PROCEDURES AND DESIGN STANDARDS
FOR
STORMWATER MANAGEMENT

MACOMB COUNTY
PUBLIC WORKS COMMISSIONER

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## Acronyms

BMPs – Best Management Practices  
CN – Curve Number  
CP – Channel Protection (design criteria)  
CTC – Certified True Copy  
CVT – City/Village/Township  
DOT – Department of Transportation  
DA – Drainage Area  
EFC – Extreme Flood Conveyance (design criteria)  
FHWA – Federal Highway Administration  
GPS – Global Positioning System  
HEC14 – Hydrologic Engineering Center's Hydraulic Design of Energy Dissipators for Culverts and Channels  
HEC-RAS – Hydrologic Engineering Center's River Analysis System  
HY8Energy – Windows 95/NT4 Energy Dissipator Design Software  
I_a – Initial abstraction  
IMPs – Integrated Management Practices  
LTU – License to Use  
MCPWO – Macomb County Public Works Office  
MDEQ – Michigan Department of Environmental Quality  
NEH - National Engineering Handbook, USDA-NRCS  
NPDES – National Pollutant Discharge Elimination System  
NRCS – National Resource Conservation Service (formerly Soil Conservation Service)  
OFP – Overbank Flood Protection (design criteria)  
OSDS – On-Site Sewage Disposal System  
Q_{ef} – Channel Forming Flow  
Q_p – Peak Flow  
RECPs – Rolled Erosion Control Products  
SAD – Special Assessment District  
SESC – Soil Erosion and Sediment Control  
SCS – Soils Conservation Services  
t_c – Time of Concentration  
TSS – Total Suspended Solids
**Acronyms**

**USDA**— United States Department of Agriculture  
**USGS** – United States Geological Survey  
**W:D** – Width to Depth Ratio  
**WQ** – Water Quality (design criteria)  
**WQV** – Water Quality Volume
Definition of Terms

100-year Floodplain: The floodplain area subject to a one percent chance of flooding in any given year.

Afforestation: Supplements existing trees with a net increase in canopy cover.

Appurtenances: A legal term for what belongs to and goes with something else, the accessories or things usually conjoined with the substantive matter in question.

Bankfull Channel: The lower stage, meander channel that corresponds to the capacity of the channel-forming (dominant) or effective discharge.

Bankfull Discharge: In stable alluvial streams with a fully connected floodplain, the point where the flow (of a stable channel) just begins to overtop the banks into its floodplain. It is determined in the field by surveying visual indicators along a stable, undisturbed reference reach.

Best Management Practice (BMP): A practice or combination of practices that prevent or reduce adverse affects of stormwater runoff and/or associated pollutants.

Borings: Cylindrical samples of soil profile used to determine infiltration capacity of soil types and ground water.

Buffer Strip: A zone where plantings capable of filtering stormwater are established or preserved and where construction, paving and chemical applications are prohibited.

Catch Basin: A collection structure below ground designed to collect and convey water into the storm sewer system.

Certified True Copy: A true copy of the final plat which includes a sworn certification by the surveyor pursuant to the rules promulgated by the Land Division Act 1967 PA 288, MCL560.101-293.

County Drain: An open or enclosed stormwater conveyance system that is under the legal jurisdiction of the Public Works Commissioner for construction, operation and maintenance.

Design Storm: A rainfall event of specified size and return frequency (i.e., a storm that has the likelihood of occurring once every 10 or 100 years) that is used to calculate the runoff volume and peak discharge rate.

Detention: The temporary storage of storm runoff to control peak discharge rates and provide gravity settling of pollutants.

Detention Basin: An area designated to temporarily store storm runoff so a controlled outflow can slowly empty the area.

Detention Time: The amount of time that a volume of water will remain in a detention basin.

Discharge: The rate of flow (the volume of water passing a point in a given period of time) leaving an area usually expressed as cubic feet per second.

Drainage Area: The total tributary area of a watershed usually expressed in square miles, acres or square feet.

Drainage Facility: Any facility used to transport or store stormwater.

Easement (also known as “Right-of-Way”): An interest in land owned by another that entitles its holder to a specific limited use and enjoyment. A legal right granted by a property owner to another entity giving that entity limited use of the property involved for a specific purpose. The
Definition of Terms

Public Works Commissioner secures temporary and permanent easements adjacent to county drains for the purpose of construction and maintenance access.

**Effective Discharge:** The term effective discharge is the streamflow that does most of the work in transporting sediment over the long term. It is determined by combining a flow duration curve and a sediment discharge rating curve.

**Emergent Zone:** The emergent zone of a wet pond is generally 0 to 18 inches deep. A wide variety of native wetland plant species are adapted to the emergent zone.

**Encroachment:** Altering property so as to restrict or burden the interest holder’s use of the property.

**Erosion:** The wearing away of the land surface by wind, water, ice and gravity dislodging soil particles. Evidence of erosion includes gullies, rills, sediment, plumes, etc.

**Fill:** Added earth which changes the contour of the land.

**Floodplain:** For a given flood event that area of land adjoining a continuous watercourse that has been covered temporarily by water.

**Floodplain Zone:** The floodplain zone is normally dry but may flood during snowmelt and after large storms. Floodplain zones are generally flat terraces and are common along rivers and streams.

**Floodway:** The level area adjacent to a stream channel that is subject to frequent overflow.

**Fluvial:** Relating to a stream or river; produced by stream action.

**Freeboard:** The space from the top of an embankment to the highest water elevation expected for the largest design storm to be stored. The space is required as a safety margin in a pond or basin.

**Geotextile:** A woven fabric capable of passing water but able to hold back soil.

**Global Positioning System (GPS):** A system capable of providing worldwide navigation and positioning by pinpointing locations.

**Hotspot:** A land use or activity that generates higher than average concentrations of pollutants.

**Infiltration Rate:** The absorption of water into the ground expressed in terms of inches/hour.

**Invert:** The interior surface of the bottom of any pipe or lowest point of an open drainage facility.

**License:** Permission or authority to do a particular act or series of acts on land of another without possessing any estate or interest in the land.

**Manhole:** A structure that allows access into a stormwater drainage system.

**On-Site Detention:** Where stormwater is detained on a site versus a regional location.

**One-Hundred Year Storm:** A storm that has one percent (1%) chance occurring in any given year.

**Peak Discharge:** The maximum instantaneous rate of flow during a storm usually in reference to a specific design storm event.

**Permeable:** Ability to absorb water.

**Petition:** A legal request to the Drain Commissioner to perform a maintenance improvement or construction project.

**Plat:** A legal procedure whereby a larger piece of property is divided into smaller sections and is accompanied by a full description of the original property the dimension of each lot to be
subdivided and all relevant deed restrictions and easements as described in the Land Division Act.

**Pollutant:** Any substance that is regulated under the Clean Water Act, 42 U.S.C. 1251 et seq. or under Part 31 of the Michigan Natural Resources Environmental Protection Act, MCC 324.3101 et seq. or is of such character and in such quantities that when it reaches a body of water, soil or air, it contributes to the degradation or impairment of its usefulness or renders it offensive.

**Proprietor:** Any person, firm, association, partnership, corporation or any combination thereof that owns property proposed for development.

**Public Works Commissioner:** A statutory officer elected on a partisan basis every four years. S/he is responsible for the administration of the Drain Code of 1956, as amended. The duties of the Public Works Commissioner include the construction and maintenance of County drains, determining drainage districts, apportioning costs of drains among property owners, and receiving bids and awarding contracts for drain construction. The Public Works Commissioner also approves drainage in subdivisions.

**Rational Formula:** A simple technique for estimating peak discharge rates for very small developments based on the rainfall intensity, watershed time of concentration and runoff coefficient.

**Reforestation:** Involves planting trees to compensate for tree clearing during site construction.

**Retention:** The holding of runoff in a basin without release except by means of evaporation, infiltration or emergency bypass.

**Retention Basin:** A stormwater management basin that captures storm water runoff and does not discharge directly to a surface water body. The water is "discharged" by infiltration or evaporation.

**Return (Recurrence) Interval:** A discharge based on statistical return intervals. Leopold determined that the bankfull discharge (measured in the field at USGS gauging stations) corresponded to the 1.2 to 1.8-yr (an average of a 1.5-yr) return interval on a flood frequency curve developed from long-term data at a gauge station. The actual return interval that corresponds to the channel-forming discharge in a stream can vary depending on the local hydrology and geology.

**Riffle:** Shallow, steeper, section of stream with fast currents at low flow.

**Right-of-Way:** A legal right of passage over another person’s land.

**Riprap:** A combination of large stone, cobbles and boulders used to line channels, stabilize banks, reduce runoff velocities or filter out sediment.

**Riparian:** Of, pertaining to, or situated or dwelling on the margin of a river or other waterbody.

**Riser:** 1. A vertical pipe extending from the bottom of a basin that is used to control the discharge rate from the basin for a specified design storm. 2. A pipe rising from underground tile to allow surface water to enter the tile in a low area.

**Runoff:** The excess portion of precipitation that does not infiltrate into the ground but "runs off" and reaches a stream, water body or storm sewer.

**Runoff Coefficient:** The ratio of the amount of water that is NOT absorbed by the surface to the total amount of water that falls during a rainstorm.
Seasonal High Water Ground Level: The highest level of groundwater that occurs frequently enough for the water to stain the soils.

Sediment: Soil material that is transported from its site of origin by water. May be in the form of bed load (along the bed), suspended or dissolved.

Sheet Flow: Runoff which flows over the ground surface as a thin even layer, not concentrated in a channel or pipe.

Soil Group, Hydrologic: A classification of soils by the Natural Resource Conservation Service into four runoff potential groups. The groups range from A soils, which are very permeable and produce little runoff, to D soils which are not very permeable and produce much more runoff.

Spillway: A depression in the embankment of a pond or basin used to pass peak discharges in excess of the design storm.

Stream: By MDNR definition; "a river, creek, or surface waterway that may or may not be defined by Act 40, P.A. of 1956: has definite banks, a bed, and visible evidence of continued flow or continued occurrence of water, including the connecting water of the Great Lakes".

Submergent Zone: The submergent zone is found in areas of 3-6 feet of water in wet ponds. Submergent vegetation makes up this zone because emergent vegetation generally does not grow deeper than 3 feet. Submergent species are important for wildlife habitat and pollutant removal, especially nitrates and phosphorus.

Swale: A natural depression or wide shallow ditch used to temporarily convey, store, or filter runoff.

Tap: A storm drain connection to a County drain.

Time of Concentration: The time it takes for surface runoff to travel from the hydraulically farthest portion of the watershed to the design point.

Tributary Area: The entire land, including adjacent property that produces runoff to a given point in the stormwater conveyance system or a storage basin.

Upland Zone: The upland zone is seldom or never inundated. A wide variety of native plant species are well adapted to the upland zone and their selection will depend on the site conditions.

Water Quality: The biological, chemical and physical conditions of a waterbody, often measured by its ability to support life.

Wet Meadow Zone: The wet meadow zone is a constantly moist area that can become inundated. The transition area between open water and the shoreline is prone to erosion. Therefore, it is an important area for plant establishment.
Introduction

Background

The Macomb County Public Works Office (MCPWO) has been operating under its 1967 Rules and Regulations for Internal and External Drainage for Subdivisions, as required by Public Act 288 of 1967. Due to new regulations affecting the MCPWO, specifically Phase II National Pollutant Discharge Elimination System (NPDES) Stormwater Regulations, and more available information for better stormwater conveyance, the MCPWO has updated its design standards. The Procedures and Design Standards for Stormwater Management will supersede the current adopted rules and regulations of 1967.

The updated MCPWO’s Procedures and Design Standards for Stormwater Management draws its authority from the following State laws:


As previously mentioned, the County’s Procedures and Design Standards for Stormwater Management were updated to address stormwater management and its impact on County drains and comply with the requirements of the Phase II National Pollutant Discharge Elimination System (NPDES) Stormwater Regulations. The County has a watershed-based NPDES General Permit and is working with local communities, school districts and other stakeholders to implement several watershed management plans. As a result, the new requirements were developed to meet many sets of goals and objectives. This integrated stormwater management approach includes design criteria for water quality, channel protection (from erosion due to increased runoff), flood protection, and long-term maintenance to ensure the long-term effectiveness of stormwater management facilities.

The types of developments covered by the Procedures and Design Standards for Stormwater Management include plats, subdivision condominiums, manufactured (mobile) home parks and any other project requiring the Macomb County Public Works Commissioner approval. Public Acts and local ordinances give the Macomb County Public Works Commissioner the authority to review these projects for drainage concerns. The "Land Division Act" (PA 288 of 1967) requires final preliminary plat approval and final plat approval by the Macomb County Public Works Commissioner. Subdivision condominiums, land divisions, and other developments may require the Macomb County Public Works Commissioner approval if the local municipality requires it. The MCPWO will review these types of developments to help minimize any possibility of adverse effects to the development, adjacent property, and the environment due to stormwater runoff.

The MCPWO exercises authority over the design of stormwater management practices that convey, store, and treat stormwater runoff from a development site and discharges to a County
The MCPWO’s *Procedures and Design Standards for Stormwater Management* regulate the design of such management facilities with the following objectives:

i. Protect public health, convenience or welfare.

ii. Promote uniform drainage procedures for development of all lands within Macomb County.

iii. Provide a comprehensive framework for managing stormwater that effectively achieves multiple objectives – water quality, channel protection and flood control.

iv. Incorporate design standards that control both water quantity and quality.

v. Encourage innovative stormwater management practices that meet the criteria contained within these rules.

vi. Provide guidelines on the selection of effective structural and non-structural stormwater management practices for development sites.

vii. Improve the quality of stormwater management practices in Macomb County including: performance, longevity, safety, ease of maintenance, community acceptance, and environmental benefits.

viii. Emphasize maintenance of the facilities.

ix. Strengthen the protection of natural features.

x. Encourage more effective soil erosion and sedimentation control measures.

**Impacts of Development on Water Resources**

Every development site is part of a drainage system or watershed. In Macomb County, each drainage system is comprised of a network of streams, drains, storm sewers, and ditches that comprise one of several subwatersheds. Most of the water that runs off the land in Macomb County ends up in the Clinton River and Lake St. Clair. A map in Appendix B (Figure B-1) illustrates the subwatersheds located within Macomb County.

**A. Altered Watershed Hydrology**

The health of any river system is largely based on how the land in the watershed is managed. Management at the subwatershed and catchment scale is the most effective in achieving measurable protection and restoration (CWP, 1998). Current research indicates that, as directly connected impervious surface area increases (with storm sewers), there is a detrimental impact on water quality, channel erosion, and stream ecology. An impervious surface is any area that no longer allows rainfall to soak into the ground. Impervious areas include, but are not limited to, roads, sidewalks, rooftops, and driveways. When a site is developed, it loses its natural storage potential for rainfall. Consequently, rain that previously infiltrated into the ground, evaporated or transpired, or was temporarily stored in depressions and tree canopies, now rapidly runs off of the site. This increased runoff causes a number of changes in watershed hydrology (Figure 2). These changes in hydrology include:

i. Increased volume of runoff, which raises the magnitude and frequency of severe flood events.
Introduction

ii. Greater frequency of “bankfull” floods - those that fill the stream channel to the top of its banks, but do not spill over into the floodplain. Increased bankfull-flooding subjects the stream channel to continual disturbance and scour.

iii. Higher velocities due to the combined effect of greater discharge, reduced time of concentration, and smoother hydraulic surfaces.

iv. Increased stream flow fluctuations as runoff is concentrated into peaks that are sharper, faster, and higher, followed by equally abrupt returns to pre-storm level discharges. Increased flow fluctuations disrupt habitats and reduce the diversity of aquatic species regardless of water quality.

v. Reduced infiltration into the underlying water table, which in turn lowers the level of water supply aquifers and surface water bodies dependent on groundwater to maintain base flows during dry periods.

B. Changes in Stream Morphology

Increased runoff and flow fluctuations change the dimensions of streams by widening and downcutting the stream channel. Other consequences include:

i. Accelerated streambank erosion occurs as channels are severely disturbed by undercutting, tree-fall, and slumping.

ii. Sediment loads may increase due to construction site runoff and streambank erosion. Excessive sediment loads settle out and form shifting bars that often accelerate the erosion process by deflecting runoff into sensitive streambank areas. Sediment deposition may also adversely affect hydraulic capacity and increase maintenance requirements.

iii. Modification of aquatic habitats begins as the pools and riffles that characterize natural streams are eliminated as the gradient of the stream adjusts to accommodate frequent floods. The voids between stones on the streambed are filled with sediment, destroying the habitat of fish and aquatic insects.

Figure 2 Stream Hydrology Changes as Runoff Rates Increase (Schueler, 1987)
Part 1  Procedures for Submission & Approval of Subdivision Plats

1.1  Purpose

All plats recorded with the Register of Deeds must conform to the Land Division Act, Act 288 of the Public Acts of 1967, as amended. Under this Act, the Macomb County Public Works Commissioner is responsible for ensuring that the drainage or stormwater management system of a subdivision is adequate for the development, and for protecting landowners and natural resources. The procedures, standards and recommendations set forth in the Procedures and Design Standards for Stormwater Management are designed for these purposes.

The Macomb County Public Works Commissioner has the authority, through the subdivision review process, in accordance with the provisions of Act 288, to require that county drains, both inside and outside a plat, be improved to the standards established by the MCPWO when necessary for the proper drainage of a proposed subdivision.

Under these Procedures and Design Standards for Stormwater Management, the MCPWO will ensure that all stormwater facilities necessary for a proposed subdivision have an appropriate governmental unit responsible in perpetuity for performing maintenance or for overseeing the performance of maintenance by a private entity, such as a property owner's association.

These standards of the MCPWO apply in the review of the following:

- Applications for permits to discharge to a county drain under P.A. 40 of 1956, as amended.
- Lot splits and subdivision sites to be platted under Public Act 288.
- Review of stormwater system plans in other classes of developments or redevelopments, when agreed upon by local governments and the county.

These rules provide minimum standards to be complied with by proprietors, and in no way limit the authority of the local municipality in which the development is situated to adopt and enforce higher standards as a condition of approval of the final plat.

1.2  Tentative Preliminary Plat Submittal and Review

A.  Submittal Requirements

The submittal of a tentative preliminary plat is encouraged but not required. The submittal will aid the site engineer and proprietor in understanding any requirements that may be required by the MCPWO. However, if a tentative preliminary plat is submitted for MCPWO review, certain plat requirements must be met. These requirements have been developed in the context of tentative preliminary plat submittal under the Michigan Land Division Act.

1. A tentative preliminary plat showing the layout of the area intended to be subdivided or developed will be submitted to the MCPWO by the proprietor. This plat will be prepared under the direction of, and sealed and signed by, a registered professional engineer or a registered land surveyor. The tentative preliminary plat shall be drawn to a standard engineering scale on 24” x 36” sheets.
2. Two copies of the tentative preliminary plat, prepared in accordance with the rules set forth in this section, will be submitted together with a letter of transmittal requesting that the tentative preliminary plat be reviewed. The names of the proprietor and engineering or surveying firm, with mailing and emailing addresses, fax, and telephone numbers for each, will be included with the transmittal.

3. Should the proprietor plan to subdivide or develop a given area but wishes to begin with only a portion of the total area, the original tentative preliminary plat will include the proposed general layout for the entire area. The first phase of the subdivision will be clearly superimposed upon the overall plan in order to illustrate clearly the method of development that the proprietor intends to follow. Each subsequent plat or phase will follow the same procedure until the entire area controlled by the proprietor is subdivided.

4. Review and comments by the MCPWO of only one portion or phase of the subdivision does not ensure final acceptance of any subsequent phases or the overall general plat for the entire area, nor does it mandate that the overall general plat be followed as originally proposed if deviations or modifications acceptable to the MCPWO are proposed.

B. General Information Requirements

The development shall accept existing drainage originating outside of the development limits that flows onto or across the development. All tentative preliminary plats will include the following information:

1. The location of the proposed development by means of a small location map.
2. Date of plat design and any revision dates.
3. North arrow.
4. The township, city or village in which the parcel is situated.
5. The sidwell number and parcel description that includes the section number, Town and Range in which the parcel is situated.
6. The number of acres to be developed.
7. Contours, at 2-foot intervals or less, with stated benchmark and horizontal and vertical NAVD 88 datum. Include contour information for 100 feet off-site on adjacent properties.
8. The proposed street, alley, and lot layouts and approximate dimensions.
9. The location, name and description of all on-site and adjacent off-site features that may be relevant in determining the overall requirements for the subdivision. These features may include, but are not limited to the following:
   a. Adjoining roads, subdivisions, and other developments.
   b. Schools, parks, and cemeteries.
   c. Drains and drain name, sewers, water mains, septic fields, and wells.
   d. High tension power lines, underground transmission lines, gas mains, pipelines and all other utilities.
   e. Railroads.
   f. Existing easements including recorded Liber and Page, if available. Existing and proposed County drain easements shall be indicated on the plat and shall be designated as ‘XX feet wide easement to the ‘DRAIN NAME’ Drainage District for drainage’.
g. Natural and artificial watercourses, regulated wetlands, and wetland boundaries, floodplains, lakes, bays and lagoons.

h. Designated natural areas.

i. Soils description in accordance with the USDA National Resource Conservation Service (NRCS) standard soils criteria.

j. Any proposed environmental mitigation features.

k. Current/proposed zoning classification.

C. Tentative Preliminary Plat Review

The MCPWO will review and provide comment on a tentative preliminary plat within thirty (30) days of its submittal. If the MCPWO has comments on the proposed tentative preliminary plat as originally submitted, the MCPWO will notify the proprietor in writing. One copy of the tentative preliminary plat, with comments, will be returned to the proprietor. Submission of the tentative preliminary plat is not required before the MCPWO will proceed with review of the final preliminary plat.

1.3 Final Preliminary Plat Submittal and Approval

A. Submittal Requirements

The MCPWO will review the final preliminary plat to assure that adequate stormwater drainage will be provided and that the proposed stormwater management system adequately provides for water quantity and quality management to ensure protection of property owners, lands, and watercourses both within the proposed development and downstream. Following are the minimum submittal requirements for final preliminary plats:

1. For all projects to be reviewed by the MCPWO, the proprietor will submit two copies of the final preliminary plat with a letter of transmittal requesting review and approval.

2. The proprietor shall include a long-term maintenance plan for the development’s stormwater management system (i.e. detention basin) and a signed maintenance agreement with the entity to assume responsibility of the maintenance. A-long term maintenance plan is also required when plats include approved Best Management Practices (BMPs) for stormwater management credit. (See Appendix J for stormwater management credit explanation).

In addition to all previously described submittal requirements, the final preliminary plat will include, at a minimum, the following information:

1. All information described in Part 1, Section 1.2 for tentative preliminary plat approval except as modified herein.

2. The names of the proprietor and engineering firm, with mailing and e-mailing addresses, fax, and telephone numbers for each shall be included with the transmittal. Plats prepared will be in accordance with Part 1 of these standards, under the direction of, and sealed and signed by, a professional engineer registered in the State of Michigan.

3. For all projects, the proprietor will submit two complete sets of the final preliminary plat, drawn to a scale no smaller than 1” = 40’, and on 24” x 36” sheets. The plat shall be sealed and signed by a professional engineer, and drawn to standard engineering scales. The
Procedures for Submission & Approval of Subdivision Plats

Submittal shall include all required information listed in Part 1, Sections 1.2 and 1.3, as well as the following, where applicable:

a. The proposed project layout with all dimensions, including the proposed drainage system for the project. Show all utility crossings.

b. Topographic maps, at two-foot contour intervals or less on NAVD 88 datum, showing existing and proposed grades, as well as off-site topography over at least 100 feet of the adjoining property. Maps will also show all existing watercourses, lakes and wetlands, and the extent of all off-site drainage areas contributing flow to the development.

c. The date the site topographic survey was performed. Where existing conditions, at the time of plan submittal, differ from conditions at the time of survey, the MCPWO may require an updated topographic survey.

d. Plans and details of proposed retention/detention facilities. Soil borings may be required at the sites of these facilities.

e. Plan views, profiles and details of all roads and storm sewers. The storm sewer plans will include type, size, and class of pipe, length of run, percent of slope, invert elevations, rim elevations, cover depth, backfill type, depth and compaction, and profile of the hydraulic gradient, as specified in these Procedures and Design Standards for Stormwater Management.

f. Storm sewer calculations indicating the number of acres, calculated to the nearest tenth of an acre, contributing to each specific inlet/outlet, the calculated hydraulic gradient elevation, maximum flow in cubic feet per second (cfs), and the flow velocities for enclosed systems. Refer to Part 4, Section 4.2.A. for calculation requirements.

g. A drainage area map, overlaid onto a copy of the site grading plan, which clearly shows the areas tributary to each inlet and/or storage basin. Any off-site drainage area boundaries tributary to a specific inlet and/or storage basin must be clearly mapped.

h. Plans, profiles, names, easements, and details of all open drains, drainage swales, and drainage structures. Approved ‘Ours to Protect’ and ‘Report a Polluter’ signage shall be required for the development at road crossings for open county drains. (See Appendix C for sign information.)

i. Plans and details of the proposed soil erosion and sedimentation control (SESC) measures, both temporary (during construction) and permanent, as required by, P.A. 451, Part 91 Public Acts of 1994, as amended and the Macomb County SESC ordinance.

j. All construction specifications for the stormwater management facilities, including design data and criteria used for designing detention/retention basins and sizing all drainage structures and channels including weighted runoff coefficient calculations.

k. Open drains and watercourses shall be shown with a typical ditch cross-section and matching contours. Proposed cross-sections shall be shown with existing and proposed elevations and labeled with appropriate stations.

l. Locations of all drain fields as approved by the Macomb County Health Department and of all reserve areas. Drain fields and reserve areas shall not be located within County drain drainage easements.

m. A single sheet showing all proposed storm drainage facilities with drainage easements shall be submitted. This sheet shall be overlaid on the overall road and utility plan and drawn to a scale no smaller than 1” = 100’.
n. Drain easement sign locations within the county drain easement for open county drains. See Appendix C for sign information.

B. Drainage Information Requirements

Development projects are required to provide access and capacity for any existing drainage tributary to the site. The increased volume of water discharged due to development of the site must not create adverse impacts to downstream property owners and watercourses. These adverse impacts may include, but are not limited to, flooding, excessive soil saturation, crop damage, erosion, and/or degradation in water quality or habitat. Proposed drainage for the development will conform to any established county drainage districts. The proposed drainage plan will, in every way feasible, respect and conform to the natural drainage patterns within the site and the watershed in which it is located or conform to drainage patterns approved by the MCPWO. All final preliminary plats will include the following required stormwater management information:

1. All calculations used in designing components of stormwater management systems.
2. The overall stormwater management system for the proposed development, indicating how stormwater management will be provided and where the drainage will outlet.
3. The location of any on-site and/or off-site stormwater management facilities and appropriate easements that will be dedicated to the entity responsible for future maintenance. Easement information will be consistent with Part 3, Section 3.6.
4. A description of the off-site outlet and evidence of its adequacy. Additional/adequate off-site easement may be required.
5. A map, at the USGS scale, showing the drainage boundary of the proposed development and its relationship with existing drainage patterns.
6. Provide a cross section of the existing drain with existing and proposed elevations.
7. Any natural watercourses and/or county drains passing through the proposed development, along with the following:
   a. Area of upstream watershed and current zoning.
   b. Preliminary calculations of runoff from the upstream area for both the 100-year and 1.5-year, 24-hour design storms, for fully proposed developed conditions according to the current land use plan for the area.
8. Any natural watercourses or county drains that are adjacent to the development. If discharging to an adjacent watercourse or county drain, then 7a & 7b requirements apply.
9. If development is proposed in an area where special drainage problems exist or are anticipated at the site, on adjacent properties, or downstream, more stringent design requirements than contained in these Procedures and Design Standards for Stormwater Management may be required. If any part of the site lies within a floodplain, then it shall satisfy local, state and federal requirements for subdivisions within a floodplain.

C. Final Preliminary Plat Approval

When the final preliminary plat has been approved, electronic copies of the final preliminary plat shall be provided in an acceptable format for those items that specifically relate to the storm drainage facilities and information required in these Rules. These items include, but are not
limited to, storm sewers, swales, ponds, grading plans, etc., as well as all available information such as complete site layout, sanitary sewer and water main plans, and topographic surveys.

Approval of the final preliminary plat by the MCPWO is valid for two calendar years. If an extension beyond this period is needed, the proprietor will submit a written request to the MCPWO for an extension. The Macomb County Public Works Commissioner may grant one year extensions of the approval, and may require updated or additional information, if needed.

Should modifications be made to the plans after approval is granted from the MCPWO, a new set of plans must be submitted for review and approval. A cover letter shall be included with the plans which states the changes made to the plans. Based on modifications, revised electronic copies may be required by the MCPWO.

1.4 Final Plat Submission and Approval

Approval of the final plat and Certified True Copy (CTC) is required. Final plat review will be completed by the MCPWO within a reasonable timeframe following submission by the proprietor. If the plat is not acceptable, written notice of rejection and the reasons therefore will be given to the proprietor. If the Commissioner approves the plat, s/he will affix his/her signature to it and the plat will be executed. As a condition of final plat approval, the Public Works Commissioner will require the following (See Appendix D for a Final Plat Checklist):

1. The municipal governing body in which the proposed development is located must approve the final preliminary plat. Evidence of this approval will be submitted to the MCPWO with the final plat.

2. On sites containing a county drain, complete subdivision agreements (including deed restrictions) and appropriate easement language must be submitted for the Public Works Commissioner’s review and approval prior to submitting the final plat.

3. All provisions and drain improvements for County drains are required prior to approval.

4. A final plat, when submitted to the Public Works Commissioner for signature, will include the Public Works Commissioner’s Certificate (see Appendix E for the Macomb County Public Works Commissioner’s Certificate).

A soil erosion permit under the guidelines of the Macomb County SESC Ordinance and the Michigan Soil Erosion and Sedimentation Control Act, P.A. 451, Part 91 Public Acts of 1994, as amended, must be obtained from the MCPWO, or other appropriate agency, prior to any construction.

1.5 Final Plat Recirculation

Upon recirculation of a final plat, the proprietor must provide in writing the reason(s) to the MCPWO for resigning. The proprietor shall provide any information to support such a request.
Part 2  Procedures for Submission & Approval of Engineering Plans for Unplatted Developments

2.1  Purpose

All site developments or projects directly impacting a county drain require engineering construction plan approval from the MCPWO. These rules provide minimum standards to be complied with by proprietors, and in no way limit the authority of the local municipality in which the development is situated to adopt and enforce higher standards as a condition of approval of the site plan. The following section outlines the requirements that shall be met when submitting plans for unplatted developments. The review of the engineering construction plans may not be as extensive as plat reviews, however involves similar requirements. Upon the request of a municipality, the MCPWO will review and offer comments on a site development not directly impacting a County drain.

A.  Engineering Construction Plan Requirements

The MCPWO will review engineering construction plans to assure that the receiving County drain is not adversely impacted by the development or project. The engineering construction plans must include, at a minimum, the following information:

1. The names of the proprietor and engineering firm, with mailing and e-mailing addresses, fax, and telephone numbers for each shall be included with the transmittal. Plans will be prepared under the direction of, and sealed and signed by, a professional engineer registered in the State of Michigan and will be in accordance with these Procedures and Design Standards for Stormwater Management.

2. The proprietor will submit two complete sets of the engineering construction plans, drawn to a scale no smaller than 1” = 40’, and on 24” x 36” sheets. The submittal shall include all required information listed in Part 1, Sections 1.2 and 1.3.

B.  Engineering Construction Plan Approval

When plans have been approved, electronic copies of the final plan set shall be provided in an acceptable format for those items that specifically relate to the storm drainage facilities and information required in these Procedures and Design Standards for Stormwater Management. These items include, but are not limited to, storm sewers, swales, ponds, grading plans, etc., as well as all available information such as complete site layout, sanitary sewer and water main plans, and topographic surveys.

A stormwater facility maintenance plan and agreement shall be submitted by the landowner for approved BMPs used for stormwater credit.

A soil erosion permit under the guidelines of the Macomb County SESC Ordinance and the Michigan Soil Erosion and Sedimentation Control Act, P.A. 451, Part 91 Public Acts of 1994, as amended, will be obtained from the MCPWO, or other appropriate agency, prior to any construction.
Approval of construction plans by the MCPWO is valid for two calendar years. If an extension beyond this period is needed, the proprietor will submit a written request to the Public Works Commissioner for an extension. The Public Works Commissioner may grant one-year extensions of the approval, and may require updated or additional information, if needed. Should modifications be made to the plans, a new set of plans must be submitted for review and approval. A cover letter shall be included with the plans which states the changes made to the plans.
Part 3 General Requirements for Drains under the Jurisdiction of the MCPWO

3.1 Purpose

The following section outlines the general requirements that shall be met when performing any work on a county drain or its appurtenances. Once the MCPWO Engineering Division has approved the engineering plans, a permit must be applied for with the MCPWO, Soil Erosion and Sedimentation Control (SESC) Division. The SESC Division issues all County drain permits for the MCPWO.

3.2 Permits

A permit shall be required from the MCPWO prior to performing any work on a county drain or its appurtenances. The purpose of the permit process is to protect the drainage district(s) from activities that could be a detriment to the county drain and add cost to that district in the future. A drain permit issued by the MCPWO will not relieve the applicant and/or his/her contractor of the responsibility of obtaining permits, approvals or clearances as may be required from federal, state or local authorities, public utility companies and private property owners. The types of work requiring a permit from the MCPWO include, but are not limited to, the following:

- Connecting/tapping to any part of a county drain, whether it is an open ditch, enclosed drain, manhole or drainage structure. A tap can be a direct connection or a pipe outlet.
- Crossing over or under any part of an open ditch or enclosed pipe. Examples of crossings include but are not limited to utility lines, driveways, culverts, and bridges.
- Performing work within a County drain easement.

Approval by the MCPWO is required prior to submitting a permit application and commencing work. Plan submittals should conform to the engineering plan requirements listed in Part 2, 1.1, A-C, as appropriate. A soil erosion permit under the guidelines of the Macomb County SESC Ordinance and the Michigan Soil Erosion and Sedimentation Control Act, P.A. 451, Part 91 Public Acts of 1994, as amended, must be obtained from the MCPWO, or other appropriate agency, prior to any construction. Depending on the extent of work proposed, a contract with the MCPWO may be required.

A. Connections to County Drains (Taps)

All taps to a county drain must conform to the MCPWO standards and requirements. It is desired that all connections be tapped into a manhole or catch basin. If this is not possible and connection must be made in the main line sewer, a blind tap may be permitted. The following tap requirements include, but are not limited to, the following:

1. Blind Taps
   a. All taps to county drains must be connected with reinforced concrete pipe, unless an alternative pipe material is approved by the MCPWO.
   b. All taps must have a concrete collar per detail 1-F or 1-F2. (Refer to Appendix F)
   c. No tap is allowed at a pipe joint.
   d. No jackhammer or sledge hammer shall be used for the tap until a diameter has been established with a star drill or concrete saw per Detail 1-F3. (Refer to Appendix F)
e. All connections must be properly sealed to prevent leakage and/or infiltration into the storm system.

f. Global Positioning System (GPS) locations (sub-meter accuracy) of all constructed taps to the County drain are required in an acceptable electronic format.

2. Manhole Taps

a. All taps shall be made so that a 1 foot (minimum) wall area exists between the proposed tap and any existing pipe inside the manhole.

b. Class B concrete collar and bedding shall be a minimum of 12 inches and shall be placed on undisturbed soil and extend to the first joint of the proposed tap per detail 1-F. (Refer to Appendix F)

c. Taps to manholes must be pointed in the inside.

d. All taps shall be cut flush with the inside wall of the manhole.

e. All debris in manhole, as a result of the tap construction, shall be removed after construction is complete.

f. GPS locations (sub-meter accuracy) of all constructed taps to the County drain are required in an acceptable electronic format.

3. Open Drain Taps

a. All taps shall be constructed at the drain invert and perpendicular to the County drain per detail 1-G. (Refer to Appendix F)

b. All taps shall include a flared end section.

c. No bar screen will be allowed on the end section.

d. Taps shall be bedded in sand cement dry mix Grade C (2500 PSI-5.0 sack) for the last 2 ½ pipe plus end section.

e. A manhole is required at the top of bank, just inside the Right of Way line. No sump allowed.

f. Taps shall be laid at a minimum pipe slope.

g. Pipe shall not extend beyond the intersection of top of pipe and drain bank. (i.e. Pipe shall not be exposed.)

h. GPS locations (sub-meter accuracy) of all constructed taps to the County drain are required in an acceptable electronic format.

4. Sump Pump Leads to Pipes

a. Blind taps for sump pump leads will only be allowed to a County drain pipe section when a manhole, catch basin or inlet does not exist for the area to which the lead will service per detail 1-H. (Refer to Appendix F)

b. GPS locations (sub-meter accuracy) of all constructed taps to the County drain are required in an acceptable electronic format.
B. Crossing a County Drain

1. A minimum clearance of five (5) feet must be maintained between the invert of the open County drain and any proposed underground utility or other underground crossings of the drain. Additional depth may be required.

2. A minimum clearance of eighteen (18) inches for an enclosed County drain shall be maintained between the outside diameter of the drain and any proposed underground utility or other underground crossings of the drain. Additional clearance may be required.

3. GPS locations (sub-meter accuracy) of all constructed crossings to the County drain are required in an acceptable electronic format.

C. Permit Requirements

1. A permit application must be completed and accompanied by any necessary fee and release of rights-of-way in recordable form, executed by all owners of interest.

2. A notice of 72 hours must be given to the MCPWO, Soil Erosion and Sedimentation Control Division prior to any construction affecting the drain.

3. All work must be completed in accordance with the plans and specifications submitted by the proprietor and approved by this office.

4. GPS locations (sub-meter accuracy) of all constructed manholes, taps and crossings are required.

5. The MCPWO shall be notified in writing within ten (10) days of the completion of a project.

6. A final inspection will be performed and a letter of permit closure may be issued.

7. A permit shall expire when work has not commenced within one (1) year of the date of issuance. The MCPWO may extend the permit upon the request of the applicant in writing.

8. The MCPWO may revoke a permit if there is a violation of the conditions of the permit or if there is a misrepresentation or failure to disclose relevant facts in the application.

3.3 Activities Not Requiring a Permit

The following activities do not require a permit from the MCPWO. There may be exceptions so always contact the MCPWO to verify whether a permit is required prior to performing any work on a County drain or its appurtenances.

1. Work being performed under a contract with the MCPWO.

2. Debris removal and/or the trimming of trees and brush in the County drain. However, if there is any tree removal or earthwork associated with the debris removal and/or trimming, a permit may be required.

3.4 Contract Requirements

A drain project agreement and separate contract shall be required from the MCPWO prior to performing any extensive work on a County drain or its appurtenances. A drain contract issued by the MCPWO will not relieve the applicant and/or his/her contractor of the responsibility of
obtaining permits, approvals or clearances as may be required from federal, state or local authorities, public utility companies and private property owners. The types of work requiring a contract from the MCPWO include, but are not limited to, the following:

- Relocating any portion of a County drain.
- Enclosing any portion of an existing open County drain.
- Performing work within a County drain easement.

The following list of items must be accomplished and/or received prior to the execution of a drain contract:

1. A petition, along with the appropriate filing fee, from the proprietor to make improvements to a County drain. See Appendix N for example petition forms.
2. A County drain board must determine the necessity of the drain improvement.
3. The MCPWO Engineering Division must approve the engineering construction plans.
4. The company name, address and phone number of the proprietor’s selected contractor and the name and title of a representative for said company who will sign the contract. The MCPWO must approve the selected contractor as qualified and in good standing.
5. The bid prices from the selected contractor for all drain construction items. Bid prices shall be from the items and quantities as listed on the approved engineering plans for the County drain. Items and prices must be based on the Standard Specifications of the MCPWO.
6. Reproducible mylars of all sheets requested by the MCPWO.
7. Contractor insurance and bonds as required by the contract.
8. All applicable local, state and federal permits.
9. An executed drain project agreement with the proprietor.

A soil erosion and sedimentation control plan developed under the guidelines of the Michigan Soil Erosion and Sedimentation Control Act, P.A. 451, Part 91 Public Acts of 1994, as amended, must be approved by the MCPWO, or other appropriate agency, prior to any construction. Upon execution of the contract and prior to commencing work, the contractor must schedule a preconstruction meeting at the MCPWO.

### 3.5 Plot Plan Requirements

If a County drain is located on the property, the following information must be included on the plot plan when applying for a permit:

1. Show and label the County drain and its associated easement.
2. If an open County drain, field verify the drain elevations. Include a drain cross-section and profile, drawn to scale.
3. Show any existing and proposed taps, crossings or encroachments in the county drain easement.
4. Add the following note: “NOTE: THE CHANGING OF GRADE, PLACEMENT OF FILL OR PERMANENT STRUCTURES (I.E. POOLS, FENCES, SHEDS, ETC.) IN THE ‘DRAIN NAME’ DRAINAGE EASEMENT IS PROHIBITED.”
5. Show any natural and artificial watercourses, regulated wetlands, and wetland boundaries, floodplains, lakes and lagoons.

3.6 Easement Requirements

1. A proposed public utility to be located in a County drain easement will only be considered when there is no other feasible alternative. If a utility is to be located within the right-of-way of any County drain or drainage easement, it shall be approved by the MCPWO. If approved, a License-to-Use (LTU) Agreement must be executed by MCPWO prior to construction. Approved utilities will be located such that it will not increase the expense of maintaining the drainage facility.

2. Easement widths will be determined by the Public Works Commissioner and be situated in such a way as to allow for maintenance access. In general, easement widths will conform to the following (round to nearest 5 ft):

   a) Open County Drains
   The easement width will vary by the width of the bankfull channel, the floodplain width ratio, and the side slope angle (Figure 4.1).

   b) Enclosed County Drains
   The easement required by the MCPWO will vary based on pipe size, depth and soil types. The following equation should be used as a guideline for estimating the easement required by the MCPWO:

   \[
   \text{Enclosed Drain Easement Width} = \text{pipe diameter} + 2 \times \text{depth} + 2 \text{ feet}
   \]

A. Drain Easements within Subdivisions or Condominium Developments

1. If a County drain easement is to be platted, the easement on final plat shall read as follows:
   “‘XX’ feet wide easement to the ‘DRAIN NAME’ Drainage District for drainage”

2. The location and purpose of drainage easements should be clearly described in the condominium master deed.

3. Language will be included within the subdivision deed restrictions or condominium master deed that clearly notifies property owners of the presence of stormwater management facilities and accompanying easements, as well as restrictions on use or modification of these areas.

B. Drain Easement Dedication

Prior to construction or work within a County Drain, a dedicated easement must be in place. If an easement does not exist or a new easement is required, the proprietor must secure the proper easements before commencing work. The easement must be dedicated to the County drain drainage district. The following requirements must be submitted to dedicate a County drain easement:

1. A metes and bounds description of both the property and the proposed easement, along with a sketch on 8 ½ x 11 inch paper.

2. The name(s) and address of the person(s) authorized to sign the easement document. Include title(s) as appropriate (i.e. husband, wife, owner, president of company, etc.).
3. Payment of the recording fee. The fee shall be made payable to the Macomb County Register of Deeds and submitted when the executed easement is returned to the MCPWO.

C. **Drain Easement Relinquishment**

In order to relinquish a County drain easement, the MCPWO must approve the request. Once approved by MCPWO, the following procedure must be completed:

1. The property owner must submit a letter requesting the relinquishment and the associated deposit to cover administrative and legal publication costs.
2. Submit an exhibit showing the parcel, the easement to be relinquished across the parcel, and the legal description of both the parcel and the easement. The exhibit shall also include the Liber and Page(s) of the easement, if available.

Relinquishing platted drain easements will also require circuit court action.

D. **Drain Easement Encroachment**

In general, encroachments are not to be allowed in County drain easements unless a hardship is demonstrated. All encroachment requests will be reviewed on a case by case basis. A LTU must be executed if an encroachment is approved. If an encroachment is discovered in a County drain that was not approved by the MCPWO, it must be removed at the expense of the owner.
Part 4  Design Criteria and Engineering Standards for County Drains

4.1  Purpose

The following section outlines the design criteria that shall be used when designing a County drain. The requirements reflect the MCPWO’s need to protect public health, convenience and welfare per the Michigan Drain Code, as well as meet its NPDES Phase 2 permit requirements.

4.2  Design Criteria for Enclosed County Drains

An enclosed storm drain system must be designed to accommodate the stormwater runoff from a 10-year, 24-hr storm from the entire contributing watershed. If located within a regulated 100-yr floodplain, then the enclosed storm drain system must be designed to accommodate the stormwater runoff from a 100-yr, 24-hr storm from the entire contributing watershed. The “Manning” formula will be used to check the pipe size:

\[ Q = \frac{1.486 \times A \times R^{2/3} \times S^{1/2}}{n} \]

Where,
- \( Q \) = flow capacity (ft\(^3\)/s)
- \( n \) = Manning coefficient of roughness
- \( A \) = cross-sectional area of pipe (ft\(^2\))
- \( R \) = hydraulic radius of pipe, \( A/P \) (ft)
- \( P \) = wetted perimeter of pipe (ft)
- \( S \) = pipe slope (ft/ft)

1. All calculations must be provided in a format similar to the Storm Drain Design Chart in Appendix L.
2. The hydraulic grade line must be calculated for the entire system. The hydraulic gradient should in no case be higher than the rim elevation of any structure.
3. The minimum pipe size for storm drains accepting surface runoff is 12-inches diameter. Rear yard pipes may be smaller, but must be used in conjunction with a drainage swale that directs runoff to a minimum 12” diameter pipe structure.
4. Premium pipe joints must be used to prevent infiltration.
5. Storm drains shall be designed to have a minimum velocity flowing full of 2.5 ft/sec and a maximum velocity of 10 ft/sec. The velocity at a pipe outfall should be between 2.5 to 5.0 ft/sec to prevent scouring at the outlet. The Manning’s ‘n’ value for concrete pipes is 0.013 and \( n=0.024 \) for corrugated metal pipe.
6. Energy dissipators may be required at outlets based on the velocity at the outfall. Riprap may consist of minimum fragmented limestone or other suitable rock underlain with geotextile fabric. Broken concrete is not allowed.

A.  County Drain Drainage Structures

Where applicable, all catch basin or manhole covers should include embossment, as appropriate to drainage outlet, of “Dump No Waste, Drains to ‘Select River or Lake’”.
B. Pipe Requirements
Contractor must supply MCPWO with copies of pipe certification slips matching pipe required for contract prior to installing.

1. Reinforced Concrete Pipe (RCP)
   a. All RCP shall be premium joint (rubber gasket) unless otherwise indicated on the set of drawings approved by MCPWO.
   b. Class of the RCP shall be that indicated on the set of drawings approved by MCPWO.
   c. All joints in RCP having a diameter of 36 inches and larger shall be pointed up on the inside with mortar after backfilling and/or grouting has been completed.

2. Corrugated Metal Pipe (CMP)
   a. Gauge of the CMP shall be that indicated on the approved set of drawings.
   b. All CMP shall be helically corrugated, continuous seam, metal pipe with re-rolled end and water tight bands (Hugger or equal).
   c. All CMP shall be bedded and backfilled with sand (compacted in 1 foot layers) or pea stone to 1 foot above the top of the pipe.
   d. When using CMP, concrete cradles shall not be allowed. An approved alternative will be required when such conditions exist.

C. Trench Width
   a. The maximum width of trench at top of pipe shall be the outside diameter of the pipe, plus 24 inches.
   b. If the maximum trench width is exceeded, the Contractor, at his own expense, shall construct a concrete cradle or other type of approved bedding to provide support for the additional load.
   c. When sand bedding is used, the maximum trench widths shall be used to permit compaction of the bedding around the pipe.
   d. If stone bedding is used, a minimum of 6 inches clearance shall be provided on each side of the pipe.
   e. In any case, the Contractor, at his own expense, shall be responsible for maintaining a safe trench at all times.

D. Bedding and Cradles for RCP
1. Bedding: (See Detail 1-B in Appendix F)
Pipe bedding is defined as that material placed from a minimum of 6 inches below the pipe to the ¼ point of the pipe. If shall consist of sand, pea stone or of Portland Cement in combination with pea stone and sand as follows:

<table>
<thead>
<tr>
<th>Pipe Size</th>
<th>Bedding Requirement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Under 48 Inches</td>
<td>Sand or Pea Stone</td>
</tr>
<tr>
<td>48 Inches and Larger</td>
<td>Pea Stone</td>
</tr>
<tr>
<td>Special Items</td>
<td>Bedding Requirement</td>
</tr>
</tbody>
</table>
In Road R.O.W. (See Details 1-Z.1 thru 1-Z.5 in Appendix F)
Horizontal Elliptical, Radius,
Precast Bends, MH “T”, Concrete Cradle
Increaser/Reducers (See Detail 1-B in Appendix F)

2. Concrete Cradle: (See Detail 1-B in Appendix F)
Concrete Cradle is defined as that material placed from a minimum of 6 inches below the pipe to the centerline of the pipe when required. It shall consist of sand, pea stone and Portland cement dry mix Grade C (2500 Psi – 5 sack).

E. Laying of Pipe
Pipe shall be laid from the lower end of sewer upstream, with the bell end up grade. The use of brick, lumps of clay, wood, etc., to level the pipe will not be permitted. Pipe shall be rammed “home” and if joints do not remain tightly closed or construction is in saturated sand, a cable and winch, or other approved means, shall be used to maintain a tight joint.

All pipe shall be laid to line and grade as called for on the plans using a laser beam and target. Each pipe as laid shall be excavated to provide equal clearance on both sides of the pipe. After the pipe is set, care shall be taken in backfilling so as not to disturb its line or grade. As work progresses, the interior of the pipe shall be thoroughly cleaned.

F. Backfilling
a. Backfilling is defined as the placement and compaction of approved material, by an acceptable method, in the excavation from the top of the bedding or top of cradle, to the proposed ground surface grade. (See Detail 1-B in Appendix F)
b. All backfill material shall be free from refuse, vegetable or organic matter, boulders, rocks or stones, or other material which is unsuitable.
c. All excavation shall be backfilled to a point 1 foot above the top of the pipe immediately after installation.
d. Backfill density when required shall be at the expense of the developer.
e. Note: For backfill within the ROAD ROW see Details 1-Z.1 thru 1-Z.5 in Appendix F.

G. Manholes, Catch Basins, and Inlets
1. In-Line Manholes: (See Details 1-C & 1-D in Appendix F)
Diameters shall be as follows:
   12-inch to 30-inch pipe = 4-foot dia.
   36-inch to 42-inch pipe = 5-foot dia.
   48-inch and Larger = Precast “T”
2. Junction Manholes or Manholes at turns: (See Detail 1-DD in Appendix F)
Shall be 8 feet diameter maximum and have a minimum of 1 foot of wall area between pipe inside the manhole. Special structures will be required for Junction Manholes and Manholes at turns requiring a diameter greater than 8 feet. Special structures will also require approval of sealed shop drawings prior to construction.
3. Materials for Manholes, Catch Basins, and Inlets
   a. Water for concrete and mortar shall be clean and fresh, free from oil, acids, and organic matter.
   b. Mortar for laying brick and/or block, for pointing of joints, and for plastering outside of structures shall be composed of 1 part Portland Cement and 2-1/2 parts masonry sand.

H. Backfill Around Structures
All backfill placed within 3 feet of manholes, catch basins, inlets and other underground structures shall be of approved sand, placed in 1-foot layers and compacted.

I. Disposal of Excavated Material
Excavated material not suitable for backfill or in excess of the quantity required for backfilling shall be disposed of by the Contractor at his own expense.

J. Maintenance of Existing Drainage
If it is necessary in the performance of the work to interrupt existing drainage, temporary drainage facilities shall be provided until the existing drainage facilities are restored. Flows in County drains must be maintained at all times during construction.

K. Method of Measurement
Sewers shall be measured in place as the actual horizontal length, in lineal feet, from the center-of-manhole to center-of-manhole. When structures such as junction chambers, pump stations, etc., are constructed on sewer lines, measurement shall be to inside-face of such structure.

L. Determination of Culvert Size
All culvert design calculations must be submitted to the MCPWO for review. Calculations must be signed and sealed by a Professional Engineer and must include:
1. Delineation on a topographic map of the area contributing to the culvert.
2. Hydrologic calculations to determine the amount of flow.
3. Hydraulic calculations used to determine the size of the culvert.
4. Calculations for height of cover, gauge size, and expected loads.
5. When an existing culvert is proposed to be modified, backwater calculations and/ or downstream calculations may also be submitted.
   a. This office will use the “Rational Method”, the SCS Method, or other prior approved method, to determine the flow contributing to the culvert. Culverts shall be sized to pass a minimum 10-year storm event or the governing design storm of the watercourse, which may be higher.
   b. The velocity within the culvert shall be neither siltative nor erosive.

4.3 Design Criteria for Open County Drains
There are several elements that must be considered during the design of an open County drain:
1. The bankfull channel must be designed to provide long-term stability and not undergo excessive erosion or deposition.

2. The flood conveyance channel needs to convey, at a minimum, the 10-year storm, 24-hr storm event plus 0.5 feet of freeboard.

3. The impacts on water quality from construction and nonpoint source pollution need to be minimized to the maximum extent practicable.

4. Additional capacity may be required at the bankfull elevation to provide floodplain drainage at bridges or culverts.

5. When a County drain is the proposed outlet for a site’s storm drainage system, the standards regarding storm water detention (Part 5) shall apply.

6. There may be cases where downstream conditions limit the existing outlet. In this situation, the discharge from the site shall be limited to conform to the governing downstream conditions or an increase in the downstream capacity may be required.

7. The allowable outflow from the proposed site will be limited to the pro-rata share of the capacity of the drain. In cases where the drain outlet has already reached capacity, the burden is on the proprietor to design and construct, at his expense, any necessary improvements to the capacity of the Drain or downstream outlet.

8. Permanent structures and detention basins may not be constructed within the permanent County drain easement.

A. Channel Design Approach

The typical cross-section for an open County drain is a multi-stage design (Figure 4.1). The cross-section shall have multiple stages consisting of an active bankfull channel within a larger floodway. The construction of a low-flow channel may also be required.

**Low Flow Channel** – the low flow (or thalweg) channel will increase channel velocity and depth during periods of low discharge to improve sediment conveyance and thereby improve channel stability.

**Bankfull Channel** – in stable alluvial stream channels with a hydraulically-connected floodplain, the point where the flow just begins to overtop the banks of a stable channel into its floodway.

**Floodway** – the area contained within terrace side slopes or setback levees which includes the bankfull channel and area adjacent to the channel that will carry moving water during times of flooding. This may or may not conform to the NFIP floodway.
Figure 4.1 Standard Multi-Stage Channel Cross-Section

The following requirements apply to the design of open County drains:

1. Size the overall drain floodway to convey at least the peak discharge of the 10yr, 24-hr storm event with a minimum 0.5 ft of freeboard.

2. The bankfull channel shall be designed to provide long-term vertical stability such that the channel gradient and dimensions are maintained and the bed will not undergo excessive erosion or deposition. Design of the bankfull channel shall conform to permissible shear stress design methods and channel stability checks, at a minimum.

3. A low flow channel may be required within the bankfull channel to increase the sediment transport capacity if the drainage area exceeds 2 square miles and sediment transport capacity has not been determined.

4. Provide or maintain floodplain form – provide a floodway with a width of three to five times the width of the bankfull channel (Figure 4.1). If constructing the required floodplain width is not possible due to site constraints, the maximum width practicable shall be provided. This may require steeper side slopes along one or both sides of the flood conveyance channel with appropriate fencing.

B. Design Discharge

The capacity of the entire floodway shall be sized to convey at least the 10-yr, 24-hr storm event with a minimum 0.5 ft of freeboard. The overall channel capacity may be determined from USGS gauge station data, estimated with the Rational Method and Manning’s equation or with appropriate models such as HEC-RAS (Appendix G). The design roughness coefficients of the channel shall be based on the fully-vegetated condition. The floodway capacity may need to exceed the 10-yr storm due to the floodway width and terrace side slope requirements.

The bankfull channel shall be sized to convey the channel-forming (or dominant) discharge (Qcf) to allow for adequate entrainment and sediment transport capacity, thereby minimizing long-term maintenance. The channel-forming discharge is a general term that is considered to be a single discharge equivalent in its effect to the range of discharges that govern the shape and size of a stable, natural channel.

The following method should be used to determine Qcf:

**Recurrence Interval:** The actual recurrence interval that corresponds to the channel-forming discharge in a stream based on statistical analysis. Leopold determined that the bankfull discharge (determined in the field at USGS gauging stations) corresponded to the 1.2-yr to 1.8-yr (average 1.5-yr) recurrence interval on a flood frequency curve developed from long-term data at a gauge station. The recurrence interval of bankfull discharge can vary depending on the local conditions; however, it is less than the 2-yr flood.

If another method is proposed, it is recommended that the designer obtain approval from MCPWO prior to proceeding with the design.

C. Open Drain Construction

Construction means and methods will vary with each county drain construction project. When constructing any portion of a new or existing county drain, the following requirements and considerations will apply:
1. The methods of construction should minimize the area and duration of land and vegetation disturbance, where possible. All disturbed areas within the County easement shall be promptly stabilized.

2. Whenever possible the riffle/pool topography of the bankfull channel bed should be retained or enhanced and not graded flat and uniform.

3. Figure 4.1 is a conceptual drawing of a typical cross section.

4. The proposed channel gradient must consider the elevation of road culverts and other permanent grade controls.

5. Landscaping shall follow the appropriate requirements of Part 6, Section 6.3 A.


7. The banks of the bankfull channel shall be predominantly deformable (unarmored) vegetated banks. Armoring banks of the bankfull channel with riprap and other structural revetments should be minimized. Bank armoring should generally be used only to protect infrastructure or where required due to a narrow floodway which may occur due to existing infrastructure (Figure 4.3). If eroded or disturbed during construction, banks should be stabilized with vegetative approaches combined with rolled erosion control products as a first consideration. See Appendix H for guidelines on rolled erosion control products and (Washington, 2003) referenced in Appendix A for more detailed streambank protection guidelines.

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**Figure 4.3 Concept of Deformable (Vegetated) Bank Treatments**
Part 5   Managing Stormwater Runoff

5.1   Purpose

This section sets forth design and construction standards to be used by the MCPWO in review of proposed stormwater management systems within its jurisdiction. The water quality standards and channel protection criteria standards apply to all new development and redevelopment projects under MCPWO’s jurisdiction that disturb one acre or more, including projects that are less than one acre that are part of a larger common plat of development or sale that would disturb one acre or more. The internal drainage for a site, as well as the downstream conditions will be reviewed in accordance with the objectives of managing both the quality and quantity of stormwater runoff. Every site is part of an overall watershed, and the system should be designed within this context.

These standards are the minimum requirements of the MCPWO and should not be construed as all-inclusive. The design engineer must also consider other requirements for entities at the federal, state, and local levels when developing stormwater management facilities. Exceptions will be considered and require approval by MCPWO.

The MCPWO recognizes that it is difficult to develop one set of uniform standards that are capable of accommodating all variables and unique site circumstances, specifically on smaller sites. Waivers or variances from specific provisions of these standards may be requested, and alternatives consistent with the overall intent of stormwater quantity and quality management may be proposed, subject to the approval of the MCPWO. Stormwater credits may be applied where applicable (Appendix J).

The MCPWO’s stormwater management criteria are listed in Table 5.1. They are further described in Section 5.3.J.
### Table 5.1 Summary of Stormwater Criteria

<table>
<thead>
<tr>
<th>Sec.</th>
<th>Criteria</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>The total detention volume of the basin required is equal to the OFP volume plus 1 ft of freeboard. A staged outlet for the CP volume must be included when CP is required.</td>
</tr>
</tbody>
</table>
| H.1. | Water Quality (WQ)              | Treat the runoff generated from the site for a 1.0” rain event. The WQ Volume is determined by Schueler’s Simple Method: WQV = (Rv)(A)(P)/12  
Where Rv = site runoff volume coefficient  
A = site drainage area (ft^2)  
P = design rainfall depth (1.0 inches)  
Design for a maximum discharge concentration of 80 mg/L Total Suspended Solids (TSS). Not required if extended detention of the CP Volume is provided. |
| H.2. | Channel Protection (CP)         | The Channel Protection (CP) Criteria was developed to prevent or minimize the channel enlargement process. The CP Volume for a 2-yr storm must be stored and released over a period of at least 24 hours. |
| H.3. | Overbank Flood Protection (OFP) | The purpose of the Overbank Flood Protection (OFP) Criteria is to prevent the increase in the magnitude and frequency of out of bank flooding generated by development. The OFP volume (100-yr or 2” over developed acreage, whichever is greater) shall be detained and released at a maximum runoff rate of 0.20 cfs per acre. |
| H.4. | Extreme Flood Conveyance (EFC)  | Safe conveyance of the 100-year storm from the site must be provided for the detention basin overflow.                                                                                                         |

### A. Stormwater Management Approach

Thoughtful site planning reduces the negative impacts associated with development. Communities, regulatory agencies, and designers must evaluate the impact of each individual development project over the long-term and on a subwatershed scale. Integrated Management Practices (IMPs) should be used that function together as a system to insure that the volume, rate, timing, and pollutant load of runoff remains similar to that which occurred under natural, pre-development conditions. This can be achieved through a coordinated network of structural and nonstructural methods designed to provide both source and site control.

### Source Controls

Source controls reduce the volume of runoff generated on-site, and eliminate initial opportunities for pollutants to enter the drainage system. They are the best option for controlling stormwater and include the following key actions:

a. Preserve existing natural features that perform stormwater management functions, such as natural depressions, wetlands, and vegetation along streambanks.

b. Reduce the area of impervious surfaces through site planning. Minimize enclosed storm sewer systems and directly connected imperviousness by conveying stormwater through vegetated swales, where possible.
c. Where site conditions allow, use infiltration practices to reduce the volume of stormwater runoff.

d. Careful design and installation of erosion control mechanisms and rigorous maintenance throughout the construction period is imperative. Effective erosion control measures include minimizing the area and length of time that a site is disturbed by construction phasing, installing and maintaining effective erosion control measures, and promptly stabilizing disturbed areas.

Site Controls

Site controls are used after the implementation of source controls to convey, pre-treat, and treat (i.e., detain, retain or infiltrate) the stormwater runoff generated by development. The engineering and design techniques available to achieve these objectives is dictated by site configuration, soil type, and the receiving waterway, but some universal guidelines for controlling stormwater quality and quantity can be stated. The following four categories of site controls are listed in order of preference.

1. **Infiltration** - The most effective stormwater quality controls are infiltration practices, which reduce both the peak runoff rate and volume. Infiltration devices are most applicable to small drainage areas and sites with suitable soils and no potential for groundwater contamination.

2. **Basins** - The next most effective stormwater site controls are detention basins which reduce peak runoff rates. The following criteria apply to detention basins:
   a. Wet extended detention basins are generally preferable to dry detention basins, since they hold stormwater longer, allow more particulates to settle out, and remove some soluble pollutants.
   b. Where site conditions prohibit the use of a wet pond, basins should be designed to provide extended detention of stormwater to meet the channel protection criteria and promote settling of sediment. The use of additional water quality treatment practices will be necessary with dry extended detention basins (see treatment trains).
   c. The discharge shall outlet within the drainage basin where flows originate and may not be diverted to another drainage basin, unless by approval of the MCPWO. A Certification Form for Adding Lands to a Drainage District (see Appendix I) must be submitted to the MCPWO.

3. **Conveyance** - Excess runoff must be discharged into conveyance systems once other methods of reducing and treating stormwater on-site have been implemented and carried off-site to a suitable outlet.

4. **Filtering Systems and Manufactured Systems** – Filtering practices and manufactured systems such as swirl concentrators may be used where adequate source controls cannot be integrated into the site design due to space constraints.

The preferred hierarchy of structural site controls provides a comprehensive framework for evaluating the place and function of individual practices within a stormwater management system. The most important practices are source controls that preserve and protect the natural environment. The use of source control measures will be credited accordingly (Appendix J). Many stormwater management practices can effectively achieve the WQ Criteria if properly
designed and constructed. A list of practices and their estimated percent Total Suspended Solids (TSS) reduction is provided in Table 5.2.

B. Acceptable Stormwater Management Practices

Table 5.2 provides the pollutant removal capabilities recognized by the MCPWO. BMPs that do not achieve the required TSS removal rate may be used as part of a treatment train. Third party testing of other BMPs may be submitted for review and acceptance.

Table 5.2 Typical Sediment Removal Rates of Stormwater Management Practices

<table>
<thead>
<tr>
<th>Type</th>
<th>TSS Removal Rate (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Infiltration basin or trench*</td>
<td>89</td>
</tr>
<tr>
<td>Pervious pavement system</td>
<td>35</td>
</tr>
<tr>
<td>Dry well</td>
<td>89</td>
</tr>
<tr>
<td>Wet extended detention pond</td>
<td>80</td>
</tr>
<tr>
<td>Dry extended detention (ED) basin</td>
<td>49</td>
</tr>
<tr>
<td>Landscaped ED basin (no buffer)</td>
<td>50</td>
</tr>
<tr>
<td>Conventional dry detention basin</td>
<td>18</td>
</tr>
<tr>
<td>Constructed stormwater wetland</td>
<td>&gt;80</td>
</tr>
<tr>
<td>Multiple pond or pond/wetland complex</td>
<td>&gt;80</td>
</tr>
<tr>
<td>Retention basin</td>
<td>89</td>
</tr>
<tr>
<td>Grass swale</td>
<td>65**</td>
</tr>
<tr>
<td>Dry swale</td>
<td>81**</td>
</tr>
<tr>
<td>Wet (wetland) swale</td>
<td>87**</td>
</tr>
<tr>
<td>Vegetative filter strip</td>
<td>81</td>
</tr>
<tr>
<td>Bioretention</td>
<td>74</td>
</tr>
<tr>
<td>Sand filter</td>
<td>86</td>
</tr>
<tr>
<td>Cistern</td>
<td>15</td>
</tr>
<tr>
<td>Manufactured BMPs*** (swirl concentrators, filter systems)</td>
<td>43</td>
</tr>
<tr>
<td>Catch basin w/sump and hooded outlet</td>
<td>20</td>
</tr>
</tbody>
</table>

*Depends on soils
** Depends on swale length and design
*** Depends on results of independent testing

C. Detention Basins

Detention basins store stormwater runoff temporarily before discharging into a waterway. Conventional dry detention basins are typically designed strictly for flood control and do not provide adequate channel protection and may not provide adequate water quality treatment. If a dry basin is proposed for a site, then it must either:

a. Have a staged outlet structure to provide extended detention of the CP volume (Section H.2),
b. Be hydraulically-connected to a second extended detention basin, or
c. The designer must demonstrate that alternative methods, such as infiltration, achieve the CP criteria through stormwater credits.
Detention Basin Guidelines

Stormwater management planning should be addressed before the design stage:

a. The developer has an obligation to contact local municipalities to determine how the proposed development will impact the subwatershed and whether the proposed stormwater management approach is consistent with the watershed management plan and/or community master plan.

b. The designer must ensure that the risk of flooding potential is minimized upstream and downstream of the proposed site.

c. Conduct a site evaluation. Identify unique or sensitive natural areas. Locate any springs near the proposed basin site and re-locate the basin if necessary to prevent instability of the detention berms and structures.

d. Try to integrate the basin into the site as a natural site amenity.

e. All utility lines and sanitary sewers should be located outside of the basin site. Verify that no local private wells will be affected by the proposed basin.

f. Collect soil samples from the site if a wet pond is proposed. Determine soil permeability and the ability to inhibit seepage and maintain a permanent pool. Determine the soils ability to support loads and maintain its shape.

g. Determine if the selected basin location will accommodate all of the required storage volumes.

h. All open channels that will discharge to the basin must be adequately vegetated to minimize erosion.

i. Verify local requirements concerning basin safety and long-term maintenance.

j. If the basin is used to control sediment during development, then the design pool depth and design grade shall be restored prior to installing permanent landscaping and stabilization measures.

D. Retention Basins

A “no-outlet” retention basin is only permissible when there is no other available positive outlet for the stormwater runoff from the property. Every effort should be made to provide a means to dewater the basin, including a pumped outlet and possible downstream improvements.

The proposed storage volume of the retention basin is calculated on the basis of total contributing acreage, including the basin area and all off-site areas that flow onto the property. Sufficient storage and dewatering capacity must be provided for two consecutive (back-to-back) 100-year storm events

a. The retention storage is calculated as volume provided in the basin above the existing groundwater elevation.

b. An overflow facility from the retention basin must be provided. Elevations of surrounding buildings, development, or other features that would be impacted by a basin overflow must be indicated. The overflow route may not endanger any existing structures or features. Downstream drainage easements are required for the off-site overflow route.

c. One (1) foot of freeboard must be provided above the proposed storage elevation.
Managing Stormwater Runoff

Sections E. through G. discuss BMPs that may be used to meet the water quality criteria if a basin is not required:

E. Infiltration Facilities

Infiltration facilities such as infiltration basins, infiltration trenches, dry wells, and permeable pavements may be considered where site conditions allow. Infiltration facilities temporarily store and infiltrate the water quality volume within 48 hours and bypass larger flows. Design guidance is provided in USEPA, 2004 (Appendix A). The following requirements apply:

a. Initial NRCS soil classification (from soil survey) and feasibility testing should be performed to assess the feasibility of infiltration practices and to eliminate unsuitable areas. The minimum infiltration rate for infiltration practices is 0.5 in/hr as verified by soils analysis or field infiltration testing. Soils suitable for infiltration shall have less than 40% silt/clay and less than 20% clay. Two borings or test pits and infiltration testing shall demonstrate an infiltration rate of > 0.5 in/hr at a depth of 18 inches to 10 feet depending on the depth and type of practice proposed.

b. Structural infiltration devices such as basins and, to a lesser degree, trenches may suffer high failure rates due to clogging. Therefore, an aggressive maintenance program and upstream pre-treatment measures (such as swirl concentrators, sedimentation basins and grass filter strips) for at least 25% of the water quality volume shall be incorporated into any stormwater management system that employs infiltration devices (except dry wells receiving rooftop runoff).

c. Infiltration facilities may serve the following maximum drainage areas:
   i. Basins – 10 acres
   ii. Trenches and permeable pavement – 5 acres
   iii. Dry wells – 5,000 ft^2

d. The bottom of infiltration facilities shall be a minimum of 2 feet from the seasonal high water table.

e. Infiltration practices shall not be used at stormwater “hotspot” sites.

f. Heavy equipment shall not be allowed in contact with the bottom of infiltration practices during construction.

F. Enhanced Vegetated Swales

This group of water quality control facilities includes wet and dry conveyance swales, as well as bioretention facilities. The design of traditional grass swales can be enhanced to provide pollutant removal. The design of water quality grass channels is a rate-based design that uses Manning’s equation to determine the velocity and depth based on channel slope and dimensions. The design of wet and dry swales is based on temporarily storing the water quality volume for a 24 hour period (Claytor and Schueler, 1996 as referenced in Appendix A). All three channel designs also safely convey the 2-yr storm at non-erosive conditions and have adequate capacity for the 10-yr, 24-hr storm with at least 6” of freeboard.

Bioretention areas are landscaped depressions that accept sheetflow from a grass filter strip and remove pollutants with mechanisms similar to a forested area. Design guidance is provided in USEPA, 2004 (Appendix A).
G. Media Filtering Systems

Filtering systems include sand filters, compost or peat/sand filters, and manufactured filtering devices. Filtering systems should be designed off-line to treat the water quality discharge for sites less than 5 acres and to bypass larger flows from treatment. Pre-treatment of filtering systems must be provided. Stormwater filtering systems are recommended to treat the runoff from stormwater “hotspot” sites. Design guidance is provided in Claytor and Schueler, 1996 and USEPA, 2004 (Appendix A).

H. Unified Sizing Criteria

It is important to recognize the difference in various components of a storm drainage system. Separate quality/quantity objectives can be met by managing various storm sizes differently with appropriate methods and criteria. Most of the historic methods of hydrologic analysis have been successfully used to control flooding from large storms. It is now possible, however, to provide drainage systems that also reduce other problems associated with stormwater runoff. A broader range of drainage objectives requires different drainage design tools, assumptions, and criteria for the study of each of the various rainfall classes.

The MCPWO’s criteria (Table 5.1) address the entire frequency of rainfall events that are anticipated at developed sites. These criteria apply to all new and re-development projects that disturb one acre or more, including projects less than one acre that are part of a larger common plan of development or sale that would disturb one acre or more. Certain stormwater management requirements may be modified by the MCPWO based on the receiving waters, the site’s location within the watershed, and other site-specific factors. If detention is required on a site to provide flood control and channel protection, the total required detention basin volume is equal to the 100-yr frequency storm using the Oakland County Drain Commission (OCDC) Simple Method (Appendix A) or 2 inches over the developed acreage, whichever is greater. The MCPWO’s integrated stormwater management program is divided into four management zones based on their relative rainfall frequency, as follows:

- H.1 Water Quality (WQ) Criteria
- H.2 Channel Protection (CP) Criteria
- H.3 Overbank Flood Protection (OFP) Criteria
- H.4 Extreme Flood Conveyance (EFC)

H.1. Water Quality (WQ) Criteria

The effectiveness of a storm water quality treatment practice is a function of how much storm water is treated by the system and how much bypasses the practice. The County assumes that the water quality criteria has been met if extended detention is provided for the CP volume. For sites without extended detention, the MCPWO WQ Criteria requires treatment of the WQ Volume to achieve a maximum discharge concentration of 80 mg/L TSS or less. The values in Table 5.3 shall be used to estimate the TSS reduction required based on land use.
Table 5.3 TSS Concentrations and Reduction Requirements by Land Use
[from Table 3-13 of Rouge Report (RRNWWDWP) RPO-MOD-TM34.00, 1994]

<table>
<thead>
<tr>
<th>Source Area</th>
<th>% Imperviousness</th>
<th>TSS Concentration* (mg/L)</th>
<th>% TSS Reduction Required to Achieve 80 mg/L</th>
</tr>
</thead>
<tbody>
<tr>
<td>Forest/Rural Open</td>
<td>2</td>
<td>51</td>
<td>0</td>
</tr>
<tr>
<td>Urban Open</td>
<td>11</td>
<td>51</td>
<td>0</td>
</tr>
<tr>
<td>Agricultural/Pasture</td>
<td>2</td>
<td>145</td>
<td>45</td>
</tr>
<tr>
<td>Low Density Residential</td>
<td>19</td>
<td>70</td>
<td>0</td>
</tr>
<tr>
<td>Medium Density Residential</td>
<td>38</td>
<td>70</td>
<td>0</td>
</tr>
<tr>
<td>High Density Residential</td>
<td>51</td>
<td>97</td>
<td>18</td>
</tr>
<tr>
<td>Commercial</td>
<td>56</td>
<td>77</td>
<td>0</td>
</tr>
<tr>
<td>Industrial</td>
<td>76</td>
<td>149</td>
<td>46</td>
</tr>
<tr>
<td>Highways</td>
<td>53</td>
<td>141</td>
<td>43</td>
</tr>
</tbody>
</table>

*Mean Event Mean Concentrations

**EXAMPLE:** For a 100 acre high density residential site, 18% TSS reduction is required. Select BMP(s) from Table 5.3 that will achieve at least 18% TSS reduction for the WQ Volume.

The water quality treatment volume may be reduced or eliminated through the use of stormwater credits (Appendix J). If extended detention is not required for the site, the WQ criteria may be achieved by one of several ways:

1. Design acceptable non-proprietary or vegetative practice such as bioretention, swales, infiltration trenches, sand filters, or combinations (treatment train) to treat the WQ volume. The WQ volume is associated on the runoff depths from a 1.0” storm. The volume of stormwater runoff from the site that must be treated (WQV) is determined by Schueler’s Short Cut Method:

   \[ R_v = 0.05 + 0.009(I), \quad \text{where} \ I = \text{site percent impervious} \]

   \[ WQV = P \times (1 \text{ in/12 ft}) \times R_v \times A \times (43,560 \text{ ft}^2/\text{ac}), \] where \( P = 1.0" \text{ and } A = \text{site area (ac)} \)

   Therefore, \( WQV (\text{ft}^3) = 3,630 \times R_v \times A \) (in acres)

2. Design acceptable manufactured stormwater quality treatment systems such as swirl concentrators, filtration units, or multi-chamber treatment trains. Manufactured systems shall be accepted on a case-by-case basis as determined by independent, third-party evaluations of BMP performance which must be submitted to the MCPWO. Conventional oil-grit separators will not be allowed without secondary treatment. All proprietary systems shall meet the following criteria:

   a. Independent third-party testing data must be submitted which demonstrates the pollutant removal efficiency of the system.

   b. Systems with no significant storage and flow rate attenuation must be based on the peak design flow rate. The system must treat 100% of the runoff from the 1” storm event and remove the required percentage of the TSS load based on a 110 micrometer particle size (OK-110 sand) or smaller.
c. The system must be able to remove all oil and grease, as well as floatable debris during the design rain event and during routine maintenance.

d. Rain events larger than the water quality design storm must safely bypass the system without causing re-suspension of sediments or loss of oil or floatable debris.

e. The system shall not raise the hydraulic grade line beyond the top of the storm conveyance pipe opening during the 10-yr, 24-hr storm event and shall not create a backwater condition during dry weather.

f. The system must allow complete and unrestricted access for inspection and maintenance from grade level. Moreover, the system must allow complete removal of sediments, oils and floating debris with a jet/vacuum cleaner without requiring confined space entry.

g. The system must be designed to handle, at a minimum, H-20 loadings if proposed in traffic areas.

h. The water quality flow (Qp) is the peak flow rate associated with the 1.0” WQ storm.

Calculating Water Quality Peak Flows

Detention basins, media filtration, infiltration, and most vegetative practices (bioretention, wet swales, dry swales, filter strips) are water volume based. However, certain water quality treatment practices use a flow rate as the design variable (a rate-based design). The water quality flow (Qp) is the peak flow rate associated with the water quality design storm (P = 1”). The rate-based design may be used for the design of the following:

- Pre-manufactured stormwater quality treatment systems such as swirl concentrators, media filtration units, or multi-chamber treatment trains.
- Grass-lined drainage channels (not wet or dry water quality swales which should be designed based on water quality volume).
- Flow diversion structures for off-line stormwater treatment practices.

H.2. Channel Protection (CP) Criteria

Channel erosion often increases due to the greater stormwater runoff volume, frequency, duration, and energy following development. The Channel Protection (CP) Criteria was developed to prevent or minimize the channel enlargement process. Unless a site can achieve considerable infiltration or uses multiple stormwater credits (as described in Appendix J), extended detention will be required to achieve the CP criteria.

The CP Volume must be stored and released over a period of not less than 24 hours. The following channel protection volume multipliers (ft³/acre) can be used to estimate storage requirements by interpolation based on curve number (CN) and time of concentration (Tc) (see Example J-3 in Appendix J):

The following additional channel protection requirements apply:

a. The extended detention release rate from the wet extended detention pond to second order and smaller receiving streams shall be checked to verify that the discharge is non-erosive.
b. The MCPWO may reduce the detention time to as little as 12 hours to reduce the potential for stream warming, depending on the applicable subwatershed management plan goals and objectives.

c. Curve numbers shall be shifted upward by one hydrologic soils group (HSG) in areas if the site will be cleared.

d. The MCPWO may waive the requirements for channel protection in certain cases such as when the site directly discharges to a lake or a fourth order river or larger.

H.3. Overbank Flood Protection (OFP) Criteria

The purpose of the Overbank Flood Protection (OFP) Criteria is to prevent the increase in the magnitude and frequency of out of bank flooding generated by development (flows that exceed the capacity of the dominant discharge channel and therefore spill over into the floodway area).

The OFP volume (100-yr or 2-inches over the developed acreage, whichever is greater) shall be detained and released at a maximum runoff rate of 0.20 cfs per acre. However, the OFP Detention Volume requirements of some local authorities may be more restrictive.

H.4. Extreme Flood Conveyance (EFC)

Safe conveyance of the 100-year, 24-hr storm must be provided from the site or through the detention basin with 1 foot of freeboard. The stormwater conveyance systems under the jurisdiction of the MCPWO shall have the minimum capacity of the 10-year storm. Review of proposed projects by other local, county, state, or federal agencies may have additional capacity requirements such as at road crossings. The MCPWO may waive or reduce the OFC requirements for certain developments that pose no or minimal threat to overbank flooding such as those directly discharging to enclosed drains near Lake St. Clair.

A flood impact analysis may be required at the MCPWO’s discretion to verify that there will be no adverse impacts on peak flow increase of the 10-yr, 24-hr, and 100-yr, 24-hr storms upstream or downstream of the property. The analysis shall be as determined by HEC-RAS or other acceptable methods. The MCPWO may require more restrictive OFP Criteria based on the flood impact analysis or where existing buildings or infrastructure are located within the 100-yr floodplain. When another authorized agency requires a model, then a copy of the approved model must be provided to the MCPWO for their records.

5.2 Site Drainage

Stormwater drainage systems may consist of open ditches, swales, closed conduits or a combination of methods to convey stormwater. Drainage facilities shall be constructed in accordance with these minimum specifications for Macomb County. Other standards may apply such as the Michigan Department of Transportation (MDOT), Road Commission of Macomb County (RCMC), or local governments, which may be more stringent and shall be adhered to when applicable.

In no event shall the maximum design rate or volume of discharge exceed the maximum capacity of the downstream land, channel, pipe or watercourse to accommodate the flow. It is the proprietor’s obligation to meet this standard. Should a stormwater system, as-built, fail to comply, it is the proprietor’s responsibility to design and construct, or have constructed at his/her
expense, any necessary additional and/or alternative stormwater management facilities. Such additional facilities will be subject to the MCPWO’s review and approval.

If no adequate watercourse exists to effectively receive a concentrated flow of water from the proposed development, the discharge shall be reduced to sheet flow at pre-development rates prior to exiting the site.
Part 6  Landscaping & Maintenance Standards

6.1.  Purpose

The stability and effectiveness of many stormwater BMPs is dependent on well-established vegetation. Proper landscaping practices, appropriate selection of the types and species of vegetation, and adequate short-term maintenance are necessary to establish vegetation and prevent invasive plant species. Once BMPs are stabilized and functioning, periodic maintenance will be necessary to insure proper functioning condition. If a BMP does not require periodic sediment removal and maintenance, then it is not working to treat water quality.

6.2.  Landscaping Requirements

A landscaping plan is required for open County drains and any BMP used for stormwater credit. Incorporating regionally native plants into the design is required because these plants are better adapted to local climate and soil conditions and tend to need less long-term maintenance. The County may consider waivers from specific landscaping requirements.

Disturbed areas must be stabilized within 5 days of final grading per Part 91, P.A. 451. Vegetative stabilization of all disturbed areas with slopes between 4:1 and 1:1 (H:V) should be completed with appropriate erosion control blankets rather than seed and mulch. Disturbed areas on flatter slopes may be stabilized with appropriate mulching or blankets. Areas exposed to channelized flow may require the use of erosion control blankets, turf reinforcement mats, stone revetment, or other measures to provide stabilization. Guidelines on the application of Rolled Erosion Control Products for permanent erosion control are provided in Appendix M.

1. Landscaping Plans should be developed to achieve a diverse mix of vegetation in riparian areas. A minimum of 6 species should be selected from each applicable planting zone list (Appendix M, Tables M-1 to M-5).

2. Seed for plant species listed in Appendix F shall be applied at a minimum rate of 10 lb/ac in addition to the cover crop mix. A recommended minimum seeding rate for over-seeding partially vegetated areas or to supplement existing vegetation is 50% of the standard seeding rate (5 lb/ac).

3. A minimum 4” of compost or relatively weed seed-free topsoil, and necessary soil amendments (as determined by soil testing) shall be tilled into compacted subsoils to a minimum depth of 8-10” where vegetation is to be established on excavated subsoils. It is the designer’s responsibility to consider specific site conditions and standard horticultural practices in the development of the Landscaping Plan.

6.3.  Native Plantings

A.  Open County Drains

1. Riparian planting materials will generally coincide with Zone 3 up to Zone 5 depending on the channel topography (Figure 6.1).

2. Vegetative buffers shall be retained or established for a minimum width of 25 feet from each side of the waters edge along open County drains.

3. Trees and woody shrubs should be retained to the extent practicable during open County drain construction. The priority is to maintain trees and/or shrubs on the east side of north-south flowing channels and on the south side of east-west flowing channels (or large trees on the north side). Tree and shrub coverage shall be retained or established along the channel
easement such that 50-70% shade canopy of the bankfull channel is provided. Trees shall be bare-root and a minimum 1-1.5” caliper.

4. Herbaceous understory plantings shall be established at appropriate planting and/or seeding rates.

5. Excessive growth of invasive woody vines and shrubs (Appendix M, Table M-6) shall be removed by cutting and spraying the stump by a licensed applicator in accordance with applicable regulations.

6. The establishment and maintenance of vegetation along open County drains may vary based on the bankfull channel width and applicable watershed management goals and objectives. The following general guidelines apply:
   a. Zone 3 – A diverse mix of herbaceous plants (primarily sedges) and marginal grasses shall be established along with occasional flood tolerant trees and shrubs.
   b. Zone 4 – Establish and maintain canopy woody vegetation for 50-70% bankfull channel canopy. Healthy, mature floodplain trees should be protected. Woody shrubs may be trimmed to the ground, if necessary, and then allowed to re-grow every 3 to 7 years along open channels. Some thinning of the canopy may be required to allow shrubs or herbaceous vegetation to become established when stabilizing streambanks using vegetative practices.
   c. Zone 5 – A low growing, “No Mow” fine fescue mix or a low growing native grass only mix should be established along the upper easement. No trees or woody shrubs.

Figure 6.1 Planting Zones for Open County Drains

B. Swales Used to Meet WQ Criteria or Stormwater Credit

Swales are broad, shallow channels that primarily remove pollutants through sedimentation. Swales provide some control of runoff quantity and timing through infiltration and an increase in time of concentration. If the use of swales has been approved by MCPWO and the local municipality to meet WQ Criteria or for stormwater credit, the swales should be vegetated predominantly with sod-forming grasses for cool humid regions such as:

- Bentgrasses (*Agrostis spp.*)
- Blue-Grasses (*Poa spp.*)
- Fescues (*Festuca rubra and F. ovina*)
- Perennial Ryegrass (*Lolium perenee*).
Wet Swales – Seed mixes for wet swales should also contain at least four (4) forb, grass, and/or sedge plant species (no trees or shrubs) from Table M-2 (in Appendix M).

Dry Swales – Seed mixes for dry swales should also contain at least four (4) forb, grass, and/or sedge plant species (no trees or shrubs) from Table M-3 (in Appendix M).

C. Upland Areas Used for Stormwater Credit

Upland meadows or areas of re-forestation may be established to obtain stormwater credits. The planting materials for upland areas should coincide with Zone 5 (Table M-5 in Appendix M).

For upland areas where a ‘no mow’ mix of grasses is desired, a mixture of four to six fine fescue species should be used. Several proprietary mixes are available.

D. Prohibited Plant Species

Exotic, invasive plant species shall not be introduced within open county drains or BMPs used for stormwater credit. Invasive species can quickly take over a disturbed reach of stream and reduce adequate conveyance. For a re-vegetation project to control erosion, benefit water quality, and allow proper conveyance, invasive species must be restricted and controlled. Common species that should be prohibited and should be removed from riparian areas are outlined in Table M-6. Long-range management plans shall be provided by the proprietor for the ongoing removal of these plant species for BMPs used for stormwater credit.

6.4. Vegetation Maintenance for BMPs Used for Stormwater Credit

The long-term maintenance plan for the development’s storm water management practices and system used for stormwater credit shall include provisions for establishing and maintaining vegetation. The first few years after planting are critical. The following periodic maintenance is required to establish plants through this phase:

1. While watering during the first year will be important, no supplemental watering will be required once native plantings are established. Extensive lawn irrigation may promote disease and lodging (breaking of stalks).

2. Access to newly seeded areas shall be limited with fencing, signage, or other appropriate methods.

3. Appropriate signage is required to insure preservation, reduce feeding of waterfowl, or to address safety issues.

4. The persons responsible for site maintenance shall be consulted and riparian residents should be educated regarding appropriate mowing and maintenance practices. Edging, temporary fencing, or other methods may be required to prevent mowing during the initial period of plant establishment. Permanent boundary markers and signage shall be installed to delineate the easement and identify “No Mow” or “Grow Zones” (See Appendix C). Areas in Zones 4 and 5 may be maintained annually by mowing or electrical trimming to a minimum height of 6-8” in late fall or early spring to remove dead plant materials. More frequent trimming and mowing of riparian areas is not recommended.

5. Natural vegetation should be allowed to grow along open drains and natural streams to control erosion and provide some shading.

6. Periodically and following storm events, stabilized areas should be inspected for erosion and any rills or gullies repaired.
7. Following the first two growing seasons, determine if reinforcement plantings are needed.

8. The emergency overflow spillway, side slopes, and detention pond embankments may be trimmed once in the late fall or early spring to a minimum height of 6-8 inches. Litter and debris shall be removed from the inlet and outlet structures and the general basin area at this time.

9. Excessive algae and ecologically invasive aquatic plant growth shall be removed to prevent decomposition, nutrient cycling, and associated nuisances.

6.5 Inspections

Prior to the approval of the final construction plans, the proprietor shall have made arrangements acceptable to the MCPWO for inspection during construction, including submittal of inspection reports, and for final verification of the construction by a Michigan registered professional engineer. These arrangements will include an inspection schedule that defines the specific junctures during construction when on-site inspection and written verification by a professional engineer will occur.

6.6 Maintenance Requirements

A satisfactory agreement that assures long-term maintenance of all drainage improvements used for stormwater credit shall be in place before submission of the final plat. This office will not accept the responsibility for the maintenance of any storm water management practice unless it is being constructed as part of a Chapter 18 County Drain. The maintenance plan must include the following general elements:

1. The plan must show the locations and the physical limits of all the storm water management practices and identify the party responsible for maintaining each system component.

2. The plan must provide for periodic monitoring of the system to determine whether the system is functioning properly. The plan must identify the personnel training and inspection and preventative maintenance activities that are necessary to ensure that the system continues to function properly. Components of the training, inspections and preventative maintenance shall include:
   a. The owner shall retain the services of a qualified individual such as a registered Civil Engineer, Certified Professional in Storm Water Quality (CPSWQ), NICET Certified Engineering Technologist in Stormwater and Wastewater System Inspection, or MDEQ Certified Storm Water Operator (NPDES – construction sites) to provide inspection and maintenance services.
   b. An inspection and maintenance schedule must be included and a log kept of all inspections, maintenance activities and repairs. The log must provide:
      i. Date of activity
      ii. Name of person performing activity
      iii. Description of activity and additional maintenance and/or repair that is needed

3. The plan must include provisions for establishing and maintaining vegetation including the vegetation that is integral to the proper functioning of the practices.
4. The plan must commit the entity responsible for maintenance to performing remedial actions necessary to repair, modify, or reconstruct the system in the event that the system does not function properly as designed.

5. The plan must set forth a schedule for implementing the activities necessary to ensure the proper functioning of the system.
Appendix A. References

References


Rosgen, D., 2006, River Assessment and Monitoring course – reference figures, Lubrecht Forest, MT.


Stormwater Management Practices Design


Open Channel and Culvert Design


BMP Monitoring


Soil Erosion and Sediment Control Measures


Additional Resources

Additional resources on stormwater management practices can be found online at:

- www.lid-stormwater.net/intro/background.htm
- www.lowimpactdevelopment.org/brochures.htm
- http://www.stormwatercenter.net/
Appendix B. Maps

Sub-Watershed Boundaries Map
Macomb County, Michigan

Figure B-1 Subwatersheds of Macomb County
Appendix C. Signage

‘Ours to Protect’ Signs
‘Ours to Protect’ signs educate and bring awareness to residents and visitors of the watershed they are located within and what County drain they are crossing. The ‘Ours to Protect’ sign shall have the County drain name on the sign. Verify with the MCPWO the correct drain name, watershed and spelling before installation. Contact the Road Commission of Macomb County (RCMC) for the sign specifications and requirements for installation within a County road easement. Please consult with the RCMC and your municipality for all installation, permits, maintenance and any other additional requirements.

‘Grow Zone’ Sign
‘Grow Zone’ signs shall be based on the Wayne County sign, shown below, but personalized to include Macomb County’s Drain Name, if applicable. ‘Grow Zone’ signs mark the boundaries of designated grow zone areas near lakes, rivers or streams. They feature trees, grasses and a flowing stream, the words: “Grow Zone” and the following caption: “To Improve Wildlife Habitat & Water Quality”. ‘Grow Zone’ signs shall be made of durable metal construction and shall measure no smaller than 8” x 12” and no larger than 12” x 18”. Please consult with your municipality for all installation, permits, maintenance and any other additional requirements.
Drain Easement Sign

DRAIN EASEMENT SIGN REQUIREMENTS AND SPECIFICATIONS FOR SUBDIVISION PLATS WITH OPEN COUNTY DRAINS

(NOT DRAWN TO SCALE)

MACOMB COUNTY DRAIN EASEMENT

Encroachments Prohibited

Macomb County Public Works Office
DO NOT REMOVE UNDER PENALTY OF LAW

SIGN REQUIREMENTS

1. Aluminum 6" high x 11.75" wide with round corners
2. Thickness .063"
3. Non-reflective
4. Sign is to be screen printed or thermal printed with white lettering and a dark green background

POST REQUIREMENTS

1. 7' long 1.12 lb. weight per foot, U channel post green color
2. 3' of post is to be buried, with 4' above ground
3. The signs are to be installed within the drain easement on the side property line of every other lot. Signs are to face the street.
Appendix D. Final Plat Checklist

For Internal Use Only

Subdivision Name: ____________________________________________________________

MCPWO Log No. ________ CVT: ________________________________________________

MCPWO Final Preliminary Plat Approval Date: __________________

Final plat lot numbers match approved final preliminary plans? _____ If no, why:

____________________________________________________________________________

The storm easements on the final plat/certified true copy were checked against the approved final preliminary plat, MCPWO Log No. ________. Initial if easements on the final plat and/or Certified True Copy are approved: CTC ________ CTC & FP ________ FP ________

County Drain Onsite? Yes No If Yes, select type: Open Enclosed

Drain Improvement Required? Yes No If Yes, Developer Agreement No. __________

Off-site Easement Required? Yes No If Yes, Executed easement on file? Yes No

Is County Drain Easement labeled properly? Yes No

Detention Required? Yes No

Deed Restrictions on File? Yes No

SAD Established? Yes No

100-year Floodplain Shown? Yes No N/A

Signage:

Note whether required and if installed.

<table>
<thead>
<tr>
<th>Type</th>
<th>Required?</th>
<th>Installed?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Easement Signs:</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>‘Ours to Protect Signs’:</td>
<td>Yes</td>
<td>No</td>
</tr>
</tbody>
</table>

Permits:

MCPWO permit required? Yes No If Yes, Permit No. __________

Disposition of Plat: __________________________________________

Reviewed by: ________________________________________________
Appendix E.  Macomb County Public Works Commissioner’s Certificate

County Drain Commissioner’s Certificate

Approved on (a), as complying with Section 192 of Act 288, P.A. of 1967, and the applicable rules and regulations published by my office in the County of Macomb.

____________________________________
Candice S. Miller
Macomb County Public Works Commissioner

Certificate signing date: (b)

(a) The date the Certified True Copy was signed.
(b) The date the mylar was signed.

Note: The Certified True Copy cannot have a date later than the mylar date.
Appendix F. Details

DETAIL 1-B

Backfill placed against undisturbed soil.

1/4 Pts.

90 degree

1 ft. min.

6" min.

BEDDING

Grade

Backfill

Cradle

Centerline of pipe

1/4 pts.

1 ft. min.

Concrete cradle

Cradle must be for the entire length of the item(s) when required.

(See Bedding Requirements—Section 5 A.)
DETAIL 1-C

FRAME AND COVER (PER PLAN)

PLACE FRAME IN FULL BED OF MORTAR.

MIN. 6" - 18" ADJUSTMENT

PRECAST ECCENTRIC CONE & MANHOLE RISER SECTION - A.S.T.M. SPEC C478

POLYPROPYLENE ( OR APPROVED EQUAL) FACTORY INSTALLED STEPS, 16" O.C. BOTTOM STEP MAX. 24" ABOVE FLOOR.

INTEGRALLY CAST MANHOLE TEE CIRCULAR PIPE - A.S.T.M. SPEC C76 CLASS 4

ELLIPICAL PIPE - A.S.T.M. SPEC C507 HE CLASS 4

48" DIA.

48" & UP

HORIZ. DIMENSION ROUND OR ELLIPICAL PIPE

CONCRETE CRADLE PER M.C.P.W.C. SPECS. (DETAIL 1-B)

STORM SEWER TEE MANHOLE
IN-LINE STORM SEWER MANHOLE

- Frame and Cover (see plans)
- Place in frame in full bed of mortar
- Min. 6" max. 12" adjustment
- Outside must be plastered with mortar
- Brick, concrete block or precast
- Polypropylene (or approved equal)
- Factory installed steps, 16" o.c.
- Bottom step max. 24" above floor

**SEWER PIPE SIZE (I.D.)** | **MIN. DIA. IF NOT ON PLAN**
---|---
30" or less | 48"
36" to 42" | 60"
48" & larger | PRECAST "T"

Pour concrete fillet (2500 p.s.i.)

Precast or poured conc. base 2500 p.s.i.
At 28 days (if precast is used) place 2" min. sand sub-base.
DETAIL 1-DD

FRAME AND COVER PER PLAN

PLACE FRAME IN FULL BED OF MORTAR

MIN 6" - MAX 18" ADJUSTMENT

BRICK CONCRETE BLOCK OR PRECAST

POLYPROPYLENE (OR APPROVED EQUAL) FACTORY INSTALLED STEPS, 16" O.C.
BOTTOM STEP MAX. 24" ABOVE FLOOR.

OUTSIDE TO BE PLASTERED WITH MORTAR.

PRECAST FLAT-TOP 2500 P.S.I. MIN 8" THICK WITH REINFORCEMENT
(#4 BARS AT 8" O.C.)

MANHOLE REQUIRING A DIAMETER GREATER THAN 8" MUST BE A SPECIAL STRUCTURE APPROVED BY THIS OFFICE.

POURED CONCRETE FILLET 2500 P.S.I.

INSIDE DIAMETER (8" MAX.)

PRECAST OR POURED CONC. BASE-2500 P.S.I. AT 28 DAYS.
(IF PRECAST IS USED, PLACE 2" MIN. SAND SUB-BASE)

#4 BARS AT 12" EACH WAY.

JUNCTION, TURN OR DROP MANHOLE
### DETAIL 1-F

**PROPOSED TAP 12"-24"**

- **Class B Concrete Collar and Bedding:** Shall be a minimum of 12", shall be placed on undisturbed soil, and extended to the first joint of the proposed tap.

- **Allowable Angle:**
  - Upper Quarter: 45°-90°
  - Lower Quarter: 45°-60°

**MANHOLE TAP**

- **Class B Concrete Collar:** Shall be a minimum of 12".
- **Proposed Tap:** Shall be placed on undisturbed soil and extended to the first joint of the proposed tap.

**Undisturbed Soil:**

- **Maximum Allowable Tap to a Manhole:** Shall be 24" diameter. The proposed tap shall be above the existing concrete fillet.

**General Notes:**

1. **Taps to Manholes and Pipes 48" or Larger:** Must be pointed on inside.
2. **Inside Joints of All Taps:** Shall be cut flush with inside wall of the manhole or tapped drain.

---

**TAP CONNECTION DETAILS**

Office of Public Works Commissioner  
Macomb County  
115 Groesbeck Highway  
Mt. Clemens, Michigan

Sheet: I  
Date: II-7-
DETAIL 1-F2

PROPOSED TAP - 27" OR LARGER

If B - A is greater than 3'
Use Section 1

If B - A is less than 3'
Use Section 2

If C is less than 18'
D must be greater than 30'

Plan

2 - 4" B over opening

Class A Concrete

Section Detail 1

2 - 4" B over opening

Class A Concrete

Re-steel each way as required walls and decks
DETAIL 1-F3

TAP WITH SAWCUT

Solid line is sawcut.
Dashed line is dia. of hole needed for tap.

Centerline

TAP WITH STAR DRILL

Dashed line is dia. of hole needed for tap.

Drill Holes

Centerline

NOTE: NUMBER OF HOLES WILL DEPEND ON SIZE OF TAP. CENTERLINE OF HOLES MUST BE MAX. 8" APART.
Appendix F

DETAIL 1-G

This area feathered to match end section and provide a smooth transition to drain bank.

Manhole to be placed just inside ROW line no Sump

Pipe not to extend beyond intersection of top of pipe and drain bank, i.e. pipe not to be exposed.

FEATHERED AREA

MIN. SLOPE %

SECTION A-A (NOT TO SCALE)

Last 2 1/2 pipe (plus end-section) to be bedded in sand-cement dry-mix. Grade C (2500 P.S.I.)

TYPICAL DETAIL OF TAP TO OPEN DRAIN
DETAIL 1-H

6" SPIGOT TAP SADDLE EPOXYED TO CORED HOLE IN CONCRETE PIPE
(AS MANUFACTURED BY PREDCO 1-800-323-6188 OR APPROVED EQUAL)

3" SCH 40 PVC

6" - 3" FERNCO COUPLING

CONCRETE PIPE

PLAN VIEW

SUMP PUMP LEAD CONNECTION DETAIL
FERNCO COUPLING (NO SCALE)
DETAIL 1-Z.1

ROAD R.O.W.
UTILITY TRENCH
TYPE B

Bedding and Backfill of pipe within the Road R.O.W. must meet the requirements of MDOT as specified in the MDOT Standards IV-83G TYPE B Utility Trench dated 10-22-91. (See Detail 1-Z.2)

Class IIIA material shall be as defined by MDOT Supplemental Specifications for Utility Trench dated 4-25-91. (See Detail1-Z.3)

Class III Granular Material shall consist of sand which meets the specifications described in Table 8.02-3, 1990 MDOT Standard Specifications for Construction. (See Detail 1-Z.4)

If pea gravel is used for Class IIIA material within the Road R.O.W. a filter fabric must be placed between the Class IIIA material and Class III material. Said filter fabric must meet requirements of MDOT Standards 8.09.02 Geotextiles. (See Detail 1-Z.5)

An acceptable alternative to using the filter fabric is to add a sand cement dry mix (Grade C - 2500 P.S.I.) to the Class IIIA material within the Road R.O.W.
DETAIL 1-Z.2

**UTILITY TRENCH "B"**

A) SEWER NOT UNDER ROADBED

B) SEWER UNDER ROADBED OR WITHIN INFLUENCE OF ROADBED

C) SEWER WITH UNDERDRAIN UNDER ROADBED

D) SEWER WITH UNDERDRAIN UNDER ROADBED (FOR SHALLOW SEWERS)

MICHHIGAN DEPARTMENT OF TRANSPORTATION
BUREAU OF HIGHWAYS STANDARD PLAN FOR

UTILITY TRENCHES

IV-83G SHEET 1 OF 3
DETAL 1-Z.3

MICHIGAN DEPARTMENT OF TRANSPORTATION BUREAU OF HIGHWAYS

SUPPLEMENTAL SPECIFICATION FOR UTILITY TRENCH BACKFILL

5.13(3c)  1 of 1  10-10-90

FHWA Approval 04-25-91

a. Description.—This work shall consist of backfilling trenches where called for on the plans with a porous bedding material in accordance with the typical trench sections shown on Standard Plan IV-B3 Series.

b. Material.—The porous bedding materials for backfilling sewer trenches shall be Granular Material Class IIIA and shall meet the requirements specified in Subsection 8.02.06 of the 1990 Standard Specifications with the following additions:

The following material is hereby added to Table 8.02-3:

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<th>MATERIAL</th>
<th>CLASS IIIA</th>
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<tr>
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<td>100</td>
</tr>
<tr>
<td>0.30mm</td>
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</table>

(a) Based on dry weights.

The following sentence is hereby added at the end of the first paragraph:

Granular Material Class IIIA for use as trench backfill may also consist of crushed concrete.

c. Construction Methods.—Trenches shall be backfilled and compacted in accordance with the methods specified under Backfilling, Subsection 5.13.08, of the 1990 Standard Specifications, except the third paragraph is hereby deleted and is replaced with the following paragraph:

Backfill for sewers within the limits of the roadbed as shown on the plans or as directed by the Engineer shall be Granular Material as shown on the plans and shall be compacted to 95 percent of Maximum Unit Weight.

d. Measurement and Payment.—The completed work as measured for UTILITY TRENCH BACKFILL will not be paid for separately. Payment for such work will be considered as having been included in the contract unit prices bid for pay items in the contract.
### Table 6.02-3  Grading Requirements for Granular Materials

<table>
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<tr>
<th>MATERIAL</th>
<th>6&quot;</th>
<th>3&quot;</th>
<th>2&quot;</th>
<th>1&quot;</th>
<th>1/2&quot;</th>
<th>No. 4</th>
<th>No. 8</th>
<th>No. 30</th>
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<td></td>
<td>150mm</td>
<td>75mm</td>
<td>50mm</td>
<td>25mm</td>
<td>12.5mm</td>
<td>6.3mm</td>
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<td>Class II</td>
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<tr>
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<td>6.3</td>
<td>0.3</td>
<td>0.100</td>
<td>0.5</td>
</tr>
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</table>

(a) Based on dry weights.
(b) Except for use in Granular Blankets, Class III granular material may be substituted for Class II granular material for projects located in the following counties: Arenac, Bay, Genesee, Gladwin, Huron, Iosco, Macomb, Midland, Oakland, Saginaw, Sanilac, Shiawassee, St. Clair, Tuscola, and Wayne counties.
(c) To be determined on that portion of the sample which passes the 1-inch sieve.
Appendix G

8.08.17 Obtain specimens of the shape and size specified for the Compression Set Test, a specimen of the largest obtainable size shall be used and the Compression Set shall not be more than 30 percent.

c. External Type Rubber Gaskets.—External rubber gaskets, mastic, and protective film for sealing culvert and sewer joints shall meet the requirements of ASTM C 877.

8.08.18 Metal End Sections.—Metal end sections shall be fabricated in accordance with the details shown on the plans and shall be furnished complete with coupling bands or hardware as indicated on the plans. The metallic coating on the end sections shall be the same as the metallic coating on the pipe, except zinc coated steel end sections may be used with aluminum coated steel pipe. Metal end sections shall conform to AASHTO M 39, where applicable.

8.08.19 Concrete End Sections.—Precast concrete end sections shall be constructed of concrete and reinforcement conforming to the requirements of AASHTO M 170 (ASTM C 76), Class II, as modified by details shown on the plans. Concrete for end sections made by the wet-cast method shall contain an entrained air content of 6.0 ± 2.0 percent. Concrete for end sections made by the dry-pack process shall contain a minimum of 658 pounds of cement per cubic yard and a liquid air entraining agent used at four times the dosage as needed for conventional slump concrete.

Connections to pipe culverts shall be by means of tongue and groove joints.

8.09 GEOTEXTILES

8.09.01 General Requirements.—Geotextiles shall be stored and handled carefully and in accordance with the manufacturer’s recommendations. Torn or punctured geotextiles shall not be used unless repaired to the satisfaction of the Engineer.

The minimum certifiable values will be based on a 95 percent confidence level and for directional properties the minimum principle direction will control.

8.09.02 Geotextiles for Pipe Wrap, Trench Linings, and Ditch Linings.—Geotextiles for pipe wrap, trench linings, and ditch linings, shall weigh at least 3.5 ounces per square yard in the condition of use and shall meet the requirements of AASHTO M 288, with the following modifications to the values listed in Table 1:

The range for Apparent Opening Size (A.O.S.) shall be 70-120 (U.S. Standard Sieve Size).

The minimum requirement for Coefficient of Permeability shall be 0.02 cm/sec.

The minimum requirement for Flow Rate shall be 60 gal/min/ft.

For pipe wrap where the backfill is being used around the pipe is

---

Granular Material Class II or better, knitted polyester geotextiles having an A.O.S. in the range of 20 to 100, weighing at least 3.0 ounces per square yard in the condition of use, and having a nominal Burst Strength of 100 psi when tested in accordance with ASTM D 3766, will be permitted as an alternate pipe wrap.

8.09.03 Geotextiles for Granular Blanket.—Geotextiles used in granular blankets shall meet the requirements for geotextiles used for trench and ditch linings with an additional requirement that the fabric shall have a rough surface to provide a high soil-to-fabric friction value.

8.09.04 Geotextile Liner for Ripp Rap.—The geotextile liner for areas to be riprapped shall weigh at least 4.5 ounces per square yard in the condition of use, shall contain a small amount of non-toxic lanolin as an ultraviolet inhibitor, and shall meet the requirements of AASHTO M 288, with the following modifications to the values listed in Table 1:

The minimum requirement for Tensile Strength shall be 200 lbs.
The minimum requirement for Burst Strength shall be 250 psi.
The range for Apparent Opening Size (A.O.S.) shall be 70-120 (U.S. Standard Sieve Size).

8.09.05 Three-Dimensional Mesh.—Three-dimensional mesh meeting the approval of the Engineer may be used as an alternate to open-graded aggregate used as a drainage layer. The Engineer’s approval of a three-dimensional mesh will be based on such characteristics as durability, drainability, strength, resistance to crushing, and thickness. The geotextile to be placed above and below the three-dimensional mesh may be heat-bonded or otherwise attached to the mesh.

8.09.06 Geotextile Silt Fence.—Geotextile silt fence shall be commercially produced product for that purpose which has the following properties:

<table>
<thead>
<tr>
<th>Property</th>
<th>Value</th>
<th>Unit</th>
<th>Test Method</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grab Tensile Strength</td>
<td>100</td>
<td>lbs</td>
<td>ASTM D 463</td>
</tr>
<tr>
<td>Trapezoid Tear Strength</td>
<td>45</td>
<td>lbs</td>
<td>ASTM D 453</td>
</tr>
<tr>
<td>Mullen Burst Strength</td>
<td>280</td>
<td>psi</td>
<td>ASTM D 378</td>
</tr>
<tr>
<td>U.V. Resistance (Strength</td>
<td>70</td>
<td>%</td>
<td>ASTM D 435</td>
</tr>
<tr>
<td>Retained</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Water Flow Rate</td>
<td>30</td>
<td>gal/min/ft</td>
<td>AASHTO M 28</td>
</tr>
<tr>
<td>Apparent Opening Size</td>
<td>0.600</td>
<td>mm</td>
<td>ASTM D 475</td>
</tr>
</tbody>
</table>

---
Appendix G. Hydrology

A. Determination of Surface Runoff

It is the designer’s responsibility to determine the most appropriate methods to calculate stormwater runoff volumes and flood peaks based on the best available data. Preferable approaches include statistical analysis of measure gauge station data, MDEQ’s modified TR-55 Method, or the Rational Method, and computer models (PC-SWMM, HEC-1, HEC-RAS). Other models and methods should be submitted to the MCPWO for approval before finalizing designs. The methods and calculations shall be submitted to the MCPWO with the Project Plans.

1. Gauged Locations – Statistical Analysis

A statistical analysis of a gauging station record provides the most accurate hydrograph and discharge-probability relationship for a watercourse. Such information may be available from the Michigan Department of Environmental Quality or the U.S. Geological Survey (USGS). The available USGS gauge station data is online at: http://waterdata.usgs.gov/mi/nwis.

Peak flow information may be calculated at a gauged site may be extrapolate upstream or downstream, or to an adjacent watershed with similar drainage characteristics. The assumption that flows are a function of drainage area may not be appropriate if basin characteristics change from the gauged site. Flow duration and flood frequency curves can also be extrapolated by dividing the flows by an index flood discharge such as bankfull discharge or the mean annual flood (recurrence interval of 2.33 years). Such transfer methods may also be useful to calibrate models. Caution should be taken when extrapolating data.

2. MDEQ Method - Computing Flood Discharges for Small Ungaged Watersheds

For watersheds up to 20 square miles, the suggested method for determining surface runoff is the latest version of the MDEQ modified TR-55 method spreadsheet “Computing Flood Discharges for Small Ungaged Watersheds” http://www.michigan.gov/deq/0,1607,7-135-3313_3684_3724-9324--00.html (see Appendix A for Sorrell, 2008). The conveyance computations should be based on the Type II rainfall distribution, 10-year, 24-hr storm. The method will require the following information:

- Drainage area
- Rainfall data
- Land use
- Soil type
- Time of concentration

3. Rational Method

The “Rational Method” may be used to determine surface runoff for small areas such as sizing swales, channels and culverts because the “Rational Method” assumes a uniform rainfall intensity. The limitations on the size of the drainage area can range from 20 to 200 acres depending on the complexity of the watershed. Larger sites should use a more appropriate method of determining flow.
The “Rational Method” is defined as follows:

\[ Q = C \times I \times A \]

Where,\n\[ Q = \text{peak runoff (ft}^3/\text{s)} \]
\[ C = \text{runoff coefficient} \]
\[ I = \text{average rainfall intensity (inches/ hour) for a storm with a duration equal to the time of concentration} \]
\[ A = \text{drainage area (acres)} \]

**Coefficient of Runoff**

A realistic coefficient of runoff will be used based upon the imperviousness of the contributing acreage. The runoff coefficient (and calculation, if applicable) must be included with plan submittal. The following runoff coefficients may be used:

<table>
<thead>
<tr>
<th>Type</th>
<th>Coefficient</th>
</tr>
</thead>
<tbody>
<tr>
<td>Residential</td>
<td>0.35</td>
</tr>
<tr>
<td>Commercial</td>
<td>0.55</td>
</tr>
<tr>
<td>Industrial</td>
<td>0.80</td>
</tr>
</tbody>
</table>

Alternatively, a composite runoff coefficient is calculated as follows:

\[
\bar{C} = \frac{\sum_{i=1}^{n} (A_i \times C_i)}{\sum_{i=1}^{n} A_i}
\]

Where, \( C_i = \) runoff coefficient for each sub-area
\( n = \) total number of sub-areas
\( A_i = \) drainage area in acres for each sub-area

**Table G-1 Minimum Acceptable Runoff Coefficients for use in Rational Method**

<table>
<thead>
<tr>
<th>Surface Type</th>
<th>Runoff Coefficient</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water surfaces</td>
<td>1.00</td>
</tr>
<tr>
<td>Roofs</td>
<td>0.95</td>
</tr>
<tr>
<td>Asphalt or concrete pavements</td>
<td>0.95</td>
</tr>
<tr>
<td>Gravel, brick, or macadam surfaces</td>
<td>0.85</td>
</tr>
<tr>
<td>Semi-pervious surfaces: lawns, parks, playgrounds</td>
<td></td>
</tr>
<tr>
<td>Hydrologic Soil Group A</td>
<td>0.15 0.20 0.25</td>
</tr>
<tr>
<td>Hydrologic Soil Group B</td>
<td>0.25 0.30 0.35</td>
</tr>
<tr>
<td>Hydrologic Soil Group C</td>
<td>0.30 0.35 0.40</td>
</tr>
<tr>
<td>Hydrologic Soil Group D</td>
<td>0.45 0.50 0.55</td>
</tr>
</tbody>
</table>

From pg. 315 of *Introduction to Hydrology, Fourth Edition*, an adjustment to the C-factor is made based on the design event due to antecedent moisture conditions as follows:

<table>
<thead>
<tr>
<th>Return Period (yrs)</th>
<th>Multiplier</th>
</tr>
</thead>
<tbody>
<tr>
<td>2 – 10</td>
<td>1.00</td>
</tr>
<tr>
<td>25</td>
<td>1.10</td>
</tr>
<tr>
<td>50</td>
<td>1.20</td>
</tr>
<tr>
<td>100</td>
<td>1.25</td>
</tr>
</tbody>
</table>

**Time of Concentration**

An initial minimum time of concentration of 20 minutes may be used on single-family residential subdivisions or a minimum of 15 minutes for medium density residential, commercial and industrial sites. The design engineer may also use a calculated time of concentration, if desired. The methodology and computations must be submitted for review. The time of concentration for unimproved, pre-development lands will be checked using the following formulas (DEQ, 1999):

\[
T_c = \frac{\text{Length}}{(V \times 3600)}
\]

Where:
- \(T_c\) = time of concentration
- Length = distance from most distant point in the watershed (feet)
- \(V\) = velocity (ft/sec)
- 3600 – converts seconds to hours

The velocity of the flood flow is determined from an empirical formula depending on the channel type:

- Small tributary: \(V = 2.1 \times S^{0.5}\)
- Waterway: \(V = 1.2 \times S^{0.5}\)
- Sheet Flow: \(V = 0.48 \times S^{0.5}\)

Where, \(S\) = slope (percent)

When more than one type of flow exists, the individual flows should be summed up to find the total time of concentration.

**Average Rainfall Intensity**

The average rainfall intensity (I) shall be determined from the following equations:

- 10-yr storm \(I = 175/(T_c + 25)\)
- 100-yr storm \(I = 275/(T_c + 25)\)
B. Mean Frequency Distributions for Storm Periods of 5 Minutes to 10 Days and Recurrence Intervals of 2 Months to 100 Years in Southeast Michigan (from Bulletin 71)

Table G-2 Rainfall (inches) for Given Recurrence Interval

<table>
<thead>
<tr>
<th>Duration</th>
<th>2-mth</th>
<th>3-mth</th>
<th>4-mth</th>
<th>5-mth</th>
<th>6-mth</th>
<th>9-mth</th>
<th>1-yr</th>
<th>2-yr</th>
<th>5-yr</th>
<th>10-yr</th>
<th>25-yr</th>
<th>50-yr</th>
<th>100-yr</th>
</tr>
</thead>
<tbody>
<tr>
<td>10-day</td>
<td>1.56</td>
<td>1.88</td>
<td>2.17</td>
<td>2.55</td>
<td>2.93</td>
<td>3.19</td>
<td>3.82</td>
<td>4.64</td>
<td>5.27</td>
<td>6.11</td>
<td>6.79</td>
<td>7.51</td>
<td></td>
</tr>
<tr>
<td>5-day</td>
<td>1.28</td>
<td>1.53</td>
<td>1.73</td>
<td>2.01</td>
<td>2.31</td>
<td>2.51</td>
<td>3.05</td>
<td>3.68</td>
<td>4.16</td>
<td>4.78</td>
<td>5.26</td>
<td>5.74</td>
<td></td>
</tr>
<tr>
<td>72-hr</td>
<td>1.18</td>
<td>1.38</td>
<td>1.56</td>
<td>0.81</td>
<td>2.08</td>
<td>2.26</td>
<td>2.74</td>
<td>3.34</td>
<td>3.76</td>
<td>4.31</td>
<td>4.74</td>
<td>5.16</td>
<td></td>
</tr>
<tr>
<td>48-hr</td>
<td>1.08</td>
<td>1.26</td>
<td>1.41</td>
<td>1.63</td>
<td>1.88</td>
<td>2.04</td>
<td>2.48</td>
<td>3.04</td>
<td>3.44</td>
<td>3.96</td>
<td>4.36</td>
<td>4.78</td>
<td></td>
</tr>
<tr>
<td>24-hr</td>
<td>1.03</td>
<td>1.20</td>
<td>1.31</td>
<td>1.51</td>
<td>1.72</td>
<td>1.87</td>
<td>2.26</td>
<td>2.75</td>
<td>3.13</td>
<td>3.60</td>
<td>3.98</td>
<td>4.36</td>
<td></td>
</tr>
<tr>
<td>18-hr</td>
<td>0.97</td>
<td>1.13</td>
<td>1.23</td>
<td>1.43</td>
<td>1.62</td>
<td>1.76</td>
<td>2.12</td>
<td>2.59</td>
<td>2.94</td>
<td>3.38</td>
<td>3.74</td>
<td>4.10</td>
<td></td>
</tr>
<tr>
<td>12-hr</td>
<td>0.90</td>
<td>1.04</td>
<td>1.14</td>
<td>1.32</td>
<td>1.50</td>
<td>1.63</td>
<td>1.97</td>
<td>2.39</td>
<td>2.72</td>
<td>3.13</td>
<td>3.46</td>
<td>3.79</td>
<td></td>
</tr>
<tr>
<td>6-hr</td>
<td>0.77</td>
<td>0.90</td>
<td>0.98</td>
<td>1.13</td>
<td>1.29</td>
<td>1.40</td>
<td>1.69</td>
<td>2.06</td>
<td>2.35</td>
<td>2.70</td>
<td>2.99</td>
<td>3.27</td>
<td></td>
</tr>
<tr>
<td>3-hr</td>
<td>0.66</td>
<td>0.77</td>
<td>0.84</td>
<td>0.97</td>
<td>1.10</td>
<td>1.20</td>
<td>1.45</td>
<td>1.76</td>
<td>2.00</td>
<td>2.30</td>
<td>2.55</td>
<td>2.79</td>
<td></td>
</tr>
<tr>
<td>2-hr</td>
<td>0.59</td>
<td>0.69</td>
<td>0.76</td>
<td>0.87</td>
<td>0.99</td>
<td>1.08</td>
<td>1.31</td>
<td>1.59</td>
<td>1.82</td>
<td>2.09</td>
<td>2.31</td>
<td>2.53</td>
<td></td>
</tr>
<tr>
<td>1-hr</td>
<td>0.48</td>
<td>0.56</td>
<td>0.62</td>
<td>0.71</td>
<td>0.81</td>
<td>0.88</td>
<td>1.06</td>
<td>1.29</td>
<td>1.47</td>
<td>1.69</td>
<td>1.87</td>
<td>2.05</td>
<td></td>
</tr>
<tr>
<td>30 min.</td>
<td>0.38</td>
<td>0.44</td>
<td>0.48</td>
<td>0.56</td>
<td>0.63</td>
<td>0.69</td>
<td>0.84</td>
<td>1.02</td>
<td>1.16</td>
<td>1.33</td>
<td>1.47</td>
<td>1.61</td>
<td></td>
</tr>
<tr>
<td>15 min.</td>
<td>0.28</td>
<td>0.32</td>
<td>0.35</td>
<td>0.41</td>
<td>0.46</td>
<td>0.50</td>
<td>0.61</td>
<td>0.74</td>
<td>0.85</td>
<td>0.97</td>
<td>1.07</td>
<td>1.18</td>
<td></td>
</tr>
<tr>
<td>10-min.</td>
<td>0.21</td>
<td>0.25</td>
<td>0.27</td>
<td>0.32</td>
<td>0.36</td>
<td>0.39</td>
<td>0.47</td>
<td>0.58</td>
<td>0.66</td>
<td>0.76</td>
<td>0.84</td>
<td>0.92</td>
<td></td>
</tr>
<tr>
<td>5-min.</td>
<td>0.12</td>
<td>0.14</td>
<td>0.15</td>
<td>0.18</td>
<td>0.20</td>
<td>0.22</td>
<td>0.27</td>
<td>0.33</td>
<td>0.38</td>
<td>0.43</td>
<td>0.48</td>
<td>0.52</td>
<td></td>
</tr>
</tbody>
</table>
Appendix H. Application Guidelines for Rolled Erosion Control Products

Guidelines on rolled erosion control products are provided to promote the use of appropriate materials to stabilize slopes and channel stabilization applications. It is the designer’s responsibility to select the appropriate materials based on local soil conditions and other site-specific variables. The County accepts no responsibility for the misapplication of the guidelines contained herein.

The following guidelines are excerpt with permission from the Erosion Control Technology Council (ECTC) Standard Specification for Rolled Erosion Control Products (RECPs). The following guidelines apply to work which consists of constructing temporary and permanent installations to control erosion, enhance vegetation establishment, establishment, and survivability on slopes, channels, and includes installing RECPs.

Rolled Erosion Control Products (RECPs) are defined by ECTC as a temporary degradable or long-term non-degradable material manufactured or fabricated into rolls designed to reduce soil erosion and assist in the growth, establishment and protection of vegetation. RECPs are designated as follows:

(a) **Mulch control netting.** A planar woven natural fiber or extruded geosynthetic mesh used as a temporary degradable rolled erosion control product to anchor loose fiber mulches.

(b) **Open weave textile.** A temporary degradable rolled erosion control product composed of processed natural or polymer yarns woven into a matrix, used to provide erosion control and facilitate vegetation establishment.

(c) **Erosion control blanket.** A temporary degradable rolled erosion control product composed of processed natural or polymer fibers mechanically, structurally or chemically bound together to form a continuous matrix to provide erosion control and facilitate vegetation establishment.

(d) **Turf reinforcement mat.** A rolled erosion control product composed of non-degradable synthetic fibers, filaments, nets, wire mesh and/or other elements, processed into a permanent, three-dimensional matrix of sufficient thickness. TRMs, which may be supplemented with degradable components, are designed to impart immediate erosion protection, enhance vegetation establishment and provide long-term functionality by permanently reinforcing vegetation during and after maturation. Note: TRMs are typically used in hydraulic applications, such as high flow ditches and channels, steep slopes, stream banks, and shorelines, where erosive forces may exceed the limits of natural, unreinforced vegetation or in areas where limited vegetation establishment is anticipated.

**Temporary Rolled Erosion Control Products**

For applications where natural vegetation alone will provide sufficient permanent erosion protection, furnish a temporary rolled erosion control product with the necessary longevity and performance properties to effectively control erosion and assist in the establishment of vegetation under the anticipated immediate site conditions. The temporary rolled erosion control product shall conform to one of the following specifications and corresponding properties found in Table H-1A to H-1C.
Permanent Rolled Erosion Control Products
For applications where natural vegetation alone will not sustain expected flow conditions and/or provide sufficient long-term erosion protection, furnish a permanent rolled erosion control product with the necessary performance properties to effectively control erosion and reinforce vegetation under the expected long-term site conditions. The permanent erosion control product shall conform to one of the specifications and corresponding properties found in Table H-2.

The Erosion Control Technology Council (ECTC) is a non-profit organization. Its mission is to develop performance standards, uniform testing procedures, and guidance on the application and installation of rolled erosion control products (RECPs). The ECTC promotes the use of erosion control mats and blankets through industry leadership and education in the hope of making a broad contribution to the science of erosion control and environmental preservation. More information about ECTC can be obtained from their website http://www.ectc.org.

Table H-1A ECTC Standard Specification for Temporary Rolled Erosion Control Products
For use where natural vegetation alone will provide permanent erosion protection.

<table>
<thead>
<tr>
<th>Type</th>
<th>Product Description</th>
<th>Material Composition</th>
<th>Slope Applications*</th>
<th>Channel Applications*</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Maximum Gradient C Factor(^{2,3}) Max. Shear Stress(^{3,4,6}) Minimum Tensile Strength(^1)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.A</td>
<td>Mulch Control Nets</td>
<td>A photodegradable synthetic mesh or woven biodegradable natural fiber netting.</td>
<td>≤0.10 @ 5:1</td>
<td>0.25 lbs/ft(^2) (12 Pa)</td>
</tr>
<tr>
<td>1.B</td>
<td>Netless Rolled Erosion Control Blankets</td>
<td>Natural and/or polymer fibers mechanically interlocked and/or chemically adhered together to form a RECP.</td>
<td>≤0.10 @ 4:1</td>
<td>0.5 lbs/ft(^2) (24 Pa)</td>
</tr>
<tr>
<td>1.C</td>
<td>Single-net Erosion Control Blankets &amp; Open Weave Textiles</td>
<td>Processed degradable natural and/or polymer fibers mechanically bound together by a single rapidly degrading, synthetic or natural fiber netting or an open weave textile of processed rapidly degrading natural or polymer yarns or twines woven into a continuous matrix.</td>
<td>≤0.15 @ 3:1</td>
<td>1.5 lbs/ft(^2) (72 Pa)</td>
</tr>
<tr>
<td>1.D</td>
<td>Double-net Erosion Control Blankets</td>
<td>Processed degradable natural and/or polymer fibers mechanically bound together between two rapidly degrading, synthetic or natural fiber nettings.</td>
<td>≤0.20 @ 2:1</td>
<td>1.75 lbs/ft(^2) (84 Pa)</td>
</tr>
</tbody>
</table>
Appendix H

Macomb County Public Works Office
Procedures and Design Standards

"C" factor and shear stress for Types 1.A., 2.A. and 3.A mulch control nettings must be obtained with netting used in conjunction with pre-applied mulch material.

1 Minimum Average Roll Values, Machine direction using ECTC Mod. ASTM D 5035.

2 "C" Factor calculated as ratio of soil loss from RECP protected slope (tested at specified or greater gradient, h:v) to ratio of soil loss from unprotected (control) plot in large-scale testing. These performance test values should be supported by periodic bench scale testing under similar test conditions using Erosion Control Technology Council (ECTC) Test Method # 2.

3 Required minimum shear stress RECP (unvegetated) can sustain without physical damage or excess erosion (> 12.7 mm (0.5 in) soil loss) during a 30-minute flow event in large-scale testing. These performance test values should be supported by periodic bench scale testing under similar test conditions and failure criteria using Erosion Control Technology Council (ECTC) Test Method #3.

4 The permissible shear stress levels established for each performance category are based on historical experience with products characterized by Manning's roughness coefficients in the range of 0.01 - 0.05.

5 Acceptable large-scale test methods may include ASTM D 6459, Erosion Control Technology Council (ECTC) Test Method # 2, or other independent testing deemed acceptable by the engineer.

6 Per the engineer’s discretion. Recommended acceptable large-scale testing protocol may include ASTM D 6460, Erosion Control Technology Council (ECTC) Test Method #3 or other independent testing deemed acceptable by the engineer.

Table H-1B ECTC Standard Specification for Temporary Rolled Erosion Control Products

For use where natural vegetation alone will provide permanent erosion protection.

<table>
<thead>
<tr>
<th>Type</th>
<th>Product Description</th>
<th>Material Composition</th>
<th>Maximum Gradient</th>
<th>Channel Applications*</th>
<th>Slope Applications*</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.A</td>
<td>Mulch Control Nets</td>
<td>A photodegradable synthetic mesh or woven biodegradable natural fiber netting</td>
<td>5:1 (H:V)</td>
<td>≤0.10 @ 5:1</td>
<td>25 lbs/ft² (12 Pa)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>5 lbs/ft</td>
</tr>
<tr>
<td>2.B</td>
<td>Netless Rolled</td>
<td>Natural and/or polymer fibers mechanically interlocked and/or chemically adhered together to form a RECP.</td>
<td>4:1 (H:V)</td>
<td>≤0.10 @ 4:1</td>
<td>5 lbs/ft² (24 Pa)</td>
</tr>
<tr>
<td>2.C</td>
<td>Single-net</td>
<td>Processed degradable natural and/or polymer fibers mechanically bound together by a single rapidly degrading, synthetic or natural fiber netting or an open weave textile of processed rapidly degrading natural or polymer yarns or twines woven into a continuous matrix.</td>
<td>3:1 (H:V)</td>
<td>≤0.15 @ 3:1</td>
<td>1.5 lbs/ft² (72 Pa)</td>
</tr>
<tr>
<td>2.D</td>
<td>Double-net</td>
<td>Processed degradable natural and/or polymer fibers mechanically bound together between two rapidly degrading, synthetic or natural fiber nettings.</td>
<td>2:1 (H:V)</td>
<td>≤0.20 @ 2:1</td>
<td>1.75 lbs/ft² (84 Pa)</td>
</tr>
</tbody>
</table>

Minimum Tensile Strength:

- 5 lbs/ft (0.073 kN/m)
- 5 lbs/ft² (0.073 kN/m)
- 50 lbs/ft (0.73 kN/m)
## Table H-1C ECTC Standard Specification for Temporary Rolled Erosion Control Products

For use where natural vegetation alone will provide permanent erosion protection.

<table>
<thead>
<tr>
<th>Type</th>
<th>Product Description</th>
<th>Material Composition</th>
<th>Maximum Gradient</th>
<th>C Factor*</th>
<th>Max. Shear Stress**</th>
<th>Minimum Tensile Strength*</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.A</td>
<td>Mulch Control Nets</td>
<td>A slow degrading synthetic mesh or woven natural fiber netting.</td>
<td>5:1 (H:V)</td>
<td>≤0.10 @ 5:1</td>
<td>0.25 lbs/ft²</td>
<td>25 lbs/ft² (0.36 kN/m)</td>
</tr>
<tr>
<td>3.B</td>
<td>Erosion Control Blankets &amp; Open Weave Textiles</td>
<td>An erosion control blanket composed of processed slow degrading natural or polymer fibers mechanically bound together between two slow degrading synthetic or natural fiber nettings to form a continuous matrix or an open weave textile composed of processed slow degrading natural or polymer yarns or twines woven into a continuous matrix.</td>
<td>1.5:1 (H:V)</td>
<td>≤0.25 @ 1.5:1</td>
<td>2.00 lbs/ft² (96 Pa)</td>
<td>100 lbs/ft² (1.45 kN/m)</td>
</tr>
<tr>
<td>4</td>
<td>Erosion Control Blankets &amp; Open Weave Textiles</td>
<td>An erosion control blanket composed of processed slow degrading natural or polymer fibers mechanically bound together between two slow degrading synthetic or natural fiber nettings to form a continuous matrix or an open weave textile composed of processed slow degrading natural or polymer yarns or twines woven into a continuous matrix.</td>
<td>1:1 (H:V)</td>
<td>≤0.25 @ 1:1</td>
<td>2.25 lbs/ft² (108 Pa)</td>
<td>125 lbs/ft² (1.82 kN/m)</td>
</tr>
</tbody>
</table>
Table H-2 ECTC Standard Specification for Permanent Rolled Erosion Control Products
For applications where vegetation alone will not sustain expected flow conditions and/or provide sufficient long-term erosion protection.

<table>
<thead>
<tr>
<th>Type</th>
<th>Product Description</th>
<th>Material Composition</th>
<th>Slope Applications*</th>
<th>Channel Applications*</th>
<th>Minimum Tensile Strength²,³</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Maximum Gradient</td>
<td>Maximum Shear Stress⁴,⁵</td>
<td></td>
</tr>
<tr>
<td>5.A</td>
<td>Turf Reinforcement Mat</td>
<td>Turf Reinforcement Mat (TRM) – A rolled erosion control product composed of non-degradable synthetic fibers, filaments, nets, wire mesh and/or other elements, processed into a permanent, three-dimensional matrix of sufficient thickness. TRMs, which may be supplemented with degradable components, are designed to impart immediate erosion protection, enhance vegetation establishment and provide long-term functionality by permanently reinforcing vegetation during and after maturation. Note: TRMs are typically used in hydraulic applications, such as high flow ditches and channels, steep slopes, stream banks, and shorelines, where erosive forces may exceed the limits of natural, unreinforced vegetation or in areas where limited vegetation establishment is anticipated.</td>
<td>5:1 (H:V)</td>
<td>6.0 lbs/ft² (288 Pa)</td>
<td>125 lbs/ft (1.82 kN/m)</td>
</tr>
<tr>
<td>5.B</td>
<td>Turf Reinforcement Mat</td>
<td>Turf Reinforcement Mat</td>
<td>5:1 (H:V)</td>
<td>8.0 lbs/ft² (384 Pa)</td>
<td>150 lbs/ft (2.19 kN/m)</td>
</tr>
<tr>
<td>5.C</td>
<td>Turf Reinforcement Mat</td>
<td>Turf Reinforcement Mat</td>
<td>5:1 (H:V)</td>
<td>10.0 lbs/ft² (480 Pa)</td>
<td>175 lbs/ft (2.55 kN/m)</td>
</tr>
</tbody>
</table>

¹ For TRMs containing degradable components, all property values must be obtained on the non-degradable portion of the matting alone.
² Minimum Average Roll Values, machine direction only for tensile strength determination using ASTM D 6818 (Supercedes Mod. ASTM D 5035 for RECPs)
³ Field conditions with high loading and/or high survivability requirements may warrant the use of a TRM with a tensile strength of 44 kN/m (3,000 lb/ft) or greater.
⁴ Required minimum shear stress TRM (fully vegetated) can sustain without physical damage or excess erosion (> 12.7 mm (0.5 in.) soil loss) during a 30-minute flow event in large scale testing. These performance test values should be supported by periodic bench scale testing under similar test conditions.
and failure criteria using Erosion Control Technology Council (ECTC) Test Method #3.

5 Acceptable large-scale testing protocol may include ASTM D 6460, Erosion Control Technology Council (ECTC) Test Method #3, or other independent testing deemed acceptable by the engineer.

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Installation of Rolled Erosion Control Products (RECPs)

For the proper installation of RECPs follow: “Installation Guide for Rolled Erosion Control Products (RECPs) Including Mulch Control Nettings (MCNs), Open Weave Textiles (OWTs), Erosion Control Blankets (ECBs), and Turf Reinforcement Mats (TRMs)”, available on the ECTC website at http://www.ectc.org/specifications.asp#table1.

ECTC also provides a visual educational tool, the “RECP Installation DVD” which gives step-by-step instruction on correct installation procedures. It includes information on site preparation; RECP placement; RECP stapling/staking; anchor trench details; and shingling of RECPs. Each of the three installation sections—slope, shoreline, and channel—is approximately eight minutes in length and is ideal for first-time installers or seasoned professionals. Available on DVD by request or by download on the ECTC website at http://www.ectc.org/DVD.asp.
Appendix I. Certification Form for Adding Lands to a Drainage District

SAMPLE CERTIFICATION FORM
FOR ADDING LANDS TO A DRAINAGE DISTRICT
TO BE RETYPED ON ENGINEERING FIRM’S LETTERHEAD
USING THE FOLLOWING LANGUAGE.

Date

Candice S. Miller
Macomb County Public Works Commissioner
115 South Groesbeck, PO Box 806
Mt. Clemens, MI  48046-0806

Attention: _________________________ (Appropriate Engineer)

RE:    ENGINEER’S CERTIFICATION
       (Insert name & location of proposed development)
       (Insert name of drainage district)
       (Insert description of lands to be added to drainage district)

Dear Commissioner Miller:

This is to certify (Insert statement #1 or #2 below, as appropriate) and that there is sufficient capacity in the (insert drain name) for it to serve as an adequate outlet for these lands without detriment or diminution of the drainage services which the outlet presently provides.

_________________________________________________________

Engineer’s signature

Registration No:_______________________

Statement #1 –  …the lands to be added naturally drain to the existing drain…..

Statement #2 -    …the existing drain is the only reasonable outlet for the lands to be added…..
Appendix J. Stormwater Credits

Stormwater management is most effective when integrated into the site design so that rainfall is stored, infiltrated, or treated near where it falls. The developer may choose to preserve natural site amenities during development or construct the project in such a way that preserves the natural hydrology or reduces environmental impacts. Innovative design features are encouraged and may be rewarded as credits. Stormwater credits reduce costs by lowering the requirements for water quality treatment or channel protection detention volume. Credits are documented in the preliminary plan stage and then verified with the final grading plan and as-built certification. The use of credits is subject to review and approval by MCPWO and the local community. The amount of credit may be adjusted by MCPWO based on site conditions and local considerations. Table 1 summarizes the different types of credits available and how credits may be determined.

The following general conditions apply to determining stormwater credits:

1. The use of stormwater credits is strictly voluntary.

2. The water quality treatment volume may be reduced for sites that do not have detention basins. Stormwater credits that reduce the water quality treatment volume are to be calculated using Schueler’s Short Cut Method (Part 5, Section H.1).

3. The channel protection volume may be reduced or eliminated through the use of stormwater credits for sites with extended detention basins. Reductions in the volume of the channel protection stage of the detention basin are determined using:

4. \( CPv = A \times \text{multiplier (from Table J-2, Example 3).} \)

5. The availability of some credits depends on local road and drainage design criteria and other local requirements.

6. Multiple credits may be used on a site, but only one credit may be used on any physical area of the site.
Table J-1: Summary of Available Stormwater Credits

<table>
<thead>
<tr>
<th>Credit</th>
<th>WQ Volume Reduction (no ED basin)</th>
<th>CP Volume Reduction</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Impervious Cover Reduction</td>
<td>Reduce I</td>
<td>Reduce % imp.</td>
</tr>
<tr>
<td>2. Redevelopment</td>
<td>Based on previous % imperviousness (Ex. 1)</td>
<td>Not required if not pre-existing</td>
</tr>
<tr>
<td>3. Waterway Buffer/Filter Strip</td>
<td>Subtract area draining to buffer/filter strip via sheetflow from WQv calcs (Ex. 2)</td>
<td>Adjust CN for area draining to buffer/filter strip via sheetflow</td>
</tr>
<tr>
<td>4. Environmentally-Sensitive Development</td>
<td>Not required</td>
<td>Adjust CN and Tc (Ex. 3)</td>
</tr>
<tr>
<td>5. Open Drainage Swale</td>
<td>Subtract area draining to swale from WQv calcs</td>
<td>Adjust Tc</td>
</tr>
<tr>
<td>6. Conservation of Natural Areas</td>
<td>Subtract preserved natural areas from WQv calcs</td>
<td>Adjust CN</td>
</tr>
<tr>
<td>7. Reforestation</td>
<td>Adjust drainage area</td>
<td>Adjust CN</td>
</tr>
<tr>
<td>8. Impervious Surface Disconnection</td>
<td>Varies</td>
<td>Adjust Tc</td>
</tr>
<tr>
<td>9. Permeable Pavers</td>
<td>Adjust drainage area</td>
<td>N/A</td>
</tr>
<tr>
<td>10. Soils Preservation</td>
<td>Adjust drainage area</td>
<td>Adjust CN</td>
</tr>
<tr>
<td>11. Green Rooftop</td>
<td>Not required</td>
<td>Adjust CN</td>
</tr>
</tbody>
</table>

1. Impervious Cover Reduction Credit

Reducing the amount of impervious cover should be a primary consideration in reducing hydrologic impacts although Impervious Cover Credits may be limited due to local codes.

WQ CREDIT: Reduce I, thereby reducing Rv and water quality treatment volume.
CP CREDIT: Reduce % imperviousness, thereby reducing CP volume.

2. Redevelopment Credit

The redevelopment of existing developments is encouraged over the construction of new developments. The credits apply to all re-development sites and include:

WQ CREDIT: The water quality credits are based on the pre-developed impervious cover. The site is exempt from the water quality criteria if the percentage of impervious cover is reduced by 25% or more from the existing condition.

Example J-1: Water Quality Volume ($W_{Qv}$) Redevelopment Credit

\[ C = I_p \times W_{Qv} \]

Where:
\[ I_p = \text{Predeveloped % Impervious Cover} \]

The credit can then be subtracted from the water quality volume.

CP CREDIT: Extended detention of the CP Volume is not required for redevelopment sites if not previously provided.
OFP CRITERIA: May be waived at the discretion of the Engineer based on the condition of receiving waters and location within the watershed.

3. Waterway Buffer/Filter Strip Credit
This credit encourages riparian buffers along streams, shorelines, and wetlands and filter strips to treat site runoff. To receive the credit, the buffer must meet the following criteria:

a. The minimum undisturbed buffer or filter strip width shall be 50 feet. See Part 5 for landscaping guidelines.

b. The maximum contributing length to the buffer or filter strip shall be 150 feet for residential developments and 75 feet for commercial/industrial developments.

c. If the contributing overland flow path is greater than 50 feet or the slope is greater than 3 percent, a level spreader shall be used to establish sheet flow.

d. The buffer shall be preserved in a conservation easement or similar protective mechanism.

WQ CREDIT: Subtract area draining to the buffer by sheetflow from the site area during the WQ volume calculations.

<table>
<thead>
<tr>
<th>Example J-2: Water Quality Volume (WQv) Buffer/Filter Strip Credit</th>
</tr>
</thead>
<tbody>
<tr>
<td>For a 30 acre site with 35% impervious cover:</td>
</tr>
<tr>
<td>Rv = 0.05 + 0.009(I), where I = site percent impervious</td>
</tr>
<tr>
<td>Rv = 0.05 + 0.009(35) = 0.365</td>
</tr>
<tr>
<td>WQV = P x (1 in/12 ft) x Rv x A x (43,560 ft²/ac), where P = 1.0” and A = site area (ac)</td>
</tr>
<tr>
<td>WQV (ft³) = 3,630 x Rv x A (in acres) = 3,630 x 0.365 x 30 = 39,749 ft³ before credit</td>
</tr>
<tr>
<td>5 acres of the site drains to a native vegetative buffer by sheetflow.</td>
</tr>
<tr>
<td>WQV = 3,630 x 0.365 x 25 = 33,124 ft³ after credit</td>
</tr>
<tr>
<td>For a credit of 6,625 ft³ (16.7% volume reduction).</td>
</tr>
</tbody>
</table>

CP CREDIT: Adjust the CN of the area draining to the buffer to “woods in good condition”.

4. Environmentally-Sensitive Development Credit
This credit applies to low density development designs that incorporate Better Site Design features. The credit exempts the site from water quality requirements and can also incorporate reductions in required volumes for channel protection. A developer may be exempt from the water quality criteria if all of the following conditions are met:

a. At least 40% of the site is preserved as open space.

b. At least 75% of the roadways are drained with open swales rather than enclosed storm sewers.

c. The total site imperviousness area is less than 15%.

d. Rooftops and other impervious surfaces are disconnected from enclosed storm sewers.

e. Vegetative buffers are established or maintained along wetlands, ponds, perennial and intermittent streams, or county drains.

f. At least 25% of the site is protected under a conservation easement or similar protection is provided in the master deed restrictions.
WQ CREDIT: Total exemption from water quality criteria.
CP CREDIT: Adjustment in calculation of runoff curve number and Tc to reduce CPv.

Table J-2 Adjustments in CP Volume Based on NRCS Runoff Curve Number

<table>
<thead>
<tr>
<th>Tc = 0.25 hr</th>
<th>Tc = 0.33 hr</th>
<th>Tc = 0.5 hr</th>
<th>Tc = 0.66 hr</th>
<th>Tc = 0.75 hr</th>
<th>Tc = 1.0 hr</th>
</tr>
</thead>
<tbody>
<tr>
<td>70</td>
<td>799</td>
<td>70</td>
<td>792</td>
<td>70</td>
<td>776</td>
</tr>
<tr>
<td>75</td>
<td>1,206</td>
<td>75</td>
<td>1,186</td>
<td>75</td>
<td>1,175</td>
</tr>
<tr>
<td>80</td>
<td>1,708</td>
<td>80</td>
<td>1,692</td>
<td>80</td>
<td>1,672</td>
</tr>
<tr>
<td>85</td>
<td>2,334</td>
<td>85</td>
<td>2,314</td>
<td>85</td>
<td>2,288</td>
</tr>
<tr>
<td>90</td>
<td>3,109</td>
<td>90</td>
<td>3,090</td>
<td>90</td>
<td>3,048</td>
</tr>
<tr>
<td>95</td>
<td>4,109</td>
<td>95</td>
<td>4,084</td>
<td>95</td>
<td>4,025</td>
</tr>
<tr>
<td>98</td>
<td>4,843</td>
<td>98</td>
<td>4,812</td>
<td>98</td>
<td>4,753</td>
</tr>
</tbody>
</table>

Example J-3: Channel Protection Volume NRCS Runoff Curve Number Adjustment

The curve number may be adjusted downward based on reductions in % site imperviousness and preservation of existing soils, open space, and vegetative buffers. The channel protection volume (CPv) can then be determined in cubic feet per acre from the Table J-2. The CPv can be adjusted by interpolation or extrapolation if an adjustment in Tc is appropriate based in open swales.

1. Determine weighted CN for a 10 acre commercial site, HSG B prior to construction (use C soils for post-construction). The Tc = 0.25 hr and CN = 94 before credits.

   **Weighted CN**

   - Impervious areas (roofs, parking, etc.), 98 x 5 ac. = 490
   - Lawn (topsoil stripped, C soils), 74 x 2 ac. = 148
   - Woods and grass (undisturbed, B soils), 58 x 2 ac. = 116
   - Vegetative buffer and filter strip (B soils), 62 x 1 ac. = 62
   - Total, 816

   Weighted CN = 816/10 acres = 81.6 (use 82)

2. Adjust Tc from 0.25 hr to 0.33 hr based on swale drainage

   Determine V in 890 ft of swale, V = 0.75 ft/s from Manning’s

   \[ Tc = \frac{L}{3,600 \times V} = \frac{890}{3,600 \times 0.75} = 0.33 \text{ hr} \]

3. Determine channel protection storage volume reduction for environmentally-sensitive site development.

   \[ \text{CPv} = A \times \text{multiplier} = 10 \text{ ac} \times 3,909 \text{ ft}^3/\text{ac} = 39,090 \text{ ft}^3 \text{ before credits} \]

   \[ \text{CPv} = 10 \text{ ac} \times 1,941 \text{ ft}^3/\text{ac} = 19,941 \text{ ft}^3 \text{ before credits (49% storage volume reduction)} \]

5. **Open Drainage Swale Credit**

   The open channel credit provides an incentive to design new developments with open channel roads, rather than curb and gutter. This credit shall not conflict with or supercede any other county standards. To receive credit, the following criteria must be met:

   a. The credit is applied to moderate to low density residential land uses (maximum density of 3 dwelling units/acre).
b. The maximum flow velocity for runoff from the one-inch rainfall shall be less than or equal to 1.0 fps

c. The bottom width shall be 6 feet maximum.

d. The side slopes shall be 3:1 or flatter.

e. The channel slope shall be less than or equal to 3.0%.

f. Credit is documented at a concept plan stage and verified with the final grading plan and with an as-built certification.

g. The length of the grass channel shall be equal to the roadway length treated by it.

**WQ CREDIT:** Subtract area draining to swale from the site area during the WQv calculations.

**CR CREDIT:** Possible adjustments in time of concentration and reduced CPv.

### 6. Conservation of Natural Areas Credit

This credit rewards the preservation of natural vegetation areas, native soils, and critical resource areas on the site. The pre-development hydrology and water quality can be maintained by conserving natural areas on development sites. Examples of natural area conservation include:

- Retaining forested areas.
- Undisturbed native high infiltration soils (Hydrologic Soils Groups A or B).
- Other lands in permanent protective easements (wetlands, floodplains, steep slopes).

**WQ CREDIT:** Subtract preserved natural areas from the site area during the WQv calculations.

**CP CREDIT:** Adjustment in calculation of curve number (Example J-2) and reduced CPv.

### 7. Reforestation Credit

This credit is similar to the conservation of natural areas credit except that it rewards active reforestation and afforestation rather than preservation of existing forests. Reforestation involves planting trees to compensate for tree clearing during site construction. Afforestation supplements existing trees with a net increase in canopy cover. In order to receive credit, the following criteria must be met:

a. Tree species used for afforestation or reforestation shall be native to the municipality and selected from a list of approved species established by local ordinance or the Macomb Conservation District.

b. Reforestation shall be guaranteed with a performance bond, letter of credit, or similar surety measure. The bond shall be returned after two successful growing seasons.

c. Plantings shall be from nursery stock, at a minimum of 1.5" diameter at breast height.

**WQ CREDIT:** Subtract half of the reforestation areas and 1.5 times the afforestation areas from the site area during the WQ volume calculations.

**CP CREDIT:** May reduce calculated curve number for reforestation/afforestation areas (Example J-2) and reduced CPv.
8. **Impervious Surface Disconnection Credit**

This credit is applied to credit disconnection of other impervious surfaces (such as rooftops, streets, and parking lots) by encouraging drainage to overland treatment such as swales or filter strips. Disconnections must meet the following criteria in order to receive the credit:

a. Disconnection must ensure no basement seepage by discharging to positive drainage areas at least 10 feet from buildings.

b. Runoff cannot come from a designated hotspot.

c. The entire vegetative "disconnection" shall be on a slope less than or equal to 3.0%.

d. The disconnection must drain continuously through a vegetated channel, swale, or through a filter strip to the property line or STP.

e. Downspouts must be at least 10 feet away from the nearest impervious surface to discourage "re-connections."

f. Disconnections are encouraged on relatively permeable soils (HSGs A and B). In less permeable soils (HSGs C and D), dry wells, french drains, or other temporary underground storage devices may be needed to compensate for a poor infiltration capability. Level spreaders may be required to create sheet flow.

g. For those rooftops draining directly to a stream buffer, one can only use either the rooftop disconnection credit or the stream buffer credit, not both.

h. The maximum contributing impervious flow path length shall be 75 feet.

i. The length of the "disconnection" must be equal to or greater than the contributing length.

j. The entire vegetative "disconnection" shall be on a slope less than or equal to 3.0%.

k. The surface imperviousness area to any one discharge location cannot exceed 1,000 ft$^2$.

**WQ CREDIT:** Reduction in WQ volume based on the amount of site disconnected, the types of infiltration and conveyance practices, and the discretion of the county engineer.

**CP CREDIT:** Possible adjustments in time of concentration and reduced CPv.

9. **Permeable Pavers Credit**

Permeable pavers refer to a broad category of products including: grass pavers, porous concrete and asphalt, and permeable brick pavers that enable some infiltration into the pavement sub-base. Such products can be used in courtyards, sidewalks, turn-arounds, driveways, overflow parking areas, etc. to reduce impervious surface area. Appropriate products and adequate sub-base materials need to be specified in areas with poorly drained soils. Stable conveyance of overflow drainage may still be required. The following criteria must be met to receive credit for permeable pavers:

a. Acceptable products must achieve a minimum storage, infiltration, or evaporation of the first 0.25 inches from rainfall.

b. Paver applications require adequate sub-base underneath the product to provide stability and infiltration. Areas with C and D HSG soils will require additional sub-base per manufacturer’s specifications.
WQ CREDIT: Subtract one half of the permeable pavement area from the site area during the WQ volume calculations.

10. **Soils Preservation Credit**
Infiltration dramatically decreases when existing vegetation and topsoil is stripped from a site and subsoils are compacted. The amount of runoff from small and moderate events can be reduced by preserving existing soils. Credits will be provided for undisturbed areas. Credits are documented in the preliminary plan stage and then verified with the final grading plan and as-built certification.

WQ CREDIT: Subtract undisturbed area from the site area during the WQ volume calculations.
CP CREDIT: Reduction in CN and CP, (Example J-2).

11. **Green Rooftop Credit**
Green rooftops are an emerging technology that establishes a thin planting media on flat roof surfaces or directs runoff to containerized rooftop gardens. Green roofs may utilize several layers that may include: a waterproof membrane, insulation, protection layer, drainage layer, filter mat, planting medium, and vegetation. Internal drainage systems direct overflow and reduce ponding. Although this practice will not capture or treat all of the WQ volume, total exemption is allowed because it is an innovative and effective BMP.

WQ CREDIT: Total exemption from water quality criteria.
CP CREDIT: Reduction in CN and CP, (Example J-2).
### Appendix K. Hydrologic Soils Groups in Macomb County

#### Table K-1: Hydrologic Soils Groups and Soil Erosivity ‘K’

<table>
<thead>
<tr>
<th>Name</th>
<th>MUS YM</th>
<th>HSG</th>
<th>K Factor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Au Gres sand</td>
<td>AsB</td>
<td>B</td>
<td>0.15</td>
</tr>
<tr>
<td>Au Gres sand, loamy substratum</td>
<td>AuB</td>
<td>B</td>
<td>0.15</td>
</tr>
<tr>
<td>Blount L</td>
<td>BlA</td>
<td>C</td>
<td>0.43</td>
</tr>
<tr>
<td>Blount L</td>
<td>BlB</td>
<td>C</td>
<td>0.43</td>
</tr>
<tr>
<td>Boyer LS, 0-2% slopes</td>
<td>BrA</td>
<td>B</td>
<td>0.17</td>
</tr>
<tr>
<td>Boyer LS, 2-6% slopes</td>
<td>BrB</td>
<td>B</td>
<td>0.17</td>
</tr>
<tr>
<td>Boyer LS, 6-12% slopes</td>
<td>BrC</td>
<td>B</td>
<td>0.17</td>
</tr>
<tr>
<td>Boyer SL, 0-2% slopes</td>
<td>BsA</td>
<td>B</td>
<td>0.24</td>
</tr>
<tr>
<td>Boyer SL, 2-6% slopes</td>
<td>BsB</td>
<td>B</td>
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</tr>
<tr>
<td>Boyer SL, 6-12% slopes</td>
<td>BsC</td>
<td>B</td>
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</tr>
<tr>
<td>Boyer SL, 12-18% slopes</td>
<td>BsD</td>
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<td>BsE</td>
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<tr>
<td>Boyer gravelly LS</td>
<td>BvB</td>
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<td>Brevort-Selfridge complex</td>
<td>Bx</td>
<td>B</td>
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<tr>
<td>Celina loam, 0-2% slopes</td>
<td>CeA</td>
<td>C</td>
<td>N/A</td>
</tr>
<tr>
<td>Celina loam, 2-6% slopes</td>
<td>CeB</td>
<td>C</td>
<td>N/A</td>
</tr>
<tr>
<td>Ceresco fine SL</td>
<td>Cf</td>
<td>B</td>
<td>0.20</td>
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<td>Cohoctah fine SL</td>
<td>Cm</td>
<td>D/B</td>
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<td>Conover loam, 0-2% slopes</td>
<td>CvA</td>
<td>C</td>
<td>0.28</td>
</tr>
<tr>
<td>Conover loam, 2-6% slopes</td>
<td>CvB</td>
<td>C</td>
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<tr>
<td>Corunna SL</td>
<td>Cx</td>
<td>D</td>
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<td>Del Ray loam, 0-2% slopes</td>
<td>DIA</td>
<td>C</td>
<td>0.43</td>
</tr>
<tr>
<td>Del Ray loam, 2-6% slopes</td>
<td>DIB</td>
<td>C</td>
<td>0.43</td>
</tr>
<tr>
<td>Del Ray-Metamora SL, 0-2% slopes</td>
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<td>C</td>
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</tr>
<tr>
<td>Del Ray-Metamora SL, 2-6% slopes</td>
<td>DmB</td>
<td>C</td>
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<td>Dryden SL, 0-2% slopes</td>
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<td>Dryden SL, 2-6% slopes</td>
<td>DrB</td>
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<tr>
<td>Edwards muck</td>
<td>Ed</td>
<td>D/B</td>
<td>N/A</td>
</tr>
<tr>
<td>Ensley-Parkhill complex</td>
<td>Ep</td>
<td>D/B</td>
<td>N/A</td>
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<td>D/B</td>
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<td>Gf</td>
<td>D/B</td>
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<td>Gm</td>
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<td>Hy</td>
<td>D/C</td>
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<tr>
<td>Lamson FSL</td>
<td>La</td>
<td>D/B</td>
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### Table K-1: Hydrologic Soils Groups and Soil Erosivity ‘K’

<table>
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<th>Name</th>
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<th>HSG</th>
<th>K Factor</th>
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<td>B</td>
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<tr>
<td>Lapeer, SL, 6-12% slopes</td>
<td>LeC</td>
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<tr>
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<td>LeD</td>
<td>B</td>
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<tr>
<td>Lapeer, SL, 18-25% slopes</td>
<td>LeE</td>
<td>B</td>
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<tr>
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<td>Lh</td>
<td>D/B</td>
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<tr>
<td>Leawee-Selfridge complex</td>
<td>Lk</td>
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<td>Linwood muck</td>
<td>Lm</td>
<td>D/A</td>
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<td>N/A</td>
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<td>Locke SL, 0-2% slopes</td>
<td>LoA</td>
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<tr>
<td>Locke SL, 0-2% slopes</td>
<td>LoB</td>
<td>B</td>
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<td>Locke very cobbly SL</td>
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<td>D/A</td>
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<tr>
<td>Metea sand, 2-6% slopes</td>
<td>MnB</td>
<td>B</td>
<td></td>
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<td>Miami L, 2-6% slopes</td>
<td>MoB</td>
<td>B</td>
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</tr>
<tr>
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<td>Minoa FSL</td>
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<td>Nappanee L</td>
<td>NaA</td>
<td>D</td>
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<td>Nappanee CL, 0-2% slopes</td>
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<td>D</td>
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<tr>
<td>Nappanee CL, 2-6% slopes</td>
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<td>Oakville FS</td>
<td>OaB</td>
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<td>Oakville FS, loamy substratum</td>
<td>OkB</td>
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<td>Parkhill L</td>
<td>Pa</td>
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<tr>
<td>Paulding C</td>
<td>Pc</td>
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<tr>
<td>Sanitary land fill</td>
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<td>N/A</td>
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<tr>
<td>Saranac CL</td>
<td>Sc</td>
<td>D/C</td>
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<td>Selfridge FS, 0-2% slopes</td>
<td>SdA</td>
<td>B</td>
<td></td>
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<tr>
<td>Selfridge FS, 2-6% slopes</td>
<td>SdB</td>
<td>B</td>
<td></td>
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<tr>
<td>Selfridge-Lamson complex</td>
<td>SeA</td>
<td>B</td>
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<td>N/A</td>
</tr>
<tr>
<td>Selfridge-Lenawee complex</td>
<td>SfB</td>
<td>B</td>
<td></td>
<td>N/A</td>
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<tr>
<td>Shoals L</td>
<td>Sh</td>
<td>C</td>
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<tr>
<td>Sims CL</td>
<td>Sl</td>
<td>D</td>
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<tr>
<td>Sisson FSL, 2-6% slopes</td>
<td>SmB</td>
<td>B</td>
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<tr>
<td>Sisson FSL, 6-12% slopes</td>
<td>SmC</td>
<td>B</td>
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<tr>
<td>Sloan L</td>
<td>Sn</td>
<td>D/B</td>
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Table K-1: Hydrologic Soils Groups and Soil Erosivity ‘K’

<table>
<thead>
<tr>
<th>Name</th>
<th>MUS YM</th>
<th>HSG</th>
<th>K Factor</th>
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<tr>
<td>Spinks LS, 0-2% slopes</td>
<td>SpA</td>
<td>A</td>
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<tr>
<td>Spinks LS, 2-6% slopes</td>
<td>SpB</td>
<td>A</td>
<td>0.15</td>
</tr>
<tr>
<td>Spinks LS, 6-12% slopes</td>
<td>SpC</td>
<td>A</td>
<td>0.15</td>
</tr>
<tr>
<td>Tawas muck</td>
<td>Ta</td>
<td>D/A</td>
<td>N/A</td>
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<tr>
<td>Toledo SICL</td>
<td>Ts</td>
<td>D</td>
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</tr>
<tr>
<td>Toledo C</td>
<td>Tt</td>
<td>D</td>
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<tr>
<td>Urban land</td>
<td>Ur</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>Wasepi LS, 0-2% slopes</td>
<td>WsA</td>
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<td>0.17</td>
</tr>
<tr>
<td>Wasepi LS, 2-6% slopes</td>
<td>WsB</td>
<td>B</td>
<td>0.17</td>
</tr>
<tr>
<td>Wasepi SL</td>
<td>WtA</td>
<td>B</td>
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<tr>
<td>Wasepi SL, silty subsoil</td>
<td>WtB</td>
<td>B</td>
<td>0.20</td>
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<tr>
<td>Wasepi-Au Gres complex</td>
<td>WvB</td>
<td>B</td>
<td>N/A</td>
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<tr>
<td>Willette muck</td>
<td>Wx</td>
<td>D/A</td>
<td>N/A</td>
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</table>
# Appendix L. Storm Drain Design Chart

$$Q = \frac{1.486 \Delta H^2}{n^2 g^{5/2}}$$

<table>
<thead>
<tr>
<th>Event</th>
<th>Rainfall int. (in/hr)</th>
<th>Time of Concentration (min)</th>
<th>Total Area (Acres)</th>
<th>Elevation at Mall (ft)</th>
<th>Elevation at Culvert (ft)</th>
<th>Flow Area (ft²)</th>
<th>Flow Coeff.</th>
<th>Elevation at Culvert (ft)</th>
<th>Elevation at Mall (ft)</th>
<th>Elevation at Invert (ft)</th>
<th>Elevation at Rim (ft)</th>
<th>Pipe Size (ft)</th>
<th>Pipe Length (ft)</th>
<th>Full Depth Vel. (ft/s)</th>
<th>Pipe Depth (ft)</th>
<th>Pipe Time (sec)</th>
<th>Pipe Stage at Invert (ft)</th>
<th>Stage of Pipe at Mall (ft)</th>
<th>Stage of Pipe at Culvert (ft)</th>
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</thead>
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<tr>
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Appendix M. Plant Lists

Table M-1   Species List for Planting Zone 1 (Adapted from Shaw & Smidt, 2003)

<table>
<thead>
<tr>
<th>Zone 1</th>
<th>Scientific Name</th>
<th>Common Name</th>
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</thead>
<tbody>
<tr>
<td>Submergent</td>
<td>Brasenia schreberi</td>
<td>Water shield</td>
</tr>
<tr>
<td>Submergent</td>
<td>Ceratophyllum demersum</td>
<td>Coontail</td>
</tr>
<tr>
<td>Submergent</td>
<td>Elodea Canadensis</td>
<td>Elodea</td>
</tr>
<tr>
<td>Submergent</td>
<td>Lemna trisulca</td>
<td>Lesser duckweed</td>
</tr>
<tr>
<td>Submergent</td>
<td>Myriophyllum exalbesius</td>
<td>Water milfoil</td>
</tr>
<tr>
<td>Submergent</td>
<td>Nuphar lutea</td>
<td>Yellow water-lily</td>
</tr>
<tr>
<td>Submergent</td>
<td>Nymphaea odorata</td>
<td>White water-lily</td>
</tr>
<tr>
<td>Submergent</td>
<td>Potamogeton illinoensis</td>
<td>Illinois pondweed</td>
</tr>
<tr>
<td>Submergent</td>
<td>Potamogeton natans</td>
<td>Floating-leaved pondweed</td>
</tr>
<tr>
<td>Submergent</td>
<td>Potamogeton pectinatus</td>
<td>Sago pondweed</td>
</tr>
<tr>
<td>Submergent</td>
<td>Ranunculus flabellaris</td>
<td>Yellow water crowfoot</td>
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<tr>
<td>Submergent</td>
<td>Spirodela polyrrhiza</td>
<td>Giant duckweed</td>
</tr>
<tr>
<td>Submergent</td>
<td>Urticularia vulgaris</td>
<td>Bladderwort</td>
</tr>
<tr>
<td>Submergent</td>
<td>Vallisneria americana</td>
<td>Wild celery</td>
</tr>
<tr>
<td>Submergent</td>
<td>Wolffia columbiana</td>
<td>Watermeal</td>
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<table>
<thead>
<tr>
<th>Zone 1</th>
<th>Scientific Name</th>
<th>Common Name</th>
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</thead>
<tbody>
<tr>
<td>Submergent</td>
<td>Alisma trivale</td>
<td>Water plantain</td>
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<tr>
<td>Submergent</td>
<td>Caltha palustris</td>
<td>Marsh marigold</td>
</tr>
<tr>
<td>Submergent</td>
<td>Polygonum amphibium</td>
<td>Water smartweed</td>
</tr>
<tr>
<td>Submergent</td>
<td>Pontederia cordata</td>
<td>Pickerelweed</td>
</tr>
<tr>
<td>Submergent</td>
<td>Sagittaria latifolia</td>
<td>Broadleaved arrowhead</td>
</tr>
<tr>
<td>Submergent</td>
<td>Sparganium eurycarpum</td>
<td>Giant burreed</td>
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Table M-2   Species List for Planting Zone 2

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<th>Common Name</th>
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<td>Cephalanthus occidentalis</td>
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<td>Emergent</td>
<td>Ilex verticillata</td>
<td>Winterberry</td>
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<tr>
<td>Emergent</td>
<td>Physocarpus opulifolius</td>
<td>Ninebark</td>
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<tr>
<td>Emergent</td>
<td>Acorus calamus</td>
<td>Sweet flag</td>
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<tr>
<td>Emergent</td>
<td>Alisma trivale</td>
<td>Water plantain</td>
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<tr>
<td>Emergent</td>
<td>Caltha palustris</td>
<td>Marsh marigold</td>
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<td>Emergent</td>
<td>Polygonum amphibium</td>
<td>Water smartweed</td>
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<tr>
<td>Emergent</td>
<td>Pontederia cordata</td>
<td>Pickerelweed</td>
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<td>Sagittaria latifolia</td>
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<tr>
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<td>Sparganium eurycarpum</td>
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<th>Scientific Name</th>
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<tr>
<td>Emergent</td>
<td>Carex aquatilis</td>
<td>Water sedge</td>
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<td>Emergent</td>
<td>Carex lacustris</td>
<td>Lake sedge</td>
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<tr>
<td>Emergent</td>
<td>Carex stricta</td>
<td>Tussock sedge</td>
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<tr>
<td>Emergent</td>
<td>Juncus balticus</td>
<td>Baltic rush</td>
</tr>
<tr>
<td>Emergent</td>
<td>Juncus effuses</td>
<td>Soft rush</td>
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<tr>
<td>Emergent</td>
<td>Scirpus acutus</td>
<td>Hardstem bulrush</td>
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<tr>
<td>Emergent</td>
<td>Scirpus fluviatilis</td>
<td>River bulrush</td>
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<tr>
<td>Emergent</td>
<td>Scirpus pungens</td>
<td>Three-square bulrush</td>
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<tr>
<td>Emergent</td>
<td>Scirpus validus</td>
<td>Soft-stem bulrush</td>
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### Table M-3  Species List for Planting Zone 3

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<td>Amorpha fruticosa</td>
<td>Indigo bush</td>
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<tr>
<td>Salix nigra</td>
<td>Black willow</td>
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<tr>
<td>Sambucus pubens</td>
<td>Red-berried elder</td>
<td></td>
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<tr>
<td><strong>Forbs and Ferns</strong></td>
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<td>Anemone canadensis</td>
<td>Canada anemone</td>
<td></td>
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<tr>
<td>Angelica atropurpurea</td>
<td>Angelica</td>
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</tr>
<tr>
<td>Asclepias incarnate</td>
<td>Marsh milkweed</td>
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</tr>
<tr>
<td>Aster lanceolatus (simplex)</td>
<td>Panicle aster</td>
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</tr>
<tr>
<td>Aster novae-angliae</td>
<td>New England aster</td>
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<tr>
<td>Aster puniceus (A. luncidulus)</td>
<td>Swamp aster</td>
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<tr>
<td>Bidens cernua</td>
<td>Beggarsticks</td>
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<td>Boltonia asteroidis</td>
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<tr>
<td>Eupatorium maculatum</td>
<td>Joe-pye-weed</td>
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<td>Eupatorium perfoliatum</td>
<td>Bonset</td>
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<td>Euthamnia graminifolia</td>
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<td>Gentiana andrewsii</td>
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<td>Helianthus annuus</td>
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<tr>
<td>Impatiens capensis</td>
<td>Jewelweed</td>
<td></td>
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<tr>
<td>Iris versicolor</td>
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<td>Liatris spicata</td>
<td>Marsh (Dense) blazingstar</td>
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<td>Lilium superbum</td>
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<td>Lysimachia thyrsiflora</td>
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<td>Onoclea sensibilis</td>
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<td>Osmunda regalis</td>
<td>Royal fern</td>
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<td>Obedient plant</td>
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<tr>
<td>Potentilla palustris</td>
<td>Marsh cinquefoil</td>
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<tr>
<td>Pycnanthemum virginianum</td>
<td>Mountain mint</td>
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<tr>
<td>Scirpus lateriflora</td>
<td>Mad-dog skullcap</td>
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<td>Thalictrum dasycarpum</td>
<td>Tall meadowrue</td>
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<td>Verbena hastata</td>
<td>Blue vervain</td>
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<tr>
<td>Vernonia missurica</td>
<td>Ironweed</td>
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<tr>
<td>Veronicastrum virginicum</td>
<td>Culver’s root</td>
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</tr>
<tr>
<td><strong>Grasses, Sedges and Rushes</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Andropogon gerardii</td>
<td>Big bluestem</td>
<td></td>
</tr>
<tr>
<td>Bromus ciliatus</td>
<td>Fringed brome</td>
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<tr>
<td>Calamagrostis canadensis</td>
<td>Canada blue-joint grass</td>
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<tr>
<td>Carex bebbii</td>
<td>Bebb’s sedge</td>
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</tr>
<tr>
<td>Carex comosa</td>
<td>Bristly (Cosmos) sedge</td>
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<tr>
<td>Carex crinita</td>
<td>Fringed sedge</td>
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<tr>
<td>Carex hystericina</td>
<td>Porcupine sedge</td>
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### Table M-3  Species List for Planting Zone 3

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<thead>
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<th>Zone 3</th>
<th>Wet meadow zone</th>
<th>Permanent moisture</th>
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<td>Zone 3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Carex lacustris</td>
<td>Lake Bank sedge</td>
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</tr>
<tr>
<td>Carex lauginosa</td>
<td>Wooly sedge</td>
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<tr>
<td>Carex lasiocarpa</td>
<td>Wooly needle sedge</td>
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</tr>
<tr>
<td>Carex retrorsa</td>
<td>Retrorse sedge</td>
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<tr>
<td>Carex stipata</td>
<td>Awl-fruited sedge</td>
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<tr>
<td>Carex vulpoidea</td>
<td>Fox sedge</td>
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<tr>
<td>Eleocharis obtusa</td>
<td>Blunt spikerush</td>
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<tr>
<td>Elymus canadensis</td>
<td>Canada Wild Rye</td>
<td></td>
</tr>
<tr>
<td>Elymus riparius</td>
<td>River Bank Wild Rye</td>
<td></td>
</tr>
<tr>
<td>Elymus virginicus</td>
<td>Virginia Wild Rye</td>
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<tr>
<td>Equisetum fluviatile</td>
<td>Horsetail</td>
<td></td>
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<tr>
<td>Glyceria grandis</td>
<td>Giant manna grass</td>
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<tr>
<td>Glyceria striata</td>
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<td>Juncus balticus</td>
<td>Baltic rush</td>
<td></td>
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<tr>
<td>Juncus effusus</td>
<td>Soft rush</td>
<td></td>
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<tr>
<td>Juncus torreyi</td>
<td>Torrey rush</td>
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<tr>
<td>Leersia oryoides</td>
<td>Rice-cut grass</td>
<td></td>
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<tr>
<td>Panicum virgatum</td>
<td>Switchgrass</td>
<td></td>
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<tr>
<td>Scirpus atrovirens</td>
<td>Green bulrush</td>
<td></td>
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<tr>
<td>Scirpus cyperinus</td>
<td>Woolgrass</td>
<td></td>
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<tr>
<td>Scirpus fluviatilis(Schoenoplectus f.)</td>
<td>River bulrush</td>
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<tr>
<td>Scirpus americanus (Schoenoplectus pungens)</td>
<td>Three-square bulrush</td>
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<tr>
<td>Scirpus validus(Schoenoplectus tabernaemontani)</td>
<td>Soft-stem bulrush</td>
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<tr>
<td>Spartina pectinata</td>
<td>Prairie cord grass</td>
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### Table M-4  Species List for Planting Zone 4

<table>
<thead>
<tr>
<th>Zone 4</th>
<th>Floodplain zone</th>
<th>Flooded during snowmelt and large storms</th>
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<tbody>
<tr>
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<td>Scientific Name</td>
<td>Common Name</td>
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<tr>
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<td>Trees and Shrubs</td>
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<tr>
<td>Acer saccharinum</td>
<td>Silver maple</td>
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<td>Alnus incana</td>
<td>Speckled alder</td>
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<tr>
<td>Aronia melanocarpa</td>
<td>Black chokeberry</td>
<td></td>
</tr>
<tr>
<td>Betula nigra</td>
<td>River birch</td>
<td></td>
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<tr>
<td>Celtis occidentalis</td>
<td>Hackberry</td>
<td></td>
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<tr>
<td>Cephalanthus occidentalis</td>
<td>Buttonbush</td>
<td></td>
</tr>
<tr>
<td>Cornus amomum</td>
<td>Silky dogwood</td>
<td></td>
</tr>
<tr>
<td>Cornus sericea</td>
<td>Red-osier dogwood</td>
<td></td>
</tr>
<tr>
<td>Physocarpus opulifolius</td>
<td>Ninebark</td>
<td></td>
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<tr>
<td>Populus deltoids</td>
<td>Eastern cottonwood</td>
<td></td>
</tr>
<tr>
<td>Quercus bicolor</td>
<td>Swamp white oak</td>
<td></td>
</tr>
<tr>
<td>Salix discolor</td>
<td>Pussy willow</td>
<td></td>
</tr>
<tr>
<td>Salix exigua</td>
<td>Sandbar willow</td>
<td></td>
</tr>
<tr>
<td>Salix nigra</td>
<td>Black willow</td>
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<tr>
<td>Sambucus pubens</td>
<td>Red-berried elder</td>
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### Table M-4  Species List for Planting Zone 4

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<th>Zone 4 Floodplain zone</th>
<th>Scientific Name</th>
<th>Common Name</th>
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<tr>
<td></td>
<td><em>Spiraea alba</em></td>
<td>Meadowsweet</td>
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<td></td>
<td><em>Viburnum lentago</em></td>
<td>Nannyberry</td>
</tr>
<tr>
<td></td>
<td><em>Viburnum trilobum</em></td>
<td>High bush cranberry</td>
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<tr>
<td><strong>Forbs and Ferns</strong></td>
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<tr>
<td></td>
<td><em>Anemone Canadensis</em></td>
<td>Canada anemone</td>
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<tr>
<td></td>
<td><em>Aster puniceus (A. luncidulus)</em></td>
<td>Swamp aster</td>
</tr>
<tr>
<td></td>
<td><em>Boltonia asteroides</em></td>
<td>False aster</td>
</tr>
<tr>
<td></td>
<td><em>Impatiens capensis</em></td>
<td>Jewelweed</td>
</tr>
<tr>
<td></td>
<td><em>Lobelia cardinialis</em></td>
<td>Cardinal flower</td>
</tr>
<tr>
<td></td>
<td><em>Lobelia siphilitica</em></td>
<td>Blue lobelia</td>
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<tr>
<td></td>
<td><em>Lysimachia thysiflora</em></td>
<td>Tufted loosestrife</td>
</tr>
<tr>
<td></td>
<td><em>Physostegia virginiana</em></td>
<td>Obedient plant</td>
</tr>
<tr>
<td></td>
<td><em>Potentilla palustris</em></td>
<td>Marsh cinquefoil</td>
</tr>
<tr>
<td></td>
<td><em>Scutterlaria lateriflora</em></td>
<td>Mad-dog skullcap</td>
</tr>
<tr>
<td></td>
<td><em>Symplocarpus foetidus</em></td>
<td>Skunk cabbage</td>
</tr>
<tr>
<td></td>
<td><em>Vernonia missurica</em></td>
<td>Ironweed</td>
</tr>
<tr>
<td><strong>Grasses, Sedges and Rushes</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td><em>Carex comosa</em></td>
<td>Bristly (Cosmos) Sedge</td>
</tr>
<tr>
<td></td>
<td><em>Elymus virginicus</em></td>
<td>Virginia wild rye</td>
</tr>
<tr>
<td></td>
<td><em>Elymus canadensis</em></td>
<td>Canada Wild Rye</td>
</tr>
<tr>
<td></td>
<td><em>Elymus riparius</em></td>
<td>River Bank Wild Rye</td>
</tr>
<tr>
<td></td>
<td><em>Leersia oryzoides</em></td>
<td>Rice-cut grass</td>
</tr>
<tr>
<td></td>
<td><em>Panicum virgatum</em></td>
<td>Switchgrass</td>
</tr>
<tr>
<td></td>
<td><em>Scirpus atrovirens</em></td>
<td>Green bulrush</td>
</tr>
<tr>
<td></td>
<td><em>Spartina pectinata</em></td>
<td>Prairie cord grass</td>
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### Table M-5  Species List for Planting Zone 5

<table>
<thead>
<tr>
<th>Zone 5 Upland zone</th>
<th>Scientific Name</th>
<th>Common Name</th>
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<tbody>
<tr>
<td></td>
<td><em>Cornus racemosa</em></td>
<td>Gray dogwood</td>
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<td></td>
<td><em>Populus tremuloides</em></td>
<td>Quaking aspen</td>
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<tr>
<td></td>
<td><em>Quercus bicolor</em></td>
<td>Swamp white oak</td>
</tr>
<tr>
<td></td>
<td><em>Viburnum lentago</em></td>
<td>Nannyberry</td>
</tr>
<tr>
<td></td>
<td><em>Viburnum trilobum</em></td>
<td>American cranberry</td>
</tr>
<tr>
<td><strong>Forbs and Ferns</strong></td>
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<td></td>
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<tr>
<td></td>
<td><em>Agastache scrophulariaefolia</em></td>
<td>Giant hyssop</td>
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<td></td>
<td><em>Allium stellatum</em></td>
<td>Prairie wild onion</td>
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<tr>
<td></td>
<td><em>Arisaema triphyllum</em></td>
<td>Jack-in-the-pulpit</td>
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<tr>
<td></td>
<td><em>Artemisia ludoviciana</em></td>
<td>Prairie sage</td>
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<tr>
<td></td>
<td><em>Asclepias tuberosa</em></td>
<td>Butterfly milkweed</td>
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<tr>
<td></td>
<td><em>Aster laevis</em></td>
<td>Smooth aster</td>
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<tr>
<td></td>
<td><em>Aster lanceolatus (simplex)</em></td>
<td>Paniced aster</td>
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<td></td>
<td><em>Aster macrophyllus</em></td>
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<td><em>Aster pilosus</em></td>
<td>Frost aster</td>
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### Appendix M

#### Table M-5  Species List for Planting Zone 5

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<thead>
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<th>Zone 5 Upland zone</th>
<th>Scientific Name</th>
<th>Common Name</th>
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<tbody>
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<td><strong>Scientific Name</strong></td>
<td><strong>Common Name</strong></td>
</tr>
<tr>
<td>Athyrium filix-femina</td>
<td>Lady fern</td>
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<td>Boltonia asteroidis</td>
<td>False aster</td>
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<tr>
<td>Epilobium angustifolium</td>
<td>Fireweed</td>
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<td>Galium boreale</td>
<td>Northern bedstraw</td>
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<td>Helianthus grosseserratus</td>
<td>Sawtooth sunflower</td>
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<td>Heuchera richardsonii</td>
<td>Prairie alumroot</td>
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<tr>
<td>Monarda fistulosa</td>
<td>Wild bergamot</td>
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<tr>
<td>Onoclea sensitilis</td>
<td>Sensitive fern</td>
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<td>Marsh cinquefoil</td>
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<tr>
<td>Pteridium aquilinum</td>
<td>Bracken fern</td>
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<td>Pycnanthemum virginianum</td>
<td>Mountain mint</td>
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<td>Ratibida pinnata</td>
<td>Yellow coneflower</td>
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<td>Smilacina racemosa</td>
<td>False Solomon’s seal</td>
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<td>Solidago flexicaulis</td>
<td>Zig-zag goldenrod</td>
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<td>Solidago riddellii</td>
<td>Riddell’s goldenrod</td>
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<td>Solidago rigidia</td>
<td>Stiff goldenrod</td>
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<td>Tradescantia ohiensis</td>
<td>Ohio spiderwort</td>
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<td>Veronicastrum virginicum</td>
<td>Culver’s root</td>
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<tr>
<td>Zizia aurea</td>
<td>Golden alexanders</td>
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#### Grasses, Sedges and Rushes

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<th>Common Name</th>
<th>National Wetland Category</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>Andropogon gerardii</td>
<td>Big bluestem</td>
<td>Upland</td>
<td>Tree</td>
</tr>
<tr>
<td>Panicum virgatum</td>
<td>Switchgrass</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Schizachyrium scoparium</td>
<td>Little bluestem</td>
<td></td>
<td></td>
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<tr>
<td>Sorghastrum nutans</td>
<td>Indian grass</td>
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#### Table M-6  Prohibited Invasive Species List

<table>
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<tr>
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<th>Common Name</th>
<th>National Wetland Category</th>
<th>Type</th>
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<tbody>
<tr>
<td>Acer ginnala</td>
<td>Amur maple</td>
<td>Upland</td>
<td>Tree</td>
</tr>
<tr>
<td>Acer platanoides</td>
<td>Norway maple</td>
<td>Upland</td>
<td>Tree</td>
</tr>
<tr>
<td>Agropyron repens</td>
<td>Quake grass</td>
<td>Facultative Upland</td>
<td>Grass</td>
</tr>
<tr>
<td>Alhagi petiolata</td>
<td>Garlic mustard</td>
<td>Facultative</td>
<td>Forb</td>
</tr>
<tr>
<td>Alnus glutinososa</td>
<td>Black alder</td>
<td>Facultative Wetland</td>
<td>Tree</td>
</tr>
<tr>
<td>Arctium minus</td>
<td>Common burdock</td>
<td>Upland</td>
<td>Forb</td>
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<tr>
<td>Berberis thunbergii</td>
<td>Japanese barberry</td>
<td>Facultative Upland (-)</td>
<td>Shrub</td>
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<tr>
<td>Berberis vulgaris</td>
<td>Common barberry</td>
<td>Facultative Upland</td>
<td>Shrub</td>
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<td>Bromus inernis</td>
<td>Hungarian brome, smooth brome</td>
<td>Upland</td>
<td>Grass</td>
</tr>
<tr>
<td>Celastrus orbiculatus</td>
<td>Oriental bittersweet</td>
<td>Upland</td>
<td>Vine</td>
</tr>
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<td>Centaurea maculosa</td>
<td>Spotted knapweed</td>
<td>Upland</td>
<td>Forb</td>
</tr>
<tr>
<td>Cirsium arvense</td>
<td>Canada thistle</td>
<td>Facultative Upland</td>
<td>Forb</td>
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### Table M-6  Prohibited Invasive Species List (Continued)

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<th>National Wetland Category</th>
<th>Type</th>
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<tbody>
<tr>
<td><em>Cirsium vulgare</em></td>
<td>Bull thistle</td>
<td>Facultative Upland (-)</td>
<td>Forb</td>
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<tr>
<td><em>Convolvulus arvensis</em></td>
<td>Field-bindweed</td>
<td>Upland</td>
<td>Forb</td>
</tr>
<tr>
<td><em>Coronilla varia</em></td>
<td>Crown vetch</td>
<td>Upland</td>
<td>Forb</td>
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<tr>
<td><em>Cotoneaster microphyllus</em></td>
<td>Cotoneaster</td>
<td>Upland</td>
<td>Shrub</td>
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<tr>
<td><em>Cotoneaster pannosus</em></td>
<td>Cotoneaster</td>
<td>Upland</td>
<td>Shrub</td>
</tr>
<tr>
<td><em>Cotoneaster lacteus</em></td>
<td>Cotoneaster</td>
<td>Upland</td>
<td>Shrub</td>
</tr>
<tr>
<td><em>Dipsacus laciniatus</em></td>
<td>Cut-leaved teasel</td>
<td>Upland</td>
<td>Forb</td>
</tr>
<tr>
<td><em>Elaeagnus umbellata</em></td>
<td>Autumn olive</td>
<td>Facultative Upland (-)</td>
<td>Shrub</td>
</tr>
<tr>
<td><em>Elaeagnus alata</em></td>
<td>Burningbush</td>
<td>Upland</td>
<td>Shrub</td>
</tr>
<tr>
<td><em>Euonymus fortunei</em></td>
<td>Wintercreaper</td>
<td>Upland</td>
<td>Vine</td>
</tr>
<tr>
<td><em>Euphorbia esula</em></td>
<td>Leafy spurge</td>
<td>Upland</td>
<td>Forb</td>
</tr>
<tr>
<td><em>Fallopia japonica</em></td>
<td>Japanese knotweed</td>
<td>Upland</td>
<td>Forb</td>
</tr>
<tr>
<td><em>Festuca pratensis (elatior)</em></td>
<td>Meadow fescue</td>
<td>Facultative Upland (-)</td>
<td>Grass</td>
</tr>
<tr>
<td><em>Hendra helix</em></td>
<td>English ivy</td>
<td>Upland</td>
<td>Vine</td>
</tr>
<tr>
<td><em>Hesperis matronalis</em></td>
<td>Dame’s rocket</td>
<td>Upland</td>
<td>Forb</td>
</tr>
<tr>
<td><em>Ligustrum obtusifolium</em></td>
<td>Border privet</td>
<td>Upland</td>
<td>Shrub</td>
</tr>
<tr>
<td><em>Ligustrum vulgare</em></td>
<td>Common privet</td>
<td>Facultative (-)</td>
<td>Shrub</td>
</tr>
<tr>
<td><em>Lonicera japonica</em></td>
<td>Japanese honeysuckle</td>
<td>Facultative Upland</td>
<td>Vine</td>
</tr>
<tr>
<td><em>Lonicera maackii</em></td>
<td>Maak’s or amur honeysuckle</td>
<td>Upland</td>
<td>Shrub</td>
</tr>
<tr>
<td><em>Lonicera morrowi</em></td>
<td>Morrow’s honeysuckle</td>
<td>Upland</td>
<td>Shrub</td>
</tr>
<tr>
<td><em>Lonicera tatarica</em></td>
<td>Smooth tartarian honeysuckle</td>
<td>Facultative Upland</td>
<td>Shrub</td>
</tr>
<tr>
<td><em>Lonicera x bella</em></td>
<td>Showy bush honeysuckle</td>
<td>Upland</td>
<td>Shrub</td>
</tr>
<tr>
<td><em>Lythrum salicaria</em></td>
<td>Purple loosestrife</td>
<td>Obligate Wetland</td>
<td>Forb</td>
</tr>
<tr>
<td><em>Melilotus alba</em></td>
<td>White sweet clover</td>
<td>Facultative Upland</td>
<td>Forb</td>
</tr>
<tr>
<td><em>Melilotus officinalis</em></td>
<td>Yellow sweet clover</td>
<td>Facultative Upland</td>
<td>Forb</td>
</tr>
<tr>
<td><em>Miscanthus sinensis</em></td>
<td>Chinese silver grass</td>
<td>Upland</td>
<td>Grass</td>
</tr>
<tr>
<td><em>Myriophyllum spicatum</em></td>
<td>Eurasian water milfoil</td>
<td>Obligate Wetland</td>
<td>Forb</td>
</tr>
<tr>
<td><em>Pachysandra terminalis</em></td>
<td>Pachysandra</td>
<td>Upland</td>
<td>Forb</td>
</tr>
<tr>
<td><em>Pastinaca sativa</em></td>
<td>Wild parsnip</td>
<td>Upland</td>
<td>Forb</td>
</tr>
<tr>
<td><em>Phalaris arundinacea</em></td>
<td>Reed canary grass</td>
<td>Facultative Wetland (+)</td>
<td>Grass</td>
</tr>
<tr>
<td><em>Phalaris canariensis</em></td>
<td>Canary grass</td>
<td>Facultative Upland</td>
<td>Grass</td>
</tr>
<tr>
<td><em>Phragmites australis</em></td>
<td>Reed</td>
<td>Facultative Wetland (+)</td>
<td>Grass</td>
</tr>
<tr>
<td><em>Polygonum cuspidatum</em></td>
<td>Japanese knotweed</td>
<td>Facultative Upland</td>
<td>Forb</td>
</tr>
<tr>
<td><em>Polygonum sachalinense</em></td>
<td>Giant knotweed, japanese</td>
<td>Upland</td>
<td>Forb</td>
</tr>
<tr>
<td></td>
<td>bamboo</td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>Rhamnus cathartica</em></td>
<td>Common/european buckthorn</td>
<td>Facultative Upland</td>
<td>Tree</td>
</tr>
<tr>
<td><em>Rhamnus frangula</em></td>
<td>Glossy buckthorn, tallhedge</td>
<td>Facultative (+)</td>
<td>Shrub</td>
</tr>
<tr>
<td><em>Rhamnus utilis</em></td>
<td>Buckthorn</td>
<td>Upland</td>
<td>Shrub</td>
</tr>
<tr>
<td><em>Rosa multiflora</em></td>
<td>Multiflora rose</td>
<td>Facultative Upland</td>
<td>Shrub</td>
</tr>
<tr>
<td><em>Rumex crispus</em></td>
<td>Curly or sour dock</td>
<td>Facultative (+)</td>
<td>Forb</td>
</tr>
<tr>
<td><em>Spiraea japonica</em></td>
<td>Japanese spiraea</td>
<td>Upland</td>
<td>Shrub</td>
</tr>
<tr>
<td><em>Taxus cuspidata</em></td>
<td>Japanese yew</td>
<td>Upland</td>
<td>Shrub</td>
</tr>
<tr>
<td><em>Typha angustifolia</em></td>
<td>Narrow leaf cattail</td>
<td>Obligate Wetland</td>
<td>Forb</td>
</tr>
<tr>
<td><em>Typha x glauca</em></td>
<td>Hybrid cattail</td>
<td>Obligate Wetland</td>
<td>Forb</td>
</tr>
<tr>
<td><em>Ulmus pumila</em></td>
<td>Siberian elm</td>
<td>Upland</td>
<td>Tree</td>
</tr>
</tbody>
</table>
Table M-7  Threatened Species List

The list below is not all inclusive. The use of Threatened Species in county drains requires approval from MCPWO.

<table>
<thead>
<tr>
<th>Zone</th>
<th>Submergent zone</th>
<th>3-6 feet of water</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Scientific Name</td>
<td>Common Name</td>
</tr>
<tr>
<td></td>
<td><strong>Forbs and Ferns</strong></td>
<td></td>
</tr>
<tr>
<td>Zone 1</td>
<td><em>Nelumbo lutea</em></td>
<td>Lotus (Threatened in Michigan)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Zone</th>
<th>Wet meadow zone</th>
<th>Permanent moisture</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Scientific Name</td>
<td>Common Name</td>
</tr>
<tr>
<td></td>
<td><strong>Forbs and Ferns</strong></td>
<td></td>
</tr>
<tr>
<td>Zone 3</td>
<td><em>Eryngium yuccifolium</em></td>
<td>Rattlesnake master (Threatened in Michigan)</td>
</tr>
<tr>
<td>Zone 3</td>
<td><em>Silphium perfoliatum</em></td>
<td>Cup plant (Threatened in Michigan)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Zone</th>
<th>Floodplain zone</th>
<th>Flooded during snowmelt and large storms</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Scientific Name</td>
<td>Common Name</td>
</tr>
<tr>
<td></td>
<td><strong>Trees and Shrubs</strong></td>
<td></td>
</tr>
<tr>
<td>Zone 4</td>
<td><em>Silphium perfoliatum</em></td>
<td>Cup plant (Threatened in Michigan)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Zone</th>
<th>Upland zone</th>
<th>Seldom or never inundated</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Scientific Name</td>
<td>Common Name</td>
</tr>
<tr>
<td></td>
<td><strong>Forbs and Ferns</strong></td>
<td></td>
</tr>
<tr>
<td>Zone 5</td>
<td><em>Rudbeckia subtomentosa</em></td>
<td>Brown-eyed Susan (Threatened in Michigan)</td>
</tr>
</tbody>
</table>
Appendix N.  Drain Improvement Petition

Application to Improve a County Drain

To:  Candice S. Miller  
Macomb County  
Public Works Commissioner

The undersigned owns property, described on Exhibit A attached, located within the Drainage District for the Crittenden Drain, an established county drain under the jurisdiction of the Macomb County Public Works Commissioner (MCPWC). The undersigned requests that a portion of the drain be improved in order to facilitate its use of the property, pursuant to provisions of the Michigan Drain Code, Public Act 40 of 1956, Michigan Compiled Laws 280.1 and, if applicable, the Michigan Subdivision Control Act, Public Act 289 of 1967, Michigan Compiled Laws 560.1. The nature and location of the drain improvement requested are generally described as follows:

The undersigned agrees to pay all costs related to the proposed drain improvement, including all costs that would otherwise be assessed against signers of a petition for the drain improvement, and other property owners in the drainage district. The undersigned agrees to deposit a non-refundable fee to the MCPWC for preliminary administrative expenses related to the processing of this application to improve a county drain and to convey all easements necessary for the drain improvement.

The undersigned agrees to protect, defend, indemnify and hold Macomb County, Macomb County Public Works Commissioner, subject Drainage District, constituent units of government and public agencies within the subject Drainage District and officers, agents and employees of the above named entities free and harmless from and against any and all losses, penalties, damages, settlements, costs, charges, professional fees or other expenses or liabilities of every kind and character arising out of or relating to any and all claims, legal fees, liens, demands, court costs, obligations, actions, proceedings or causes of action of every kind and character in connection with or arising directly or indirectly out of this Petition and/or its performance. Without limiting the generality of the foregoing, all claims, etc. relating to personal injury, death, damage to property, defects in materials or workmanship, actual or alleged infringement of any patent, trademark, copyright or of any other tangible or intangible personal or property right, or any actual or alleged violation of any applicable statute, ordinance, administrative order, rule, regulation, or court decree, shall be included in the indemnity. The Petitioner agrees to investigate, handle, respond to, provide defense for and defend any such claims, etc., at its sole expense and agrees to bear all other costs and related expenses, even if the claims, etc. are groundless, false or fraudulent. In any case in which this indemnification would violate legal prohibition, the foregoing provisions concerning indemnification shall not be construed to indemnify the indemnitees for damage arising out of bodily injury to persons or damage to property caused by or resulting from the sole negligence of the indemnitees.
Exhibit A

Description of Applicant's property located within the Drainage District for the Spencer Drain.

City, Township or Village:
Property Sidewell Number:
Property Address, if available:
Commercial Name, if applicable:
Legal Description:

Completed petition is to be accompanied by a check in the amount of $2000, payable to the MACOMB COUNTY TREASURER, to cover publication and mailing expenses.

Do not write below this line. To be completed by Macomb County Public Works Office.
Amount of Deposit       Date of Deposit       Check Number
OFFICE OF  
MACOMB COUNTY PUBLIC WORKS COMMISSIONER  
Candice S. Miller  

PETITION FOR IMPROVEMENT OF A COUNTY DRAIN  
The undersigned petition the Macomb County Public Works Commissioner to clean out, deepen, enclose, extend, relocate, straighten, tile, widen, construct a relief, or add a branch to the Drain located and established in Macomb County, Michigan, because of the accumulation of silt and debris and to provide an adequate outlet for lands in the district. The undersigned state that they are freeholders of property located within the above drainage district and that they are subject to assessment for the proposed drain improvement.

<table>
<thead>
<tr>
<th>NAME</th>
<th>PROPERTY OWNED WITHIN DRAINAGE DISTRICT</th>
<th>PHONE NUMBER</th>
<th>DATE</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Property ID Number</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Property ID Number</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Property ID Number</td>
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<td>Property ID Number</td>
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<td></td>
<td>Property ID Number</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Property ID Number</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
AFFADAVIT OF CIRCULATOR OF PETITION

I HEREBY CERTIFY that I did personally circulate this petition and that the signatures to same were made in my presence and are the genuine signatures of those whose names are affixed.

Name of Circulator:

Date (Sign) (Print)

INSTRUCTIONS FOR CIRCULATOR OF PETITION

Property within the drainage district must be identified by street address, permanent parcel number, or subdivision name and lot number. One of these forms of identification must be provided or the petition will not be accepted.

The term “Freeholder” includes persons who own real property free and clear, who own property subject to a mortgage, and who are buying or selling property on a land contract. It also includes parties who own a life estate or who have a lifetime lease on property within the drainage district.

On property owned by a husband and wife, both may sign the petition and have their signatures counted.

If property is owned by a corporation, the petition must be signed by its president or secretary.

If property is being sold on land contract, both the buyer or seller may sign and have their signatures counted.

On property owned by joint tenants in common, all tenants may sign and have their signatures counted.

A minimum of five signatures is required.

Completed petition is to be accompanied by a check in the amount of $3,000, payable to the MACOMB COUNTY TREASURER.