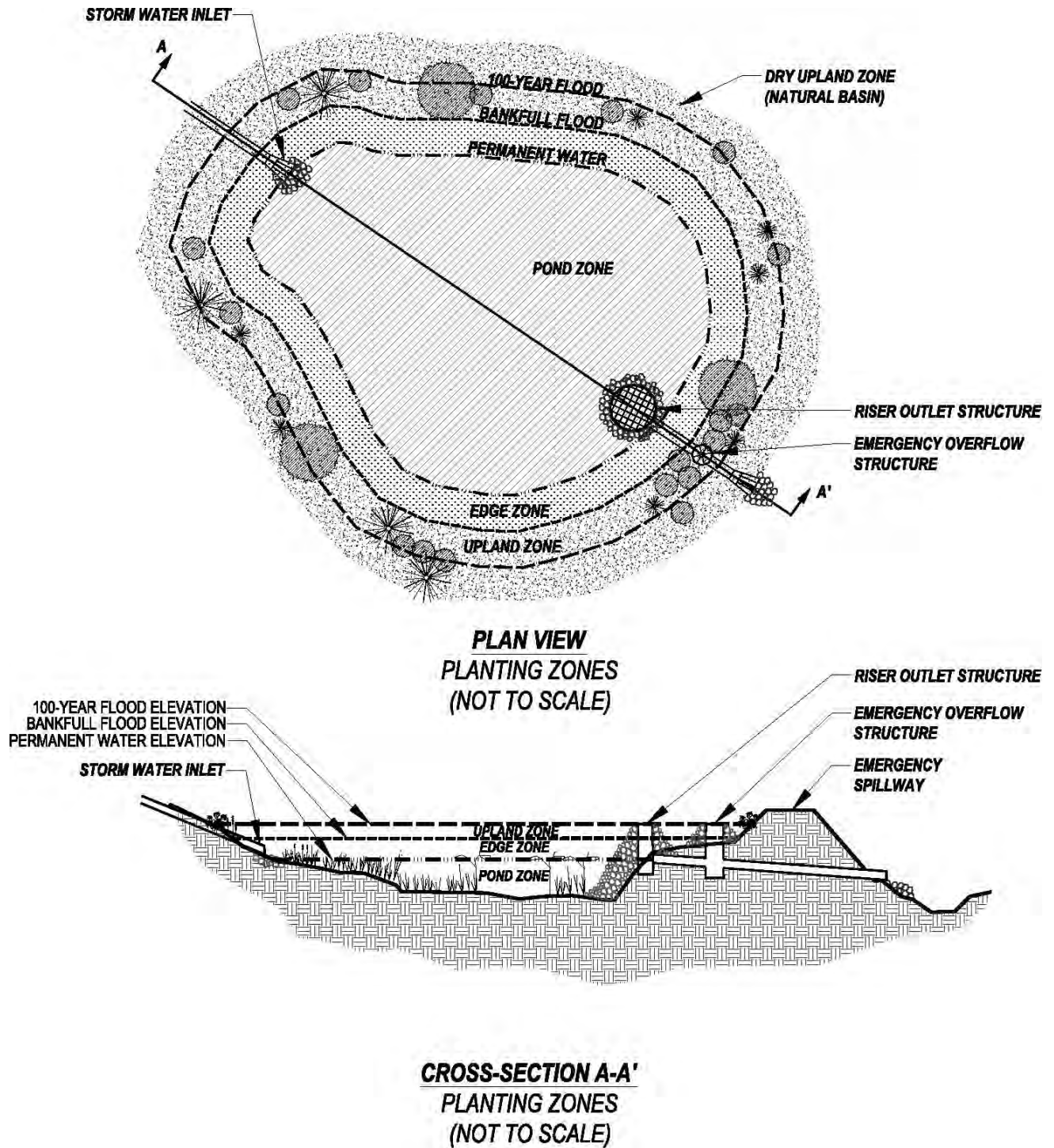
Management Systems, August 6, 2014 (and previous version May 15, 2000). Available from link on webpage <http://www.ewashtenaw.org/government/drain>

[_commissioner/dc_webPermits_DesignStandards/dc_Rules/frontpage](#)

- Wild Ones Organization, <http://www.wildones.org>

ATTACHMENT A: SPECIFICATIONS FOR PLANTING ZONES FOR OPEN DETENTION BASINS

All material in this appendix is adapted from "General Landscaping Requirement, Storm Water Detention Basins", Zoning of the Code of Laws and Ordinances, Charter Township of Canton, July 11, 2006 and used courtesy of Canton Township, Municipal Services Division.



SCHEMATIC OF PLANTING ZONES FOR OPEN DETENTION BASINS

OPEN DETENTION BASINS: POND ZONE VEGETATION

A combination of native plant plugs and bare-root stock should be planted in the pond zone (0 to 3 feet deep). The tables below identify native plants recommended for the pond zone of an open detention basin. Alternate species or genus from those recommended in the following tables may be specified if they meet the criteria for successful establishment in each pond zone.

Additional factors for design of vegetation within the pond zone of an open detention basin include:

- Plants should be selected based on whether they will be submerged, emergent, or wetland edge.
- A minimum of four plant species is recommended for the pond zone, planted in equal numbers of species, scattered in groupings of similar species throughout the entire zone.
- Initial plantings should cover a minimum of 25% of the outer 15 foot perimeter of the pond zone.
- For constructed wetlands, rooted wetland species, such as cattails, bulrush and sedges, are placed throughout the majority of the wetland area.
 - A mixture of wetland plants should be used in the shallow pool that extends laterally across the basin.
 - A diversity of depth zones should be used throughout the system to meet the unique growing requirements of divergent wetland plants.
- Planting of purple loosestrife is not permitted as this invasive plant forms dense colonies which out-compete the native environment.

Alternately, the pond zone may be seeded with a suitable mix if it is demonstrated that the pond hydrology will be controlled for the establishment of the proposed mix.

Native Plants for Pond Zone (minimum 4 species)

Scientific Name	Common Name	Spacing (inches on center)	Scientific Name	Common Name	Spacing (inches on center)
<i>Acorus calamus</i>	Sweet flag	24	<i>Polygonum amphibium</i>	Water knotweed	36
<i>Carex lacustris</i>	Common lake sedge	24	<i>Pontederia cordata</i>	Pickerel weed	24
<i>Cephalanthus occidentalis</i>	Buttonbush	5 feet	<i>Potamogeton natans</i>	Common pondweed	36
<i>Decodon verticillatus</i>	Swamp Loosestrife	24	<i>Potamogeton pectinatus</i>	Sago pondweed	36
<i>Elodea canadensis</i>	Common waterweed	36	<i>Sagittaria latifolia</i>	Common arrowhead	24
<i>Hibiscus laevis</i>	Halberd-leaved rose mallow	24	<i>Scirpus acutus</i>	Hard-stemmed bulrush	18
<i>Hibiscus palustris</i>	Swamp rose mallow	24	<i>Scirpus atrovirens</i>	Dark green rush	18
<i>Iris virginica shrevei</i>	Blue flag iris	18	<i>Scirpus cyperinus</i>	Wool grass	24
<i>Justicia americana</i>	Water willow	5 feet	<i>Scirpus fluviatilis</i>	River bulrush	18
<i>Nelumbo lutea</i>	Lotus	48	<i>Scirpus validus creber</i>	Great bulrush	18
<i>Nuphar advena</i>	Yellow pond lily	36	<i>Sparganium americanum</i>	American bur reed	18
<i>Nymphaea tuberosa</i>	White water lily	36	<i>Sparganium eurycarpum</i>	Common bur reed	18
<i>Peltandra virginica</i>	Arrow arum	18	<i>Vallisneria Americana</i>	Tape grass	36

Note: Plant species selected should cover 25% of the pond zone and should also cover the range of water depths within the pond zone (0 ft to 3 ft). (For example, 4 plant species may not all be placed at an 18-inch water depth covering 25% of the pond zone.)

OPEN DETENTION BASINS: EDGE ZONE VEGETATION

A variety of trees, shrubs, wildflowers, and grasses may be planted in the edge zone along the banks of detention basins. A native wetland edge or native sedge meadow seed mix is recommended.

Edge Zone: Native Seed Mixes

Grasses/Sedges/Rushes (Minimum 5 species)

<i>Scientific Name</i>	<i>Common Name</i>	<i>Scientific Name</i>	<i>Common Name</i>
<i>Carex `lurida</i>	Bottlebrush sedge	<i>Juncus effuses</i>	Common rush
<i>Carex vulpinoidea</i>	Brown fox sedge	<i>Leersia oryzoides</i>	Rice cut grass
<i>Echinochloa crusgalli</i>	Barnyard grass	<i>Scirpus acutus</i>	Hard-stemmed bulrush
<i>Elymus Canadensis</i>	Canada wild rye	<i>Scirpus atrovirens</i>	Dark green rush
<i>Glyceria striata</i>	Fowl manna grass	<i>Scirpus pungens</i>	Chairmaker's rush
		<i>Scirpus validus creber</i>	Great bulrush (softstem)

Native Forbs (Minimum 9 species)

<i>Scientific Name</i>	<i>Common Name</i>	<i>Scientific Name</i>	<i>Common Name</i>
<i>Acorus calamus</i>	Sweet flag		
<i>Actinomeris alternifolia</i>	Wingstem	<i>Mimulus ringens</i>	Monkey flower
<i>Alisma subcordatum</i>	Common water plantain	<i>Peltandra virginica</i>	Arrow arrum
<i>Asclepias incarnate</i>	Swamp milkweed	<i>Polygonum pensylvanicum</i>	Pinkweed
<i>Aster simplex</i>	Panicked aster	<i>Pontederia cordata</i>	Pickernel weed
<i>Bidens spp.</i>	Bidens, various	<i>Rosa palustris</i>	Swamp rose
<i>Cassia hebecarpa</i>	Wild senna	<i>Rudbeckia laciniata</i>	Wild golden glow
<i>Eupatorium perfoliatum</i>	Common boneset	<i>Sagittaria latifolia</i>	Common arrowhead
<i>Helenium autumnale</i>	Sneezeweed	<i>Spiraea alba</i>	Meadowsweet
<i>Iris virginica shrevei</i>	Blue flag iris	<i>Verbena hastata</i>	Blue vervain
<i>Ludwigia alternifolia</i>	Seedbox	<i>Vernonia fasciculata</i>	Common ironweed

Note: A quick growing species such as annual rye grass (*lillium multiflorum*)) and species which will provide the permanent cover (e.g., seed oats) should also be included in all Edge Zone seed mixes.

Edge Zone: Native Shrubs

<i>Scientific Name</i>	<i>Common Name</i>	<i>Scientific Name</i>	<i>Common Name</i>
<i>Alnus rugosa</i>	Speckled alder	<i>Ilex verticillata</i>	Winterberry (MI Holly)
<i>Aronia melanocarpa</i>	Black chokeberry	<i>Potentilla fruticosa</i>	Shrubby cinquefoil
<i>Betula pumila</i>	Bog birch	<i>Sambucus Canadensis</i>	Elderberry
<i>Cephalanthus occidentalis</i>	Buttonbush (plant in min. 6" water)	<i>Spiraea alba</i>	Meadowsweet
<i>Cornus amomum</i>	Silky dogwood	<i>Viburnum lentago</i>	Nannyberry
<i>Cornus stolonifera</i>	Red-oiser dogwood	<i>Viburnum trilobum</i>	American highbush cranberry

Edge Zone: Native Trees

<i>Scientific Name</i>	<i>Common Name</i>	<i>Scientific Name</i>	<i>Common Name</i>
<i>Acer saccharinum</i>	Silver maple	<i>Quercus bicolor</i>	Swamp white oak
<i>Betula nigra</i>	River birch	<i>Liquidambar styraciflua</i>	Sweetgum
<i>Carpinus caroliniana</i>	American hornbeam	<i>Liriodendron tulipifera</i>	Tuliptree
<i>Nyssa sylvatica</i>	Black gum	<i>Quercus palustris</i>	Pin oak
<i>Platanus occidentalis</i>	Sycamore	<i>Salix nigra</i>	Black willow

OPEN DETENTION BASINS: UPLAND ZONE VEGETATION

A variety of trees, shrubs, wildflowers, and grasses may be planted in the edge zone in the upland zone of open detention basins. Depending on the location and function of a detention basin within a development, vegetation within the Upland Zone may vary. Native plants recommended for the upland zone of an open detention basin are shown in the following tables.

For detention basins located at development entrances, adjacent to primary or secondary roads, adjacent to or directly behind proposed homes or are located within more formally landscaped areas in the proposed development: It is recommended that the seed mix for the Upland Zone extend from the upper boundary of the Edge Zone to the top of bank or slope. The area beyond the top of bank or slope of the basin should be sodded with an approved sod material. Section 8.5.1 provides additional specifications for sod installed as part of storm water management systems.

For detention basins adjacent to natural areas (forested areas, creeks/streams, wetlands), in remote areas, within interior areas of the development, adjacent to or directly behind proposed homes and terraced basins: seed mix appropriate for the areas extending beyond the 100-year flood elevation and top of bank or slope and functioning as a buffer for the pond should be a mesic-to-dry prairie mix, consisting of a broad-spectrum of prairie grasses and wildflowers with species that vary in height profile and also offer a variety of cover and food options for wildlife. The natural area seeded with prairie mix should be a minimum of fifteen (15) feet wide.

Upland Zone: Seed Mixes **Grasses/Sedges/Rushes (Minimum 5 species)**

<i>Scientific Name</i>	<i>Common Name</i>	<i>Scientific Name</i>	<i>Common Name</i>
<i>Calamagrostis canadensis</i>	Blue joint grass	<i>Glyceria striata</i>	Fowl manna grass
<i>Carex comosa</i>	Bristly sedge	<i>Juncus effusus</i>	Common rush
<i>Carex hystericina</i>	Porcupine sedge	<i>Leersia oryzoides</i>	Rice cut grass
<i>Carex stricta</i>	Common tussock sedge	<i>Panicum virgatum</i>	Switch grass
<i>Carex vulpinoidea</i>	Brown fox sedge	<i>Scirpus atrovirens</i>	Dark green rush
<i>Echinochloa crusgalli</i>	Barnyard grass	<i>Scirpus validus creber</i>	Great bulrush
<i>Elymus canadensis</i>	Canada wild rye	<i>Spartina pectinata</i>	Prairie cord grass

Upland Zone: Native Forbs (Minimum 9 species)

<i>Scientific Name</i>	<i>Common Name</i>	<i>Scientific Name</i>	<i>Common Name</i>
<i>Agalinis tenuifolia</i>	Slender false foxglove	<i>Juncus effusus</i>	Common rush
<i>Alisma subcordatum</i>	Common water plantain	<i>Liatris spicata</i>	Marsh blazing star
<i>Angelica atropurpurea</i>	Great angelica	<i>Lobelia cardinalis</i>	Cardinal flower
<i>Asclepias incarnata</i>	Swamp milkweed	<i>Lobelia siphilitica</i>	Great blue lobelia
<i>Aster novae-angliae</i>	New England aster	<i>Ludwigia alternifolia</i>	Seedbox
<i>Aster puniceus</i>	Bristly aster	<i>Peltandra virginica</i>	Arrow arum
<i>Aster simplex</i>	Panicled aster	<i>Physostegia virginiana</i>	Obedient plant
<i>Aster umbellatus</i>	Flat-top aster	<i>Pycnanthemum virginianum</i>	Common mountain mint
<i>Bidens cernua</i>	Nodding Burr marigold	<i>Sagittaria latifolia</i>	Common arrowhead
<i>Cassia hebecarpa</i>	Wild senna	<i>Silphium perfoliatum</i>	Cup plant
<i>Coreopsis tripteris</i>	Tall coreopsis	<i>Solidago rugosa</i>	Rough goldenrod
<i>Eupatorium maculatum</i>	Spotted joe-pye weed	<i>Sparganium eurycarpum</i>	Common bur reed
<i>Eupatorium perfoliatum</i>	Common boneset	<i>Spiraea alba</i>	Meadowsweet
<i>Gentiana andrewsii</i>	Bottle gentian	<i>Verbena hastata</i>	Blue vervain
<i>Helenium autumnale</i>	Sneezeweed	<i>Vernonia fasciculata</i>	Common ironweed
<i>Iris virginica shrevei</i>	Blue flag iris	<i>Zizia aurea</i>	Golden alexanders

Notes:

- An quick growing species such as annual rye grass (*lillium multiflorum*)) and species which will provide the permanent cover (e.g., seed oats) should also be included in all Upland Zone seed mixes.
- These native plants are appropriate for the Upland Zone; from the bank full elevation to the 100-year flood elevation and beyond. This seed selection consists of sedge meadow, wet-to-mesic prairie, and dry-to-mesic prairie plant species.

Upland Zone: Native Shrubs

<i>Scientific Name</i>	<i>Common Name</i>	<i>Scientific Name</i>	<i>Common Name</i>
<i>Ceanothus americanus</i>	New Jersey tea (dry-mesic)	<i>Lindera benzoin</i>	Spicebush (mesic)
<i>Cornus foemina</i>	Gray dogwood	<i>Physocarpus opulifolius</i>	Ninebark (dry or mesic)
<i>(C. racemosa)</i>	(dry to wet-mesic)	<i>Rhus aromatica</i>	Fragrant sumac (dry)
<i>Corylus americana</i>	American filbert (dry or mesic)	<i>Sambucus canadensis</i>	Elderberry (wet-mesic)
<i>Hamamelis virginiana</i>	Witch-hazel (dry-mesic)	<i>Viburnum dentatum</i>	Arrowwood (dry-mesic)

Upland Zone: Native Trees

<i>Scientific Name</i>	<i>Common Name</i>	<i>Scientific Name</i>	<i>Common Name</i>
<i>Acer rubrum</i>	Red maple (mesic)	<i>Cercis Canadensis</i>	Redbud (mesic)
<i>Acer saccharum</i>	Sugar maple (mesic)	<i>Crataegus crusgalli</i>	Cockspur hawthorn (dry)
<i>Amelanchier arborea</i>	Serviceberry (Juneberry)(dry or mesic)	<i>Gymnocladis dioicus</i>	Kentucky coffeetree (mesic)
<i>Betula alleghaniensis</i>	Yellow birch (mesic)	<i>Ostrya virginiana</i>	Hip-hornbeam Ironwood (dry-mesic)
<i>Carya cordiformis</i>	Bitternut hickory (mesic)	<i>Quercus alba</i>	White oak (mesic)
<i>Carya glabra</i>	Pignut hickory (dry)	<i>Quercus imbricaria</i>	Shingle oak (mesic)
<i>Carya lacinosa</i>	Shellbark hickory (mesic)	<i>Quercus macrocarpa</i>	Bur oak (dry or mesic)
<i>Carya ovata</i>	Shagbark hickory (dry-mesic)	<i>Quercus muehlenbergii</i>	Chinkapin oak (dry or mesic)
<i>Celtis occidentalis</i>	Hackberry (mesic)	<i>Quercus prinoides</i>	Dwarf chinkapin oak (dry)
<i>Celtis tenuifolia</i>	Dwarf hackberry (dry-mesic)	<i>Quercus rubra</i>	Red Oak (mesic)
		<i>Tilia americana</i>	American basswood (mesic)

Note: These plants range from dry to mesic according to the moisture conditions in the Upland Zone. Small sizes of native trees and shrubs may be proposed to increase plant diversity. The total tree caliper inches must equal the calculated caliper inches of required trees.

Natural Basin: Dry Upland Zone: Permanent Grasses (Minimum 5 species)

<i>Scientific Name</i>	<i>Common Name</i>	<i>Scientific Name</i>	<i>Common Name</i>
<i>Andropogon gerardii</i>	Big bluestem grass	<i>Koeleria cristata</i>	June grass
<i>Andropogon scoparius</i>	Little bluestem grass	<i>Panicum virgatum</i>	Switch grass
<i>Bouteloua curtipendula</i>	Side-oats gramma	<i>Sorghastrum nutans</i>	Indian grass
<i>Elymus canadensis</i>	Canada wild rye	<i>Sporobolus heterolepis</i>	Prairie dropseed

Natural Basin: Dry Upland Zone: Native Forbs (Minimum 9 species)

<i>Scientific Name</i>	<i>Common Name</i>	<i>Scientific Name</i>	<i>Common Name</i>
<i>Amorpha canescens</i>	Lead plant	<i>Lupinus perennis</i>	Wild lupine
<i>Anemone cylindrica</i>	Thimbleweed	<i>Monarda fistulosa</i>	Wild bergamot
<i>Aquilegia canadensis</i>	Wild columbine	<i>Parthenium integrifolium</i>	Wild quinine
<i>Asclepias tuberosa</i>	Butterfly weed	<i>Petalostemum purpureum</i>	Purple prairie clover
<i>Aster ericoides</i>	Heath aster	<i>Physostegia virginiana arenaria</i>	Prairie obedient plant
<i>Aster laevis</i>	Smooth blue aster	<i>Pycnanthemum virginianum</i>	Common mountain mint
<i>Aster novae-angliae</i>	New England aster	<i>Ratibida pinnata</i>	Yellow coneflower
<i>Baptista leucantha</i>	White wild indigo	<i>Rudbeckia hirta</i>	Black-eyed susan
<i>Cassia fasciculata</i>	Partridge pea	<i>Rudbeckia subtomentosa</i>	Sweet black-eyed susan
<i>Coreopsis lanceolata</i>	Sand coreopsis	<i>Silphium laciniatum</i>	Compass plant
<i>Coreopsis tripteris</i>	Tall coreopsis	<i>Solidago juncea</i>	Early goldenrod
<i>Echinacea purpurea</i>	Broad-leaved purple coneflower	<i>Solidago nemoralis</i>	Old-field goldenrod
<i>Eryngium yuccifolium</i>	Rattlesnake master	<i>Solidago rigida</i>	Stiff goldenrod
<i>Helianthus mollis</i>	Downy sunflower	<i>Tradescantia ohiensis</i>	Common spiderwort
<i>Heliopsis helianthoides</i>	False sunflower	<i>Vernonia altissima taeniotricha</i>	Hairy tall ironweed
<i>Lespedeza capitata</i>	Round-headed bush clover	<i>Veronicastrum virginicum</i>	Culver's root
<i>Liatis aspera</i>	Rough blazing star		

Note: These native plants are appropriate for areas surrounding basins categorized as natural basins and recommended within areas that have elevations higher than the 100-year flood elevation. This seed selection consists of dry-to-mesic prairie, basic prairie, and low-profile prairie plant species.

ATTACHMENT B: WETLANDS CONSTRUCTION TECHNIQUES



Photo courtesy ECT

- *Step 1 - Prepare the Final Pondscaping and Grading Plans for the Wetland:* At this stage the engineer, landscape architect, and wetland expert work jointly to prepare a pondscaping and grading plan for the wetland. It is also an appropriate time to order the wetland plant stock from aquatic nurseries, since up to six to nine months lead time may be needed to fill orders.
- *Step 2 - Grade the Wetland to Interim Elevations:* Once the basic excavation of the storm water wetland has been completed, it is time to create the major topographic features within the wetland, such as wedges, benches, and deep water channels. A skid loader or other excavator can be used to form the internal complexity within the wetland. These topographic features can only be added while working in the “dry.” Spot surveys should be made to ensure that the interim elevations are 3 to 6 inches below the final elevations for the wetland.
- *Step 3 - Add Topsoil/Wetland Mulch Amendments:* Since most storm water wetlands are excavated to deep subsoils, they often lack the nutrients and organic matter needed to support vigorous growth of wetland plants. It is therefore essential to add 3 to 6 inches of topsoil or wetland mulch to all depth zones in the wetland from 1 foot below the normal pool to 6 inches above. Topsoil can be stockpiled during

construction of the wetland or can be scavenged from elsewhere at the development site. Wetland mulch is preferable to topsoil if it is available.

- The importance of soil amendments in excavated wetlands cannot be overstressed; poor survival and future wetland coverage are likely if these soils are not added (Bowers, 1992). Fertilizers and other soil amendments are not needed if topsoil or wetland mulch are used.
- *Step 4 - Grade the Wetland to Final Elevations:* After topsoil or wetland mulch has been added to the storm water wetland, the wetland can be graded to its final elevations. This is normally done by “roughing up” the interim elevations with a skid loader or other equipment to achieve the desired micro topography across the wetland. All wetland features above the normal pool should be temporarily stabilized by hydroseeding or seeding over straw.
- *Step 5 - Measure and Stake Planting Depths:* The storm water wetland is surveyed and staked at the onset of the planting season. Depths in the wetland should be measured to the nearest inch to confirm the original planting depths of the planting zone. At this time, it may be necessary to modify the pondscape plan to reflect altered depths or the availability of wetland plant stock. Surveyed planting zones should be marked on the as-built or design plan, and also located in the field using stakes or flags.

For constructed wetlands, plant plugs or container-grown wetland plant stock should be planted. The transplanting window extends from early April to mid-June. Planting after these dates is quite chancy, as emergent wetland plants need a full growing season to build the root reserves needed to get through the winter. If at all possible, plants should be ordered at least six months in advance to ensure the availability of desired species.

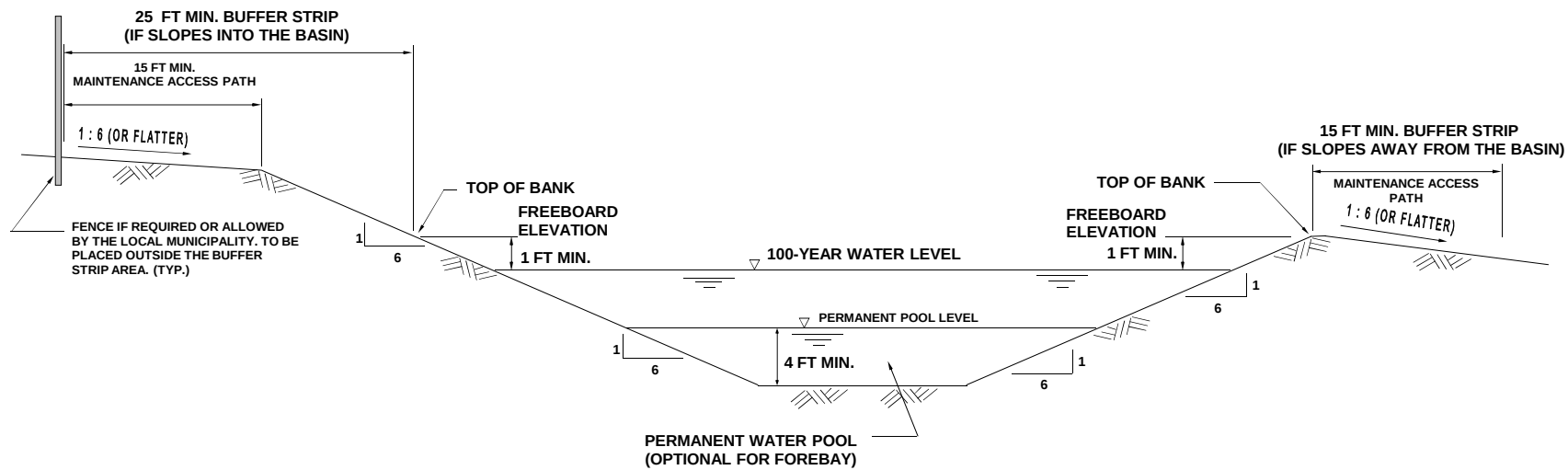
It is not necessary to plant more than half the wetland surface area. If the appropriate planting depths are achieved, the entire wetland should be colonized within three years. The wetland area should be subdivided into separate planting zones of more or less constant depth. One plant species should be planted within each flagged planting zone based on its approximate depth requirements. Individual plants should be planted 18 inches on center within each single species "clump."

Post-nursery care of wetland plants is very important during the interval between delivery of the plants and subsequent planting, as they are prone to desiccation. Stock should be frequently watered and shaded while on-site.

After the second growing season, reinforcement plantings may be needed to expand the spatial coverage of the wetland.

ATTACHMENT C:

**DETAIL FOR REQUIRED BUFFER STRIPS FOR FOREBAYS, OPEN DETENTION
BASINS, AND RETENTION BASINS
WITH DRAINAGE AREA GREATER THAN 5 ACRES**



REQUIRED BUFFER STRIP FOR FOREBAYS, OPEN DETENTION BASINS, AND
RETENTION BASINS
(DRAINAGE AREA GREATER THAN 5 ACRES)
 NOT TO SCALE

8.1.2 Retention Basins

Description

Retention basins are man-made surface waters designed to provide gravity settling of pollutants and to promote infiltration into the soil rather than discharging the storm water runoff to a surface water or closed conduit. The soils beneath a proposed retention basin must be sufficiently permeable to allow the infiltration of storm water.

Design Standards

Design standards for retention basins include the following:

- A registered Professional Engineer must certify that the soils beneath a proposed retention basin are sufficiently permeable to allow the infiltration of storm water and storm water runoff. Calculations showing the percolation rate of soils below the proposed retention basin must be provided.
- A forebay or other pretreatment system is required at each inlet to the retention basin. Pretreatment systems trap sediment before entering the retention basin, reduce the incoming runoff velocities, and spread runoff evenly over the retention basin to create sheet flow conditions. Section 8.2 of this manual provides detailed information and design criteria for pretreatment systems.
- All closed conduits entering retention basins should have an end treatment and adequate soil erosion protection, as described in Section 8.3.1. Some enclosures should also be covered with a grate to prevent children and animals from entering the enclosure.
- Retention basins must be designed to retain the volume of storm water equal to the runoff from two consecutive 100-year storm events as described in Section 6.2.2. The design storage volume in a retention basin must be provided above the existing ground water elevation.
- A minimum of one (1) foot of freeboard is required above the design water level of a retention basin.
- Providing a safe design is a primary consideration for all storm water management basins. Side slopes for retention basins may not be steeper than 1:6. Further safety measures (e.g., safety shelves, vegetative and barrier plantings) may be warranted depending on the type of development.
- Although use of terraced side slopes generally is discouraged when other alternatives exist, terraced side slopes may be approved for retention basins in certain, limited circumstances at the discretion of Wayne County. The overall slope of a terraced side of a retention basin should not be steeper than 1:3. An example detail for terraced side slopes is provided in Appendix E-3.
- An emergency spillway is required for all retention basins. The applicant must demonstrate that there exists a defined drainage path downstream from the emergency spillway to allow discharge when flows exceed the design water level. Design criteria for emergency spillways are the same as those for open detention basins as described in Section 8.1.4.
- Retention basins may not be located within pre-existing surface waters.
- A buffer strip must be provided around all surface waters such as retention basins.. Except as noted below, the buffer strip must be at least 25 feet wide measured from the minimum freeboard elevation of the basin or surface water. Of the minimum 25 ft width, a minimum of 15 feet of the buffer strip should be exterior to the pond perimeter defined by the top of bank. The slope of the buffer strip should be 1:6 or flatter. These provisions ensure that there is sufficient room along the top of the basin to provide access to the basin for maintenance. The buffer strip requirements illustrated in the figure “Required Buffer Strip for Forebays, Open Detention Basins, and Retention Basins” in Attachment C of Section 8.1.1 for open detention basins are applicable to retention basins.
- In the following situations, the minimum width of the buffer strip around retention basins is 15 feet measured from the minimum freeboard elevation of the basin:

- o When a retention basin has a drainage area 5 acres or less; or
- o When a retention basin has a drainage area greater than 5 acres and no storm water from areas outside of or within the buffer strip enters the basin via direct sheet flow (see the right side of the figure “Required Buffer Strip for Forebays, Open Detention Basins, and Retention Basins” in Attachment C of Section 8.1.1).
- Plant vegetation, such as along the side slopes of retention basins, is necessary to control erosion and enhance sediment entrapment. A landscaping plan is required for retention basins, due to the importance of the vegetation to the function of the entire system. Use of a professional landscape architect with experience in storm water management system design and native landscaping is encouraged.

Preferred Design Elements

- Calculations showing the percolation rate of soils should be based on soil borings. Wayne County generally requires soil borings to be taken as follows:
 - o Minimum four soil borings per retention basin.
 - o Borings should be taken every 200 feet within the perimeter of the basin.
 - o Borings should be at least 10 feet deep, measured from the bottom elevation of the proposed basin.
- Soil samples collected from borings should be collected every five vertical feet. Soil analysis should include:
 - o Sieve analysis
 - o Hydrometer reading
 - o Soil classification
 - o Standard penetration numbers
 - o The shape and configuration of retention basins may vary, depending on storage requirements, local topography, land availability, hydraulic considerations, and other site-specific constraints.
- Retention basins should be designed to maximize sheet flow across the open water portion of the facility.
- If aerating devices are used as part of a storm water management system, they should be

designed to minimize disturbance of bottom sediments. For example, retention basins may need to have a deeper permanent pool if an aerating device is used. Bubbler systems are the preferred type of aerating device as they have been found to be more efficient at providing aeration. The manufacturer’s recommendations should be followed in regards to design and maintenance.

- If a terraced side slope is approved for use in a retention basin, the materials proposed for use in its construction should be approved by the local community.

Vegetation Specifications

The type of vegetation used is dependant on site-specific conditions, such as soil types, amount of sunlight, and other factors. Vegetation specifications for retention basins are the same as those for open detention basins (see Section 8.1.1).

Maintenance

Required maintenance activities for retention basins are the same as those for open detention basins (see Section 8.1.1). These activities must be identified in the submitted maintenance plan. Additionally, provision for maintenance access should be shown on the plan; it is recommended that the maintenance access be a minimum of 15 feet wide.

References

See references in Section 8.1.1

8.1.3 Underground Detention Systems

Description

Underground detention systems consist of one or more underground pipes or structures designed to provide the required storage volumes (both the bankfull flood and flood control volumes) for a development project. Just as with any above ground means of storm water detention, underground detention systems must have a restricted outlet that limits outflow for the bankfull flood and for the maximum allowable release rate from the development site.

Underground detention systems are the least preferred method of detention and generally are allowable only when an open detention system is not feasible for a given site.

Preferred Design Elements and Materials

Before entering an underground detention system, storm water runoff must pass through a pretreatment system as described in Section 6.3.1. All construction components and materials used from the pre-treatment structure through the underground detention system out to the point of discharge must be tested, inspected and approved by Wayne County. The pretreatment system includes the last structure in the collection system leading into the treatment system.

For underground detention systems consisting of pipes, spacing of the pipes should conform to the manufacturer's recommendation except that a minimum clearance of 12 inches is required between pipes to provide for adequate backfill and support (as described in "Installation," below).

Underground detention systems must confine storm water runoff to the interior of the detention system, and may discharge storm water only through a restricted outlet. Examples of two types of restricted outlets are shown on the following pages. Example A, a restricted outlet with no overflow, is appropriate for underground detention systems that discharge to

a storm water management system within a Wayne County road right-of-way or other County-owned property, or to any other storm water management system with restrictions on the allowed inflow. Example B, a restricted outlet with overflow, is appropriate for underground detention systems that discharge to surface waters or other storm water management systems. Note that the designs for a restricted outlet for underground detention systems shown in Examples A and B illustrate acceptable designs; other designs also may be acceptable.

If a manufactured treatment system is installed upstream of the underground detention system, the underground detention system should be designed, to the extent possible, such that the flood control design water elevation within the underground detention system is equal to or below the controlling water surface elevation in the manufactured treatment system. This design consideration is necessary to maximize the performance of this type of pretreatment system and to minimize the resuspension of collected sediment.

Wayne County prefers gravity outlets to pumped outlets from underground detention systems. If an underground detention system is designed to include a pumped outlet:

- Pumps should be located downstream of the flow restrictor within the outlet
- Two pumps should be provided in any pumped outlet system:
 - If the system is designed to use one pump, with one pump as a backup, each pump should be sized to operate such that the maximum pumping capacity does not exceed the allowable release rate (Q_a)
 - If the system is designed to use two pumps alternately or at the same time, the maximum pumping capacity of the system should not exceed the allowable release rate (Q_a) at any time.

- A manhole structure should be provided downstream of the pump station.

Access

All underground detention systems should have a means to inspect and maintain the entire system. For underground detention systems made of pipes, access risers (minimum of 24-inch diameter) and clean outs (size as recommended by manufacturer) are required. For storm water collection chamber (SCC) underground detention systems, inspection ports (sized as recommended by manufacturer) are required.

It is the responsibility of the system manufacturer to detail the access to the system. For systems made of corrugated metal pipe and polymer-coated corrugated steel pipe, the gauge of the material used for the risers should follow the same requirements as listed for the detention system pipe materials.

Materials

Wayne County is authorized to restrict the types of materials that may be used to construct underground detention systems. Generally, underground detention systems should be constructed from pre-cast or cast-in-place concrete, corrugated metal pipe (CMP), polymer-coated corrugated steel pipe (PCCSP), reinforced concrete pipe (RCP), smooth-lined corrugated plastic pipe (CPE), or storm water collection chambers (SCC). Unless otherwise indicated in this section, materials used for underground detention systems should meet the requirements of the current MDOT Standard Specification for Construction.

Storm water detention systems made of pre-cast or cast-in-place reinforced concrete structures should conform to current Wayne County Specifications for Structural Concrete with the wall thickness not less than the minimum thickness necessary to sustain HS20 loading requirements, as determined by a registered Professional Engineer. Pipe openings should be sized to accept pipes of the specified size(s) and material(s) and should be sealed with hydraulic cement conforming to ASTM C595.

Underground detention systems made of reinforced concrete pipe should conform to ASTM C76.

Circular CMP should conform to AASHTO M36 (ASTM A760) and should be made from aluminum coated sheet conforming to AASHTO M274. The use of the continuous welded seam process in the fabricating of pipe is not permitted. Unless otherwise approved by the Wayne County Permit Engineer, CMP is limited to a maximum diameter of 60-inches. See Table 8.2.3-1 for additional information.

Polymer coated corrugated steel pipe (PCCSP) should conform to AASHTO M245 (ASTM A762) using AASHTO M246 (ASTM A742) Grade 250/250 polymer on zinc coated steel meeting AASHTO M218. The use of the continuous welded seam process in the fabricating of pipe is not permitted. Unless otherwise approved by the Wayne County Permit Engineer, PCCSP is limited to a maximum diameter of 60-inches. See Table 8.1.3-1 for additional information.

Smooth-lined corrugated plastic pipe should conform to AASHTO M294, Type S and should be limited to a maximum size of 60-inches. In areas where the CPE pipe will be under the influence of pavement, the cover should be a minimum of 24-inches measured from the top of pipe to the top of a concrete (rigid) pavement or 24-inches from the top of pipe to the bottom of asphalt (flexible) pavement.

Underground detention systems consisting of SCC should conform to ASTM F 2418. The structural design of the SCC, its structural backfill and requirements for its installation should ensure that the load factors specified in the AASHTO LRFD Bridge Design Specifications, Section 12.12 are met. It is required that the factors for both long-duration dead loads and short-duration live loads, based on the AASHTO Design Truck for HS-20 live loads and deep burial earth loads with consideration for impact and the presence of multiple vehicles. To date, the Stormtech™ SC-740, SC-310, MC-3500, and MC-4500 have been approved by Wayne County as meeting these criteria.

Testing

The manufacturer of underground detention system elements must contact the Wayne County Testing Office (734-595-6504 x 2015) at least 72 hours prior

to fabrication to schedule inspection during fabrication. Wayne County inspects the material fabrication process to ensure that the manufacturer's testing of the product occurs at the applicable AASHTO or ASTM standards. Testing of pipe materials should occur at the following frequencies:

- RCP should be tested at a frequency of one test per 200 pieces per size per day.
- CMP and PCCSP should be tested at a frequency of one test per 2,500 lineal feet per heat number.
- CPE should be tested at a frequency of one test per 1,000 straight length of pipe per diameter per lot number.

Testing of SCC and end caps should occur at a frequency of one test per 200 pieces (chambers or end caps) or per shift, whichever is less.

Installation

Wayne County is authorized to restrict the methods used to construct underground detention systems. At a minimum, unless otherwise directed by the County, installation of underground detention systems constructed of pipes should conform to the current MDOT specification(s) for installation of the specific pipe material used. Based on soil conditions, Wayne County may require the entire underground detention system to be enveloped with geotextile fabric conforming to MDOT Section 910.

For underground detention systems consisting of pipes and SCC, a stable foundation is necessary to insure that the proper line and grade is maintained. Unstable foundations may be undercut and replaced with MDOT Class I granular bedding material placed in 6 inch lifts and compacted to 95% of its maximum unit weight. Other methods of stabilization can be used if approved by the Wayne County Permit Engineer.

For underground detention systems consisting of CPE, CMP, and PCCSP, embedment materials should be worked under the haunches by hand for pipes 30-inches and larger.

When installing underground pipe as part of a underground detention system, backfill should be as follows:

- RCP: backfill should conform to Wayne County Trench "A" backfill and Trench "B" backfill specifications.
- CPE, CMP, or PCCSP: the dimensions of the trench backfill are the same as Trench "A" and "B"; however, 2G, 34G, 6A or 21AA stone or gravel should be used as backfill to a minimum of 6-in above the pipe. In the event that a different backfill is used above the 2G, 34G, 6A or 21AA stone or gravel, a geotextile separation fabric shall be used between the two different materials. A minimum cover from the bottom of the pavement to the top of the pipe should be 12 inches except for CPE pipe under the influence of pavement, in which case the cover shall be a minimum of 24-inches measured from the top of pipe to the top of a concrete (rigid) pavement or 24-inches from the top of pipe to the bottom of asphalt (flexible) pavement.
- CMP and PCCSP: the minimum cover (including the 21AA or 22A backfill from the top of pipe) from the top of the pipe to the bottom of the pavement is 12-inches, plus the pavement thickness.

For underground detention systems consisting of SCC, foundations and embedment stone should be clean, angular stone meeting the requirements of MDOT 4AA, 6AA, 6A or the requirements of Wayne County Specifications for 3-in x 1-in maintenance aggregate (no crush concrete) with a maximum percentage of 5% passing the #200 sieve.

Backfill for all types of underground detention system should be installed as follows:

- All backfill materials should be placed in a balanced manner making sure that no more than a 2 lift differential is present from one side of the pipe/SCC/structure to the other. Balanced lifts should be advanced across the width of the system, evenly along the length of the system throughout the backfilling process.
- All backfill materials should be placed in lifts of maximum 10-inches.

- For each backfill lift, all materials should be compacted to a minimum of 95% (90% minimum required for 6A and 21AA) of the backfill material's maximum unit weight at moisture content not greater than optimum. The maximum unit weight of the backfill materials should be determined by the AASHTO T 180 or Michigan Cone Method. The frequency of the compaction testing should be one test per lift of backfill per 200 lineal feet or less of trench.

A Wayne County Permit Engineer must observe the installation of all underground detention systems.

Contact the Wayne County Permit Office (734-595-6504 x 2009) at least 72 hours prior to installation to schedule inspection during installation. Wayne County will not accept any underground detention systems installed when a County Permit Engineer is not present; permits and financial assurances will not be released at the conclusion of construction for such systems.

Documentation of the following items relative to the installation of underground detention systems is required to be submitted to the Wayne County Permit Engineer before permits and financial assurances are released:

- All backfill materials are from Wayne County tested stock.
- All backfill materials were placed in lifts of maximum 10-inches.
- For each backfill lift, all materials were compacted to a minimum of 95% of the backfill material's maximum unit weight at moisture content not greater than optimum. If 6A and 21AA backfill was used, materials were compacted to 90% of the backfill material's maximum unit weight at moisture content not greater than optimum.
- The maximum unit weight of the backfill material was determined by the AASHTO T 180 or Michigan Cone Method.
- The compaction was tested a minimum of one test per lift of backfill per 200 lineal feet or less of trench.

Maintenance

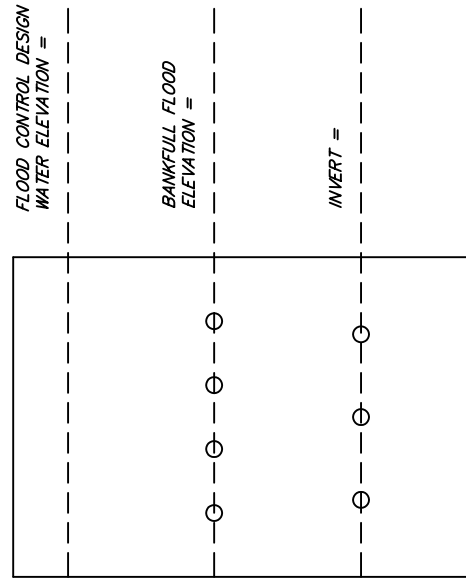
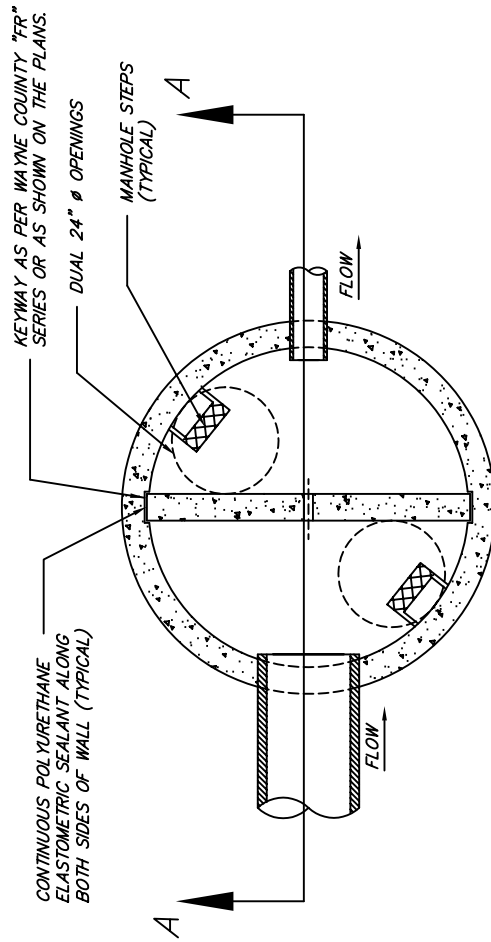
Underground detention systems should be inspected every 6 months to verify proper operation, and to identify and perform any necessary maintenance. As a general rule, the detention system requires cleaning if its volume is reduced by more than 10 percent due to the accumulation of silt and sediment.

Table 8.1.3-1

**WALL THICKNESS REQUIREMENTS FOR CORRUGATED METAL PIPE AND
POLYMER COATED CORRUGATED STEEL PIPE
(DIAMETER-GAUGE)**

DIAMETER (INCHES)	SIZE OF CORRUGATION		
	2 2/3-in x ½-in	3-in x 1-in	5-in x 1-in
UP TO 30	0.079-in - 14 ga.	---	---
36 - 54	0.079-in - 14 ga.	0.079-in - 14 ga.	0.079-in - 14 ga.
60	0.109-in - 12 ga.	0.079-in - 14 ga.	0.79-in - 14 ga.

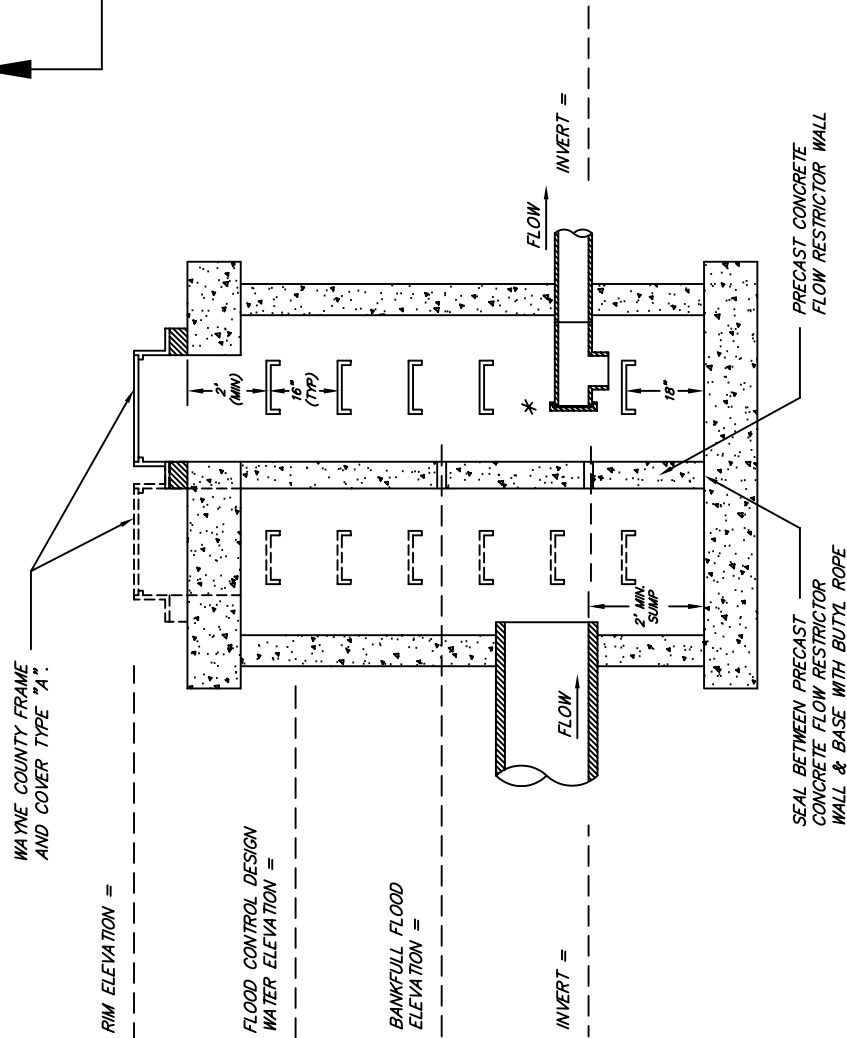
- All welds for aluminized pipe should be coated with a paint containing zinc dust as described in the Materials Section of ASTM A 780 and should be applied to a dry film thickness of at least 0.005 inch. Any repair to damaged aluminized coatings should be in accordance with ASTM A 760 Section 11.
- All welds for polymer pre-coated pipe (PCCSP) should first be coated with a zinc dust paint as described above followed by a polymer coating similar and compatible to the original polymer coating or a protective coating meeting ASTM A 849. Repairs to damaged PCCSP should be in accordance with ASTM A 762.
- Welding on site is not permitted unless approved by the Wayne County Permit Engineer.
- Elliptical CMP or PCCSP is not permitted.
- CMP and PCCSP connections should be per the manufacturer's recommendations.
- Larger size CMP or PCCSP will be as approved by the Wayne County Permit Engineer.



FLOW RESTRICTOR WALL
FRONT VIEW

NUMBER AND SIZE OF HOLES AS PER DESIGN, MINIMUM 1" DIA.
EQUALLY SPACED, MINIMUM 6" O/C.

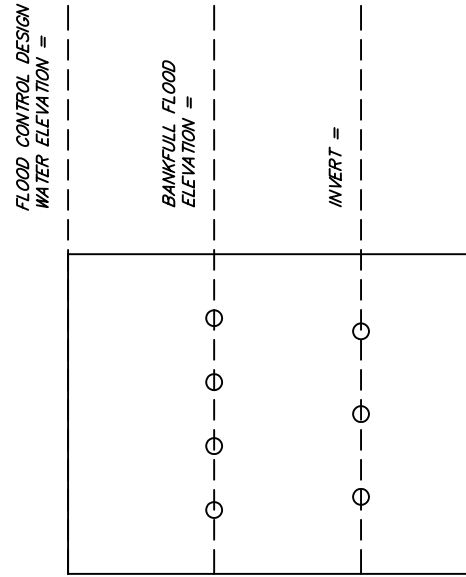
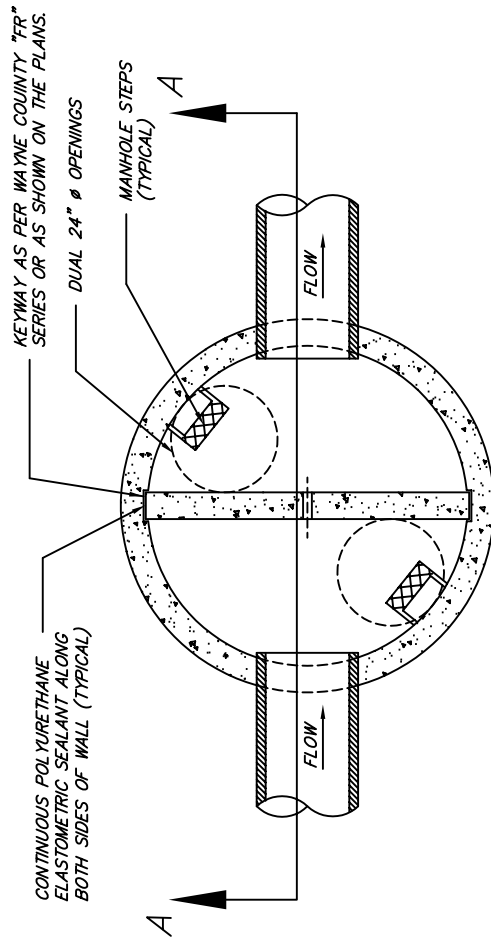
* OIL/WATER SEPARATOR IS REQUIRED FOR OUTFLOW PIPE LESS THAN 12" DIA.



SECTION "A-A"

1. THIS TYPE OF FLOW RESTRICTOR STRUCTURE TO BE USED ONLY WITH UNDERGROUND DETENTION SYSTEMS.
2. OVERFLOW IS NOT ALLOWED TO A WAYNE COUNTY ROAD STORM SYSTEM OR ENCLOSED DRAIN.
3. THE PRECAST REINFORCED FLOW RESTRICTOR STRUCTURE SHALL BE MANUFACTURED PER ASTM C-478 SPECIFICATIONS AND MEETING HS20 LOADING REQUIREMENTS.
4. THE STRUCTURE GEOMETRIC AND REINFORCEMENT DETAILS SHALL BE PER WAYNE COUNTY STANDARD DETAILS "FR" SERIES.

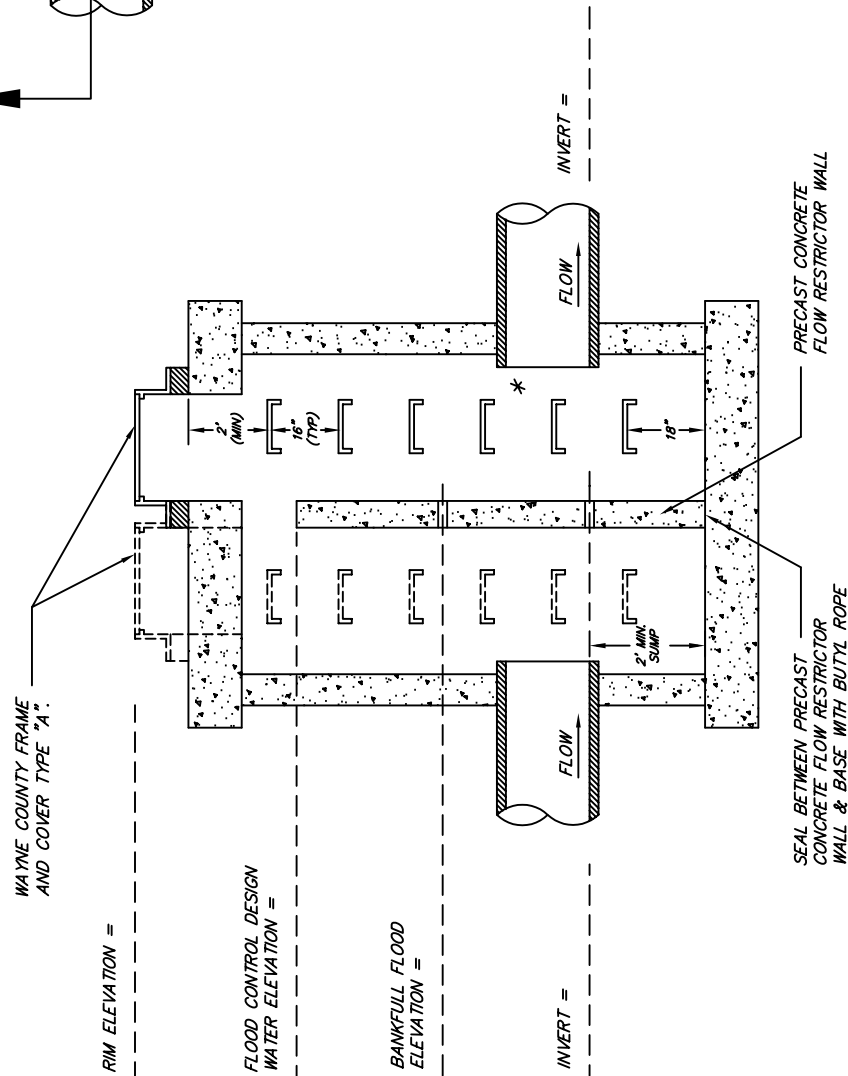
EXAMPLE A: FLOW RESTRICTOR WITHOUT OVERFLOW
NOT TO SCALE



FLOW RESTRICTOR WALL
FRONT VIEW

NUMBER AND SIZE OF HOLES AS PER DESIGN, MINIMUM 1" DIA. EQUALLY SPACED, MINIMUM 6" O/C.

* OIL/WATER SEPARATOR IS REQUIRED FOR OUTFLOW PIPE LESS THAN 12" DIA.



SECTION "A-A"

1. THIS TYPE OF FLOW RESTRICTOR STRUCTURE TO BE USED ONLY WITH UNDERGROUND DETENTION SYSTEMS.
2. OVERFLOW IS NOT ALLOWED TO A WAYNE COUNTY ROAD STORM SYSTEM OR ENCLOSED DRAIN.
3. THE PRECAST REINFORCED FLOW RESTRICTOR STRUCTURE SHALL BE MANUFACTURED PER ASTM C-478 SPECIFICATIONS AND MEETING HS20 LOADING REQUIREMENTS.
4. THE STRUCTURE GEOMETRIC AND REINFORCEMENT DETAILS SHALL BE PER WAYNE COUNTY STANDARD DETAILS "FR" SERIES.

EXAMPLE B: FLOW RESTRICTOR WITH OVERFLOW
NOT TO SCALE

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8.1.4 Outlets for Forebays and Open Detention Basins

Description

Forebay outlets convey flow from a forebay into detention systems and retention basins. Forebay outlets must include a flow restrictor, which conveys restricted flow, and a weir, which conveys unrestricted flow.

Outlets from open detention basins convey flow from the detention basin into a surface water or off-site closed conduit. Required outlets from open detention basins include a flow restrictor to convey restricted flow, an overflow structure to discharge when the water level exceeds the design water level, and an emergency spillway to convey unrestricted flow. An example of a storm water management system with forebay and open detention basin outlets is shown in the detail at the end of this section.

Design Standards for Forebay Outlets

Outlets for forebays must be designed as follows:

- Flow restrictors in forebays must be placed near or within the embankment of the forebay to provide ready maintenance access and must be constructed of materials that minimize future maintenance requirements.
- Flow restrictors must be designed to gradually release the first flush storage volume over a period of twenty-four (24) hours, as described in Section 6.3.1.
- Forebays must include a weir to allow discharge from the forebay into the detention system or retention basin when the forebay water level exceeds the top of the forebay storage volume. The weir must be designed to convey the peak flow rate tributary to the forebay for the 10-year design storm.

Design Standards for Open Detention Basin Outlets

Outlets for open detention basins must be designed as follows:

- A flow restrictor is required in each detention basin. Depending on which performance standard(s) the system is being designed to meet, the flow restrictor may be designed to meet the flood control outflow requirements, the bank full flood outflow requirements, or both.
 - For flood control, the flow restrictor must be designed such that the maximum outflow rate at the design water level does not exceed the maximum allowable

outflow rate for flood control as determined by the equations described in Section 6.2.1.

- For water resources protection, the flow restrictor must be designed to gradually release the bank full flood storage volume over a period of forty (40) hours as described in Section 6.3.2.
- Flow restrictors in open detention basins must be placed near or within the embankment of the basin to provide ready maintenance access. Flow restrictors must be constructed of materials that minimize future maintenance requirements.
- An overflow structure must be provided to allow discharge when the basin water level exceeds the design water level. The overflow structure and its outlet pipe must be designed to convey the peak flow rate tributary to the basin for the 10-year design storm.
- An emergency spillway with a defined downstream drainage path must be provided to allow discharge from the basin when flows exceed the capacity of the overflow structure. The emergency spillway elevation must be 6 inches below the top of freeboard elevation. The spillway must be armored to prevent erosion of the berm.

Preferred Design Elements and Materials

- Wayne County prefers gravity outlets versus pumped outlets from open detention basins. If an open detention basin is designed to include a pumped outlet:
 - Pumps should be located downstream of the flow restrictor within the outlet
 - Two pumps should be provided in any pumped outlet system:
 - If the system is designed to use one pump, with one pump as a backup, each pump should be sized to operate such that the maximum pumping capacity does not exceed the allowable release rate (Q_a)
 - If the system is designed to use two pumps alternately or at the same time, the maximum pumping capacity of the system should not exceed the allowable release rate (Q_a) at any time.
 - A manhole structure should be provided downstream of the pump station.

- Risers and overflow structures should be constructed of 12-gage corrugated metal pipe (CMP) conforming to ASTM A760 and should be made from aluminum coated sheet conforming to AASHTO M274. The use of the continuous welded seam process in the fabricating of pipe is not permitted. Risers and overflow structures should have a minimum diameter of 36-inches.
- Riser holes should be 1 inch minimum diameter but no larger in size than the surrounding stone. The holes should be spaced a minimum of 4 inches apart, on center, both vertically and horizontally. The holes should be pre-drilled prior to galvanizing.
- Risers and overflow structures should have a 2-foot deep sump and a concrete base of 6-inch minimum thickness. The concrete base should be constructed of either pre-cast concrete meeting ASTM C478, or cast-in-place concrete with a 28-day strength requirement of 3,500 psi.
- Risers and overflow structures should be securely attached to the base. They may be embedded in concrete or affixed by an approved fastening method.
- The top of risers and overflow structures should be equipped with a steel grate. Openings should be a minimum of 3 inches square and a maximum of 4 inches square.
- Stone filter backfill around risers should consist of 3-inch diameter washed stone, with an outer blanket of MDOT 6A stone. The side slope of the stone blanket is typically 1:4.
- The berm on which an emergency spillway rests should be made of approved material free of debris, organic material and large rocks (over 4 inches in diameter).
- Suggested options for armoring spillways include riprap, tri-lock, geoweb with infill material, and reinforced turf.
- The outlet "Tee" should be equipped with a removable cap in the horizontal direction; the vertical leg should serve as an oil separator. The horizontal leg often is used as a clean out.
- The minimum preferred outlet pipe diameter is 4 inches.
- An anti-seepage collar should be provided on each outlet pipe. The anti-seepage collar consists of a watertight joint; the specifications for watertight joints vary depending on the type of material used for the outlet pipe.

Testing

The CMP riser must be inspected during fabrication. CMP manufacturers must contact the Wayne County Testing Office (734-595-6504 x 2015) at least 72 hours prior to fabrication to schedule inspection during fabrication. Wayne County inspects the material fabrication process to ensure that the

manufacturer's testing of the product occurs at the applicable AASHTO or ASTM standards.



Installation

Wayne County is authorized to restrict the methods used to construct outlets from forebays and open detention systems. Specifications for construction of these types of outlets include:

- Any field modifications to risers, overflow structures, or other outlet pipes should be performed in accordance with ASTM A780.
- The berm on which an emergency spillway rests should be made of approved embankment material placed and compacted as roadway embankment per the current MDOT Standard Specifications for Construction.
- The concrete base for the risers and overflow structures should be constructed on a suitable subgrade material compacted to 95% of its maximum unit weight. Unsuitable subgrade materials will be removed at the direction of the Permit Engineer, backfilled with MDOT Class 2 granular material in no more than 10-in lifts, and compacted to 95% of its maximum unit weight.
- Onsite welding of the CMP riser is not permitted unless approved by the Wayne County Permit Engineer

A Wayne County Permit Engineer must observe the installation of outlets for forebays and open detention systems. Contact the Wayne County Permit Office (734-595-6504 x 2009) at least 72 hours prior to installation to schedule inspection during installation. Wayne County will not accept any forebay or detention system outlet installed when a County Permit Engineer is not present; permits and financial assurances will not be released at the conclusion of construction for such systems.

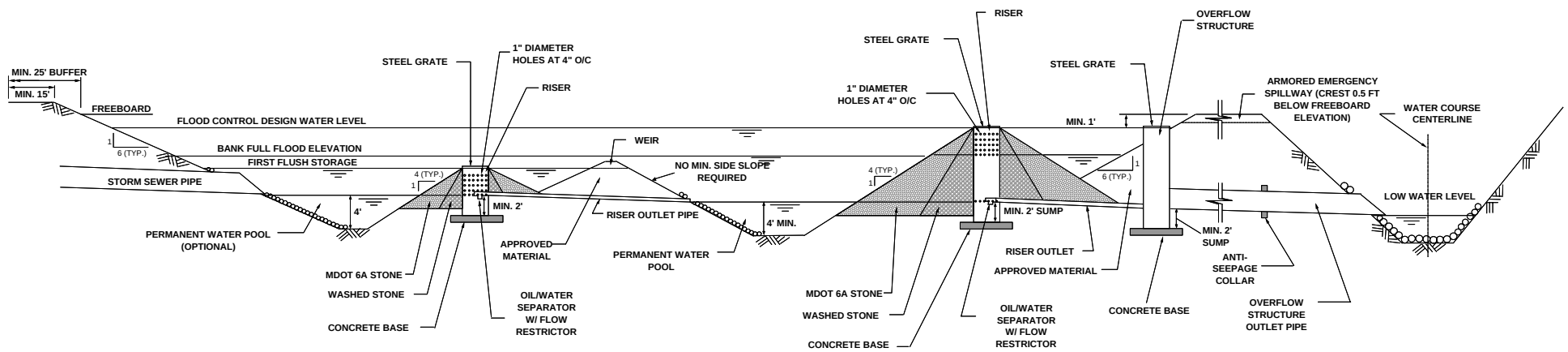
Documentation of the following items relative to the installation of outlets for forebays or open detention systems is required to

be submitted to the Wayne County Permit Engineer before permits and financial assurances are released:

- MDOT 6A stone, 3-inch washed stone, and Class 2 granular material were from Wayne County tested stock.
- Berm materials were compacted to the requirements of roadway embankment per the current edition of the MDOT Standard Specification for Construction.
- Test reports indicating the 28-day compressive strength of the cast-in-place concrete utilizing 6-in x 12-in cylinders. Concrete failing to meet the 28-day compressive strength of 3,500 psi must be removed and replaced with concrete meeting the 28-day strength requirement.
- All pre-case manhole bases were provided from Wayne County tested stock.
- In the event any unsuitable soils were removed to create a suitable subgrade for the base(s), test results for the compacted backfill must be provided.

Maintenance

Inlets and outlets should be checked regularly for clogging and the system should be cleaned as necessary. Sediment should be removed if accumulation reaches 6 inches or if re-suspension is observed. Pipe inspections should be made to verify that the pipe is not crumbling or broken.



**EXAMPLE: FOREBAY AND OPEN DETENTION BASIN
DETAIL**