

APPENDIX

PART I

PROCEDURES FOR SUBMISSION AND REVIEW OF DEVELOPMENT PLANS

I. PURPOSE

- A. To ensure that drainage or stormwater management systems are adequate to address stormwater management needs within a proposed development, and for protecting downstream landowners from flooding and degradation of water quality. The procedures, standards and recommendations set forth in these rules are designed for these purposes.
- B. To ensure that all stormwater facilities necessary for a proposed development will 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.
- C. These rules provide minimum standards to be complied with by developers, and in no way limit the authority of the Township to adopt or publish and enforce higher standards as a condition of approval of developments.
- D. Stormwater management technologies are rapidly developing and improving; these rules will be revised as necessary, with the most recently dated sheets being applicable.

II. SUBMISSION OF PRELIMINARY PLAN FOR APPROVAL

A. SUBMISSION AND GENERAL INFORMATION REQUIREMENTS

- 1. A preliminary plan showing the layout of the area intended to be developed will be submitted by the developer. This plan will be prepared under the direction of, and sealed by, a registered professional engineer or a registered land surveyor, and should fit on a sheet of paper that does not exceed 24" by 36", drawn to a standard engineering scale.
- 2. Three prints prepared in accordance with the rules set forth in this section, will be submitted together with a letter of transmittal requesting that the plan be reviewed and, if found satisfactory, approved. The names of the owner and engineering or surveying firm, with mailing addresses, fax and telephone numbers for each, will be included with the transmittal.
- 3. The plan will include:
 - a. The location by means of a small location map

- b. The township, city or village in which the parcel is situated
 - c. The section and part of section in which the parcel is situated
 - d. The proposed drainage system for the development
 - e. The proposed street, alley and lot layouts and approximate dimensions
 - f. The location and description of all on- and adjacent off-site features that may be relevant in determining the overall requirements for the development. For example:
 - ⊗ Adjoining roads and developments
 - ⊗ Railroads
 - ⊗ High tension power lines or underground transmission lines
 - ⊗ Cemeteries
 - ⊗ Parks
 - ⊗ Natural and artificial watercourses, wetlands and wetland boundaries, floodplains, lakes, bays and lagoons
 - ⊗ Designated natural areas
 - ⊗ Any proposed environmental mitigation features
 - ⊗ Drains, sewers and water mains
 - ⊗ Existing and proposed easements
 - g. The number of acres
 - h. Contours, at two-foot intervals or less, with U.S.G.S. datum
 - i. A map, at the U.S.G.S. scale, showing the drainage boundary of the proposed development and its relationship with existing drainage patterns
 - j. Any water course passing through the development, along with the following:
 - (1) area of upstream watershed and current zoning
 - (2) preliminary calculations of runoff from the upstream area for both the 100-year and 1.5-year 24-hour design storms, for fully-developed conditions according to the current land use plan for the area
 - k. Soil borings may be required at various locations including the sites of proposed retention/detention facilities, and as needed in areas where high ground water tables exist.
4. All calculations used in designing all components of stormwater management systems must be submitted along with plans.

5. Easement information will be shown, consistent with Part II, Section XIII of these rules.
6. A description of the mechanism to be established to provide for long-term maintenance of the development's stormwater management system, and the government agency responsible for maintenance oversight if maintenance is to be performed by a private entity. A County drainage district may be required to be established for future maintenance.
7. In general roadside ditches are maintained by the Washtenaw County Road Commission if they are within the right-of-way of a public road.
8. Should the wishes to begin with only a portion of the total area, the original plan will include the proposed general layout for the entire area. The first phase 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 plan will follow the same procedure until the entire area controlled by the proprietor is developing.

Final approval of only one portion or phase does not ensure final acceptance of any subsequent phases or the overall general plan for the entire area; nor does it mandate that the overall general plan be followed as originally proposed, if deviations or modifications acceptable to the Township are proposed.

B. DRAINAGE INFORMATION REQUIREMENTS

1. REQUIRED STORMWATER MANAGEMENT INFORMATION

The plan will include:

- a. The general stormwater management scheme for the proposed development- indicating how stormwater management will be provided and where drainage will outlet.
- b. A description of the offsite outlet and evidence of its adequacy. If no adequate watercourse exists to effectively handle a concentrated flow of water from the proposed development, discharge will be reduced to sheet flow prior to exiting the site, and cannot exceed 0.15 cfs/acre. Additional volume controls may be required in such cases and/or acquisition of rights-of-way from downstream property owners receiving the stormwater flow.
- c. Any on-site and/or off-site stormwater management facilities and appropriate easements, dedicated to the entity that will be responsible for future maintenance.

- d. Any drainage originating outside of the development limits that flows onto or across the development. In general, drainage from off-site shall not be passed through on-site stormwater storage facilities.
 - e. Any natural watercourses and County Drains that traverse or abut the property.
2. Proposed drainage for the development will conform to any established County drainage districts.
 3. 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.
 4. Proposed drainage should complement any local stormwater management plans that may exist and/or comply with any ordinance in effect.
 5. The increased volume of water discharged due to development of the development must not create adverse impacts to downstream property owners and water courses (e.g. flooding; excessive soil saturation; crop damage; erosion; degradation in water quality or habitat destruction).

C. DEVELOPMENT APPROVAL

1. The Township will approve or reject a plan within a reasonable time of its submittal. If the proposed plan is not approved as originally submitted, the Township will notify the proprietor in writing, setting forth the reasons for withholding approval, and will state the changes necessary to obtain approval. If the proposed plan as submitted meets all requirements, one approved copy of the plan will be returned to the proprietor. Approval of the plan is required before the Township will proceed with review of final construction plans.
2. Payment of all fees is prerequisite to approval (See Fee Schedule, Appendix 0).

III. FINAL CONSTRUCTION PLAN APPROVAL

- A. The proprietor will submit final stormwater management facility construction plans with a letter of transmittal. Plans will be prepared under the direction of, and sealed by, a registered professional engineer and will be in accordance with Part II of these rules.

The Township will review final construction plans to assure that adequate storm drainage will be provided and that the proposed stormwater management system provides adequately for water quantity and quality management to ensure protection of property owners and watercourses both within the proposed development and

downstream. Submission requirements include, but will not be limited to the following:

1. Two complete sets of construction plans are required, drawn to a scale no smaller than 1" = 50', and on sheets no larger than 24" x 36". The scales used shall be standard engineering scales and shall be consistent throughout the plans. When plans have been completed with computer aided design technology, a copy of the electronic file shall also be provided. Construction plans shall include the following:
 - a. Development layout of lots, roads and utility and drainage easements.
 - b. Plans, profiles and details of all roads and storm sewers. The storm sewer details will include type and class of pipe, length of run, percent of slope, invert elevations, rim elevations, and profile of the hydraulic gradient, as specified in Part II of these rules.
 - c. A storm sewer computation sheet 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 cfs and the flow velocities for enclosed systems.
 - d. Plans, profiles and details of all open ditch drains, drainage swales and drainage structures.
 - e. Plans and details of the proposed soil erosion and sedimentation control measures, both temporary (during construction) and permanent.
 - f. Plans and details of retention detention facilities.
 - g. A drainage area map, overlaid onto a copy of the site grading plan, which clearly shows the areas tributary to each inlet an/or storage basin.
 - h. Topographic maps, at two foot contour intervals or less on U.S.G.S. datum, showing existing and proposed grades of the entire area to be subdivided, as well as off-site topography over at least 100' of the adjoining property. Maps will also show all existing water courses, lakes and wetlands, and the extent of all off-site drainage areas contributing flow to the development.
 - i. The number of acres proposed to be developed and, for phased developments, the number of acres in each phase.
 - j. Locations of all drain fields as approved by the Washtenaw County Environmental Services Division and of all expansion areas. Drain fields shall not be located within drainage easements.
2. Specifications governing construction of stormwater management facilities.

3. Design data and criteria used for sizing all drainage structures, channels and retention basins. including weighted runoff coefficient calculations. (Refer to Appendix D for Values of Relative Imperviousness.)
 4. A stormwater facility maintenance plan, schedule, and budget estimating the costs that will be associated with system maintenance (See Part II, Section X. D.)
 5. In addition to the foregoing, a single sheet including the entire site plan along with all proposed storm drainage facilities and drainage easements shall be submitted.
- B. A soil erosion permit under “The Michigan Soil Erosion and Sedimentation Control Act”, P.A. 451, Part 91 Public Acts of 1994 as amended, will be obtained from the appropriate agency prior to any construction.
 - C. The proprietor will make arrangements acceptable to the Township for inspection during construction and for final verification of the construction by a registered professional engineer prior to the approval of the final construction plans. (See Appendix G for a sample Engineer's Certificate of Construction.)
 - D. Review of construction plans by the Township will not proceed until plan approval has been granted. The Land Division Act of 1996 gives no time limit in which final construction plans must be reviewed. The Township will attempt to review these plans in the shortest possible time.
 - E. Approval of construction plans by the Township is valid for one calendar year. If an extension beyond this period is needed, the proprietor will submit a written request to the Township for an extension. The Township may grant one year extensions of the approval, and may require updated or additional information if needed.
 - F. For site condominiums, complete Master Deed documents (including “Exhibits” drawings) must be submitted for the Township's review and approval prior to recording.

IV. FINAL DEVELOPMENT APPROVAL

- A. Final plan review will be completed by the Township within 10 days of submission by the proprietor. If the plan is not acceptable, written notice of rejection and the reasons therefor will be given to the proprietor. If the Township approves the plan, it will affix a signature to it and the plan will be executed.
- B. As a condition of final plan approval, the Township will require the following:

1. Before approval of the final plan, it must be demonstrated that all necessary Wetland, Floodplain, Inland Lakes and Streams, Erosion Control or other needed state, federal or local permits are in place.
2. If the stormwater management system is constructed before the proprietor seeks final plan approval, written verification of the stormwater system will be submitted by a registered professional engineer. This verification will state that the stormwater facilities were installed in an acceptable manner and according to construction plans approved by the Township. Inspection fees will be deposited in advance with the Township.
3. A satisfactory agreement that assures long-term maintenance of all drainage improvements will be in place before submission of the final plan. Documentation of maintenance agreement will be supplied to the Township.
4. The proprietor will post cash or a letter of credit in an amount not less than 10% of the cost of the stormwater facilities for projects of less than \$100,000 or 5% of the cost for projects over \$100,000 (See Sections C and D below). This deposit will be held for one year after the date of completion of construction and final inspection of the stormwater facilities, or until construction on all phases in the development are completed, whichever time period is longer.

This deposit will be returned to the proprietor (in the case of cash) or allowed to expire (in the case of a letter of credit), as provided above, provided all stormwater facilities are clean, unobstructed and in good working order.

6. Reproducible mylars of the as-built stormwater management system(s) will be submitted by the proprietor or his/her engineer to the Commissioner along with the final plan, or upon completion of system construction. The mylars are to be of quality material and 3 mils in thickness.
7. Complete development agreements (including deed restrictions) must be submitted for the Township's review and approval prior to recording.

C. PROCEDURES WHEN STORMWATER MANAGEMENT FACILITIES ARE BUILT BEFORE SUBMISSION OF FINAL PLAN

1. If the proprietor desires to construct the stormwater management facilities necessary in the proposed development before submission of the final plan, construction plans as required within Section III will be submitted to, and approved by the Township before commencing any work.
2. The proprietor will make satisfactory arrangements with the Township before performing any work in the development to provide for the inspection of the project by a registered professional engineer or the municipality's engineer.

3. Inspection deposits will be computed and payment will be made to the Township. The proprietor will be responsible for the actual and necessary inspection costs incurred by the Township.
4. If the drainage work involves a relocation, tiling, deepening, widening, or other work within an existing County drain, or its easement, application for permission will be filed with, and approved by the Township prior to construction. This permit application will be accompanied by any necessary release of rights-of-way in recordable form, executed by all owners of interest, and any required state permits.

D. PROCEDURES WHEN STORMWATER MANAGEMENT FACILITIES ARE BUILT AFTER APPROVAL OF FINAL PLAN

1. If the proprietor desires to have the plan approved before completing the drainage improvements, he or she will enter into an agreement with the Township and post a cash deposit or a letter of credit in an amount sufficient to complete construction of the stormwater management facilities, as determined by the proprietor's engineer and approved by the Township's engineer.
2. Under this agreement, the time of completion of construction of stormwater management facilities will not extend for a period greater than one year from the original date of the agreement. If after this period the improvements are not completed, the Township may exercise the right under the terms of the agreement to use proceeds of the proprietor's deposit to fulfill the proprietor's obligation under such agreement, at such time and in such manner as the Township may determine.
3. In the event that the proprietor makes a cash deposit to guarantee the requirements with the plan, the Township may refund portions of the original deposit as the work progresses. However, the amount of deposit retained by the Township will, at no time, be reduced to less than the cost for completion of the remaining work.

V. DRAINS UNDER THE JURISDICTION OF THE DRAIN COMMISSIONER

- A. Drainage districts will not be altered when designing development drainage, except as provided under Section 433 of Act 40, Public Act 1956 as amended.
- B. Existing county drain easements will be indicated on the plans as well as the final plan and will be designated as “_____” (County) Drain. County drain easements prior to 1956 were not required by statute to be recorded immediately; therefore, it may be necessary to check the permanent records of the Drain Office to see if a drain easement is in existence on the subject property.

- C. A permit will be obtained from the Drain Office prior to tapping or crossing any county drain. The permit must be obtained prior to final plan approval. (See Appendix N for a sample permit application.)
- D. Proposed relocations of county drains will be processed through the office of the Drain Commissioner.
- E. If a development is being developed in an area where special drainage problems are anticipated at the site, on adjacent properties or downstream, more stringent design requirements than are contained within Part II of these rules may be required.

VI. APPEAL PROCECURES

If the proprietor believes a decision made by the Township is unsatisfactory or improper, an appeal may be filed in writing within 14 calendar days of that decision. If an appeal is filed with the Township, an informal hearing will be scheduled within 20 calendar days from the date of the filing.

The informal hearing will allow the proprietor an opportunity to submit additional information or reemphasize previously submitted data. The Township will then review the information and make a final decision, within 20 days of the informal hearing, and forward this final decision to the proprietor by first class mail.

PART II
**DESIGN CRITERIA FOR
STORMWATER MANAGEMENT SYSTEMS**

This section sets forth specific design and construction standards that will be used by the Township in review of proposed stormwater management systems; in accordance with the objectives of managing both the quantity and quality of stormwater runoff.

It is difficult or impossible to develop one set of uniform standards that is capable of accommodating all variables and unique site circumstances. In particular, it is recognized that these standards may be difficult to realize on small 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 Township.

I. DEVELOPMENT DRAINAGE – GENERAL REQUIREMENTS

A. STORMWATER DISCHARGE

1. In no event will 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 to have constructed at his/her expense, any necessary additional and/or alternative stormwater management facilities. Such additional facilities will be subject to the Township's review and approval.
2. If no adequate watercourse exists to effectively handle a concentrated flow of water from the proposed development, discharge will be reduced to sheet flow prior to exiting the site, and cannot exceed 0.15 cfs/acre. Additional volume controls may be required in such cases and/or acquisition of rights-of-way from downstream property owners receiving the stormwater flow.
3. Discharge should outlet within the drainage basin where flows originate, and generally may not be diverted to another basin.

B. DETERMINATION OF SURFACE RUNOFF

1. The "rational method" of calculating stormwater runoff is generally acceptable for sites less than 150 acres in size; however, it may not be considered an adequate design tool for sizing large drainage systems. More precise methodologies for predicting runoff such as runoff hydrographs are widely available, and may be required by the Township for sizing the drainage systems on large sites and/or smaller sites that are deemed potentially problematic. Acceptable alternative methods will include (See Appendices I and J for more

information):

- ☒ Corps of Engineers HEC-1
- ☒ Soil Conservation Service UD-21, TR-20 and TR-55
- ☒ U.S. EPA's SWMM
- ☒ Continuous simulation (e.g. HSPF)

- a. Unless a continuous simulation approach to drainage system hydrology is used, all design rainfall events will be based on the SCS Type II distribution.
- b. Computations of runoff hydrographs that do not rely on a continuous accounting of antecedent moisture conditions will assume a conservative wet antecedent moisture condition.

II. DESIGN STANDARDS FOR CONSTRUCTED STORMWATER MANAGEMENT FACILITIES

A. RETENTION AND DETENTION SYSTEMS

BACKGROUND

Whereas basin design for flood control is concerned with capturing and detaining relatively infrequent, severe runoff events, such as the 10-, 25-, or 100-year Storm, designs for water quality control require that the more frequent storm events (e.g. 2-year storm or less) must be addressed as well. The need for managing smaller storms is directly related to urbanization within Washtenaw County and the accompanying increase in impervious area, which affects surface water quality in two important ways.

First, eroded soil and other pollutants that accumulate on impervious surfaces, such as metals, fertilizers, pesticides, oils and grease, are flushed off by the early stages of runoff, which then carries a shock loading of these pollutants into receiving waterways.

By capturing and treating the first 0.5 inch of runoff, up to 90% of pollutants that are washed off of the land can be removed from stormwater before it enters into the drainage system.

Second, as recent studies by the MDEQ have shown, development within the County has caused stream flow fluctuations to rise dramatically. As impervious surface area increases and opportunities for infiltration are reduced, the frequency and duration of bankfull flow conditions, typically represented by the 1.5-year storm event, have intensified. As a result, streams adjust their capacities to convey the increased flows, which can then lead to channel and bank erosion and the destruction of aquatic habitat.

To manage both water quantity and quality, basins must be designed to capture and treat three different storm events:

1. The 100-year storm event
2. The bankfull flood: The 1.5-year/24 hour storm event

3. The “first flush”: The first 0.5 inch of runoff from the entire contributing watershed

Controlling both extremely large events, to prevent flooding, and more frequent events, to mitigate water quality impacts and channel erosion, can be achieved through the proper design of detention/retention basins. Among alternatives, wet ponds and constructed marsh systems are the most effective for achieving control of both stormwater volume and quality. Extended detention ponds providing two-stage pond designs (containing an upper, dry stage and a lower stage with a permanent pool) are also acceptable.

NOTE:

- 1) *Extensive literature is available on specific design concepts and alternatives, and references are available within this document's bibliography.*
- 2) *Diagrams for this section are contained within Appendix B. Several other structural BMPs not referenced within the following text are also illustrated.*

1. GENERAL REQUIREMENTS

The following criteria will apply to the design of all stormwater retention and detention facilities.

- a. In general, wet ponds and stormwater marsh systems will be preferred to dry ponds. Dry ponds providing extended storage will be accepted when the development site's physical characteristics or other local circumstances make the use of a wet pond infeasible.
- b. When discharge is within a watershed where thermal impacts are a primary concern, dry ponds will be preferred to wet ponds, and extended detention (first flush and bankfull) requirements may be reduced to 12 hours (see Appendix C, Paint Creek and Johnson Creek Watersheds). Shade plantings on the west and south sides of facilities are encouraged.
- c. Public safety will be a paramount consideration in stormwater system and pond design (see Part II, Section X). Providing safe retention is the proprietor's responsibility. Pond designs will incorporate gradual side slopes, vegetative and barrier plantings, and safety shelves. Where further safety measures are required, the proprietor is expected to include them within the proposed development plans.
- d. Stormwater management systems incorporating pumps are not permitted.
- e. **Storage Volumes and Release Rates**

On-site management of storm drainage will be designed for control of flooding, downstream erosion and water quality. Submission of flow

calculations, cross sections and other pertinent data will be required.

- i. The volume of storage provided for flood control will be equal to or in excess of that required by the Washtenaw County Drain Commissioner's "A Simple Method of Detention Basin Design" for a 100-year frequency storm (See Appendix H).

The allowable release rate from the flood control storage volume will normally be between 0.1 and 0.15 cfs per acre of the property being drained, or as determined by the Township.

If discharge does not outlet to a clearly defined downstream channel, the allowable release rate shall not exceed 0.10 cfs per acre.

- ii. The volume and storage provided for controlling the "bankfull" flood, will be equal to or in excess of the total rain from a 1.5-year storm, which can be determined by:

$$\underline{5160 \times \text{acreage} \times \text{the relative imperviousness factor } C}$$

The release rate from the "bankfull" storage volume will be such that this volume will be stored not less than 24 nor more than 40 hours.

- iii. The "first flush" of runoff will be captured and detained for at least 24 hours or within a permanent pool. The first flush is defined as the first 0.5 inch of runoff over the entire site, which can be determined by:

$$\underline{1815 \times \text{acreage} \times \text{the relative imperviousness factor } C}$$

- f. A sediment forebay will be provided at the inlet of all stormwater management facilities, to provide energy dissipation and to trap and localize incoming sediments.

- i. The forebay will be a separate cell, which can be formed by gabions or an earthen berm.

- ii. Capacity of the forebay should account for 15 years of sediment accumulation, and will not be included in calculating overall basin stormwater storage capacity.

- iii. Direct maintenance access to the forebay for heavy equipment will be provided.

- iv. An adequate disposal area shall be provided for accumulated sediment.

g. Basin Inlet/Outlet Design

- i. Velocity dissipation measures will be incorporated into basin designs to minimize erosion at inlets and outlets, and to minimize the resuspension of pollutants.
- ii0 To the extent feasible, the distance between inlets and outlets will be maximized. The length and depth of the flow path across basins and marsh systems can be maximized by:
 - ∞ increasing the length to width ratio of the entire design
 - ∞ increasing the dry weather flow path within the system to attain maximum sinuosity

If possible, inlets and outlets should be offset at opposite longitudinal ends of the basin.

- iii. The use of V-notched weirs, dual outlets, or other designs to assure an appropriate detention time for all storm events is required.
- iv. The outlet will be well protected from clogging. A reverse-slope submerged orifice or a hooded, broad crested weir are recommended options. If a reverse-slope pipe is used, an adjustable valve may be necessary to regulate flows.
- v. Where a pipe outlet or orifice plate is to be used to control discharge, it will have a minimum diameter of 4 inches. If this minimum orifice size permits release rates greater than those specified in these rules, alternative outlet designs will be utilized that incorporate self-cleaning flow restrictors, such as perforated risers and “V” notch orifice plates that provide the required release rate. Calculations verifying this rate are to be submitted to the Township for approval.
- vi. Backwater on the outlet structure from the downstream drainage system will be evaluated when designing the outlet.
- vii. Riser Design

- ∞ Orifices used to maintain a permanent pool level should withdraw water at least one foot below the surface of the water.
- ∞ Hoods or trash racks should be installed on the riser to prevent clogging.

- ⌘ The riser shall be placed near or within the embankment, to provide for ready maintenance access.
 - ⌘ Inlet and outlet barrels and risers will be constructed of materials that will reduce future maintenance requirements. The riser pipe shall be a minimum of 24" in diameter.
 - ⌘ Where feasible, a drain for completely de-watering the pond should be installed for maintenance purposes.
- viii. All outlets will be designed to be easily accessible for heavy equipment required for maintenance purposes.

h. Vegetative Plantings Associated with Retention/Detention Facilities

- i. Basins and marsh designs will be accompanied by a landscaping plan that uses native plant species. (See Appendix R.)
 - ii. A permanent buffer strip of natural vegetation at least 25 feet in width will be maintained or restored around the perimeter of all ponds and marshes. No lawn care chemical applications shall be applied to the buffer area.
 - iii. Viability of plantings will be monitored for two years after establishment by the proprietor, and reinforcement and replacement plantings provided as needed.
- i. For safety purposes and to minimize erosion, basin side slopes will generally not be flatter than 20:1 nor steeper than 5:1. Steeper slopes may be allowed if fencing at least 5 feet in height is provided.
- j. Anti-seep collars should be installed on any piping passing through the sides or bottom of the basin to prevent leakage through the embankment.
- k. A minimum of one foot of freeboard will be required above the 100-year stormwater elevation on all detention/retention facilities.
- I. All basins will have provisions for a defined emergency spillway, routed such that it can be picked up by the main outflow channel.
- m. Adequate maintenance access from public or private right-of-way to the basin will be reserved. The access will be on a slope of 5:1 or less, stabilized to withstand the passage of heavy equipment, and will provide direct access to both the forebay and the riser/outlet.

- n. For sites where chemicals may be stored and used (e.g. certain commercial and industrial developments) a spill response plan will be developed that clearly defines the emergency steps to be taken in the event of an accidental release of harmful substances that may migrate to the stormwater system. As a result of this plan, design elements such as shut-off valves or gates may be needed.
- o. The placement of retention/detention basins within a floodplain is discouraged. Where retention/detention basins are proposed within a floodplain, information will be provided to verify that the facility will operate as designed during flood events.
- p. Requirements for stormwater quantity control may be waived for developments in the downstream-most locations of a watershed, although quality management will still be necessary. Determinations will be made on an individual site basis.

2. PERMANENT RETENTION PONDS

a. Storage Volume

Retention basins with no outlet will be capable of storing two consecutive 100-year storms, which can be determined by:

$33.000 \times \text{acreage} \times \text{the relative imperviousness factor } C$

- i. An overflow assessment will be required. The assessment should include descriptions of the surrounding areas that would be impacted in the event of an overflow.
- ii. The proprietor must submit a soil boring log, taken within the basin bottom area to a depth of 25 feet below existing ground or 20 feet below proposed basin bottom elevation.
- iii. The volume required may be modified based upon the percolation rate of the soil, groundwater table elevation and a recommendation from a licensed hydro-geological consulting engineer.

3. WET DETENTION BASINS

a. Storage Volume

Storage volume on a gravity outflow wet basin is defined as "the volume of detention provided above the invert of the outflow device". Any volume provided below the invert of the outflow device will not be considered as detention.

At a minimum, the volume of the permanent pool should be at least:

2.5 x 0.5 inch³ x runoff coefficient x site drainage area

- b. Wet detention pond configuration will be as follows:
 - i. Surface area to volume ratio should be maximized to the extent feasible
 - ii. In general, depths of the permanent pool should be varied and average between 3 and 6 feet
 - iii. A minimum length to width ratio of 3:1 should be used unless structural measures are used to extend the flow path
 - iv. Ponds should be wedge-shaped, narrower at the inlet and wider at the outlet
 - v. Irregular shorelines are preferred
- c. A marsh fringe should be established near the inlet or forebay and around at least 50% of the pond's perimeter.
- d. A shelf, a minimum of 4 feet wide at a depth of one foot, will surround the interior of the perimeter to provide suitable conditions for the establishment of aquatic vegetation, and to reduce the potential safety hazard to the public.
- e. To avoid drawdowns, a reliable supply of baseflow and/or groundwater will be required.
- f. If underlying soils are highly permeable (e.g. in the "A" or "B" hydrologic groupings), the bottom of the basin should be lined with an impermeable geotextile or a 6 inch clay liner. (For SCS Soil Hydrologic Groupings, see Appendix K).
- g. In-line detention basins are strongly discouraged in all circumstances, and are prohibited on water courses greater than 2 square miles upstream or on a County drain. In-line basins are also prohibited if the waterway to be impounded traverses any area outside of the proposed development.

0.5" represents the mean storm event. This was determined by adding the total precipitation rainfall recorded at Detroit Metro Airport from 1977 to 1987 and dividing by the total number of storm events. Storms below 0.2" of total precipitation, snowfall, and snowmelt were omitted.

4. EXTENDED DETENTION BASINS

a. A two-stage design is required, with separate outlet controls to detain both the 1.5-year and larger rain events.

i. Lower Stage

The lower stage should contain a shallow, permanent pool designed to store and treat the "first flush", or 0.5 inch of runoff over the entire site. This pool should be managed as a shallow marsh or wetland, and average 6-12 inches in depth.

At a minimum, the volume of runoff detained in the entire lower stage should be equivalent to the runoff volume produced by a 1.5-year storm.

ii. Upper Stage

The upper stage should be sized for the 100-year, 24-hour storm, as provided in Part 2 Section II.A.1.d.i. of these rules, and should be graded to remain dry except during large storms.

A low flow channel, stabilized against erosion, will be provided through the dry portion of the basin. This channel should have a minimum grade of 0.5%, and the remainder of the basin should drain toward this channel at a grade of at least 1%.

The low flow channel should end at the lip of the lower stage, where riprap or gabion baffles will be placed to prevent scour and resuspension.

5. STORMWATER WETLAND SYSTEMS

BACKGROUND

Stormwater wetlands are defined as constructed systems explicitly designed to mitigate the stormwater quality and quantity impacts associated with development. They do so by temporarily storing stormwater runoff in shallow pools that create growing conditions suitable for emergent and riparian wetland plants. The runoff storage, complex microtopography and emergent plants in the stormwater wetland together form an ideal system for the removal of urban pollutants. Because of their water quality benefits, the use of stormwater wetlands is encouraged.

As a general rule, stormwater wetlands should not be located within delineated natural wetland areas, nor be confused with created wetlands that are used to mitigate the loss of natural wetlands.

The design of an effective and diverse stormwater wetland requires a

sophisticated understanding of hydrology and wetland plant ecology. Therefore, wetland construction, re-construction or modification must be overseen by a qualified professional with specific wetland expertise. An excellent reference for the design of storm water wetlands is by Thomas R. Scheuler, "Design of Stormwater Wetland Systems" (published by the Metropolitan Washington Council of Governments).

1. Stormwater wetland systems must be designed to perform in conformance with all standards for storage volume and discharge rate established in these rules.
2. The developer will provide for the monitoring of wetland plantings and replacement as needed for a two-year period after construction.

B. STORMWATER CONVEYANCE

All structures will be constructed in accordance with governing specifications. (Michigan Department of Transportation, Washtenaw County Road Commission, City or Township). In the event of no other governing specifications, the latest edition of the Michigan Department of Transportation standards will be observed.

Stormwater conveyance Systems incorporating pumps are not permitted.

1. NATURAL STREAMS AND CHANNELS

- a. Natural streams are to be preserved. Natural swales and channels should be preserved, whenever possible.
- b. If channel modification must occur, the physical characteristics of the modified channel will meet the existing channel in length, cross-section, slope, sinuosity, and carrying capacity.
- c. Streams and channels will be expected to withstand all events up to the 100-year storm without increased erosion. Armoring banks with riprap and other manufactured materials will be accepted only where erosion cannot be prevented in any other way. such as by the use of vegetation.

2. VEGETATED SWALES/OPEN DITCHES

- a. Open swale/ditch drainage Systems will be preferred to enclosed storm sewers where applicable governmental standards and site conditions permit.
- b. Swales should:
 - ∩ follow natural, pre-development drainage paths insofar as possible. be well vegetated, wide and shallow.

- c. Open ditch flow velocities will be neither siltative nor erosive. In general, the minimum acceptable velocity will be 2.0 ft./sec., and the maximum acceptable velocity will be 6.0 ft./sec.
- d. Open ditch slopes will depend on existing soils and vegetation and, whenever possible, will be greater than 1.5%. For slopes less than 1.5%, additional inspection will be necessary to ensure proper, positive drainage. In no case shall slopes be less than 1.0%, unless other techniques such as infiltration devices are implemented. Maintenance for such devices must be detailed in the overall Maintenance Plan.
- e. Side slopes of ditches should be no steeper than 3:1. Soil conditions, vegetative cover and maintenance ability will be the governing factors for determining slope requirements.
- f. Slopes and bottoms of open ditches and swales will be stabilized to prevent erosion.
- g. Swale length should be a minimum of 200 feet whenever possible, to increase the contact time of stormwater.
- h. In general, a 5-foot clearance will be provided between open swale/ditch inverts and underground utilities unless special provisions are employed. Special provisions, for example, could be the encasement of utility lines in concrete when crossing under the channel. In no case will less than 2 feet of clearance be allowed.
- i. Permanent metal or plastic markers will be placed on each side of the drain to show the location of underground utilities
- j. All bridges will be designed to provide a 2 foot minimum flood stage freeboard to the underside of the bridge. Footings will be at least one foot below the invert grade of the channel. Depending on soils, additional footing depth may be required.
- k. A series of check dams or drop structures across swales should be provided to enhance water quality performance and reduce velocities.
- l. Designers should consider integrating additional redundant pollutant removal enhancement features such as stilling basins and stone infiltration trenches.

3. ENCLOSED DRAINAGE STRUCTURES

- a. Enclosed storm drain systems will be sized to accommodate the 10-year storm, with the hydraulic gradient generally kept below the top of the pipe.

- b. Restricted conveyance systems designed to create backflow into stormwater storage facilities are not permitted.
- c. Drainage structures will be located as follows:
 - i. To assure complete positive drainage of all areas of the development
 - ii. At all low points of streets and rear yards
 - iii. Such that there is no flow across a street intersection
 - iv. For smaller enclosed pipes (12-24 inches), manholes will not be spaced more than 400 feet apart. Longer runs may be allowed for larger sized pipe but in all cases maintenance access must be deemed adequate by the Township.
 - v. In conformance with any more stringent local requirements
- d. The catch basin or inlet covers should be designed to accept the 10-year design storm. No ponding of water should occur during this storm event.
- e. Discharge from enclosures will be as follows:
 - i. All outlets will be designed so that velocities will be appropriate to, and will not damage, receiving waterways.
 - ii. Outlet protection using riprap or other approved materials will be provided as necessary to prevent erosion.
 - iii. The soils above and around the outlet will be compacted and stabilized to prevent piping around the structure. Riprap extending 3 feet above the ordinary high water mark is recommended for all outlets.
 - iv. When the outlet empties into a detention/retention facility, channel or other watercourse, it will be designed such that there is no overfall from the end of the apron to the receiving waterway.
- f. Pipe will conform to the following criteria:
 - i. In order to avoid accumulation of sediment in the drain, pipe

will be designed to have minimum velocity flowing full of 3 ft/sec., with the exception of sediment chambers. In isolated circumstances, 2 ft/sec. will be allowed. The allowable maximum velocity flowing full will be 10 ft/sec. Special cases where topography is steep may be granted exception.

- ii. Pipe joints will be such as to prevent excessive infiltration or exfiltration
- iii. All materials will be of such quality as to guarantee a maintenance-free expectancy of at least 50 years and will meet all appropriate A.S.T.M. standards.
- g. In areas where local ordinance requires sump pump leads to be connected into an enclosed system, these taps shall be made directly into storm sewer structures.

4. DETERMINATION OF CHANNEL SIZE

- a. The “Mannings” formula will be used to size the open channel or pipe.

“Mannings Formula”

$$Q = \frac{14.9}{n} AR^{2/3} S^{1/2}$$

Q = flow, in cubic feet per second

A = cross sectional area, in square feet

n = Mannings coefficient of roughness
(See Appendix E for reference)

R = hydraulic radius = A/P, in feet

P = wetted perimeter

S = slope of the bottom of the drain

If the “Mannings” formula is not used, the alternative method used will be approved by the Township.

- b. A minimum “n” of 0.035 will be used for the roughness coefficient unless special treatment is given to the bottom and side slopes, such as sodding, riprap or paving.

5. DETERMINATION OF CULVERT SIZE

- a. Under Michigan State Law (Act 451, PA. Part 301 of 1994 and Act 451, P.A. **Part X** of 1994), crossroad culverts draining two square miles or more must be reviewed and approved by the Michigan Department of Natural Resources. (See Appendix F.)

- b. Crossroad culverts draining less than 2 square miles of upstream watershed will be sized by the proprietors engineer and approved by the Washtenaw County Road Commission and Washtenaw County Drain Commissioners office.
- c. In general, culverts will pass the 100-year storm flow with the velocity not exceeding 8 feet per second, and with no increase in adverse water conditions occurring off of the development property or flooding of structures within the development. A minimum of one foot of freeboard is required.
- d. Acceptable methods of determining the quantity of water needed to pass through the culvert are listed below. The proprietors engineer may use any of the methods listed or another if approved by the Township:
 - i. Rational Method
 - ii. U.S.D.A. Soil Conservation Service Method
 - iii. The Michigan Department of Natural Resources Method
 - iv. Continuous flow modeling
- e. The discharge velocity from culverts should consider the effect of high velocities, eddies, or other turbulence on the natural channel, downstream property and roadway embankment. The culvert exit velocity should not cause downstream channel erosion or scour.
- f. Sizing of culvert crossings will consider entrance and exit losses as well as tailwater conditions on the culvert. Once the design flow is determined, the required size of the culvert will be determined by one of the following methods:
 - ☞ The "Mannings" formula
 - ☞ The inlet headwater control/outlet tailwater control nomographs
 - ☞ Other methods approved by the Township
- g. Wing walls, headwalls and all other culvert extremities will be designed to assure the stability of the surrounding soil. It is recommended that Michigan Department of Transportation standard designs be observed unless special exemption is given.

**C. ADDITIONAL STORMWATER MANAGEMENT BMPS:
INFILTRATION TRENCHES AND SAND FILTERS**

A variety of best management practices, other than those detailed within these rules, provide effective water quality and quantity control. The following section provides design standards for only two of many approaches that may be acceptable to the Township.

1. INFILTRATION TRENCHES

BACKGROUND

In filtration devices are designed to capture and treat stormwater runoff from smaller rain events, that are managed for water quality purposes. They function to reduce runoff at its source, since the diverted “first flush” is not discharged to surface water but is stored until it is gradually removed by infiltration and evaporation. Through these mechanisms, infiltration can remove pollutants, provide groundwater recharge and help reduce the volume of runoff leaving a site. Infiltration devices are generally incorporated as one component of an overall stormwater system that utilizes other management approaches as well.

While the concept of infiltration best conforms to the stormwater management goals of water quantity and quality control stated within these rules, in practice, infiltration approaches to stormwater management have limited application. Although many infiltration devices are very effective for removing fine sediment particles and the pollutants associated with them, coarse sediments and oil wit; clog infiltration systems, and must be removed prior to entering them. Clogging of infiltration devices is a primary reason for failure, causing many to fail during the first few years of operation. The use of erosion control measures, sedimentation basins and grass filter strips to pre-treat runoff is essential, as well as a very aggressive maintenance program. In addition, studies have shown that many infiltration facilities fail or do not work as designed due to poor initial site selection. Therefore, soil suitability and the contributing drainage area must be carefully assessed. The potential for groundwater contamination must also be seriously considered prior to implementation.

Infiltration approaches to stormwater management are particularly attractive for small catchment areas of less than 10 acres in size, where the employment of more traditional BMP's such as wet ponds, artificial marshes, and/or extended detention dry ponds is often neither feasible nor desirable.

NOTE: Infiltration basins will not be permitted due to universally high failure rates.

a. Design Criteria for Infiltration Trenches

- i. Infiltration trenches are limited to small tributary areas of approximately 5 acres.
- ii. Infiltration trenches are not feasible where the slope of the site is greater than 20%, unless proper energy dissipation devices are installed. Trenches are also not recommended where the slope of the contributing watershed is greater than 5%. The slope of the trench bottom should be close to zero to evenly distribute exfiltration.
- iii. Minimum design volume will be based on infiltration of 0.5 inch runoff over the entire drainage basin.
- iv. All trenches will be designed to hold water for a minimum of 6 hours and a maximum of 72 hours.

- v. Filter fabric will be used to line the sides of the trench, and either filter fabric or 6” of sand will be used on the trench bottom. (Filter fabric placed 6 to 12 feet below the surface of an open trench can prevent the need for major rehabilitation).
- vi. Cleaned, washed stone aggregate, 1.5 to 3 inches in diameter, will be used within the stone reservoir.
- vii. The trench bottom will be a minimum of 4 feet above seasonally high groundwater and bedrock. Infiltration trenches will not be located within 100 feet of a water supply well or a building foundation.
- viii. To remain operative in freezing weather, the bottom of the trench will be placed 3 feet below the frost line.
- ix. Stormwater Pre-treatment
 - ⌘ A sediment settling basin, or other stormwater management practice, will be provided to remove coarse sediment from stormwater flows before they reach infiltration trenches.
 - ⌘ The use of pre-treatment systems that provide some degree of storage (e.g. sump pits, swales with check dams or plunge pools) is encouraged.
 - ⌘ For surface trenches, a minimum 25 foot wide grass buffer is required as a filter.
 - ⌘ Underground trenches will receive water directed through an oil/grit separator or other form of pre-treatment that will remove both coarse solids and oils.
- x. Where an overflow pipe is provided for flows in excess of design, the pipe will be placed near the surface of the trench and outlet to an acceptable point of discharge.
- xi. Underground trenches will be readily accessible for maintenance purposes.
- xii. An observation well, consisting of a perforated vertical pipe within the trench, will be installed in every trench to monitor performance.
- b. Infiltration trenches will not be built downslope of new construction until the entire development area has been permanently stabilized.
- c. Infiltration trenches should be located on soils in hydrologic groups “A” or “B” as designated by the U.S. Soil Conservation Service. Where infiltration

trenches are proposed, a sufficient number of soil borings will be provided in each location to allow evaluation of site suitability.
(For SCS Soil Hydrologic Groupings, see Appendix J)

- d. The bottom of the trench will be roto-tilled after construction, to reduce the possibility of initial soil compaction (caused by excavation with heavy equipment)
- e. A legally enforceable and binding maintenance agreement will be included in the property deed for each trench. All trenches will require annual inspection and maintenance.

2. SAND FILTERS

BACKGROUND

Sand filters are a technique for treating stormwater, whereby the first flush of runoff is diverted into an off-line, self-contained bed of sand. The runoff is then strained through the sand, collected in underground pipes and returned back to the stream or channel. Enhanced sand filters utilize layers of peat, limestone, and/or topsoil, and may also have a grass cover crop. In general, sand filters have a limited ability to reduce peak discharges and are usually designed solely to improve water quality.

Because sand filters are a self-contained, artificially constructed soil system, they have few constraining factors and can be applied to most development sites, including those too small to be effectively served by ponds (i.e. small in fill developments). Sand filters are also useful in areas with concerns over groundwater contamination and poor soil infiltration rates, and as end-of-pipe retro fits. The upper limit on sand filters appears to be about 50 acres; however, most have a contributing watershed between 0.5 and 10 acres.

While the technology is still developing, a number of standard sand filter designs are available and may be acceptable to the Township.

In general, all designs incorporate three basic components: 1) a pre-treatment wet pool or sedimentation basin; 2) an on-line diversion weir for isolating the stormwater to be treated, and; 3) an off-line sand filter bed area. A good reference for the design of sand filters is by Warren Bell, P. E., "A Catalogue of Stormwater Quality Best Management Practices for Ultra-Urban Watersheds". A copy of this paper is available through the Townships office.

General standards for the design of sand filter systems are as follows:

- a. The system should be designed to capture and treat the first 0.5 inch of runoff from the impervious portion of the contributing watershed.
- b. Pre-treatment of stormwater will be required before discharge into the sand filter. The following pre-treatment mechanisms may be acceptable to the Township:

⊘ Wet pools

- ⊗ Sedimentation basins
- ⊗ Oil-grit separators
- ⊗ Grass filter strips

- c. Sufficient sediment storage volume will be provided within pre-treatment devices, so that clean-out intervals are reduced to once every 2 to 3 years.
- d. Design stormflows will be conveyed to the sand filter bed basin at a non-erosive velocity. Generally, this velocity will be less than one foot per second.
- e. An over-sized perforated hood/trash guard will be incorporated into weir designs to minimize clogging of the baseflow pipe.
- f. Excess runoff volumes will be returned to the receiving conveyance channel via a rip-rapped baseflow/overflow channel.

g. Sand Filter Bed

- i. A variety of formulas for sizing sand filter beds are available, and may be acceptable to the Township.
- ii. The maximum surface ponding time for the design runoff volume will be limited to 24 hours.
- iii. An impermeable liner may be required to eliminate potential groundwater infiltration/exfiltration problems.
- h. Because of the potential for system failure due to bed clogging, sand filter system use is restricted to stabilized drainage areas.
 - i. Regular inspection and timely periodic removal of sediment and trash will be required. Grass cover crops, when provided, will be mowed whenever they exceed 10 cm. height (approx. once per week) and all grass cuttings removed.
 - j. The filter bed area will be clearly marked, and an appropriate drainage easement provided.

III. NATURAL WETLANDS

This section governs natural wetlands (as distinct from stormwater wetland systems that are constructed expressly for stormwater management purposes), when a natural wetland is incorporated in an overall stormwater management scheme.

- A. Wetlands will be protected from damaging modification and adverse changes in runoff quality and quantity associated with land developments. Before approval of the final development plan, all necessary wetland permits from the Michigan Department of

Environmental Quality (MDEQ) and the Township will be in place.

- B. Direct discharge of untreated stormwater to a natural wetland is prohibited. All runoff from the development will be pre-treated to remove sediment and other pollutants prior to discharge to a wetland. Such treatment facilities will be constructed before property grading begins.
- C. Site drainage patterns will not be altered in any way that will modify existing water levels in protected wetlands without proof that all applicable permits from the MDEQ and the Township have been obtained.
- D. Wetland construction, reconstruction, or modification will be overseen by a qualified professional with specific wetland expertise.
- E. Whenever possible, a permanent buffer strip, preferably vegetated with native plant species, will be maintained or restored around the periphery of wetlands. (See Appendix R.)
- F. Wetlands will be protected during construction by appropriate soil erosion and sediment control measures.

IV. LOT GRADING

Approval of final lot grading is the responsibility of the local municipality. The Township is not responsible for inspection of, or enforcing corrections to, final lot grading. It is the Township's responsibility to ensure that the overall plan is consistent with sound stormwater management and drainage practices. The development stormwater management plan will provide for the following:

- A. The grading of lots will be such that surface runoff is away from homes and toward swales, ditches or drainage structures. Provision for drainage through properly graded stormwater conveyance systems will be made for all areas within the proposed development.
- B. Where finished grades indicate a substantial amount of drainage across adjoining lots a drainage swale of sufficient width, depth and slope will be provided on the lot line to intercept this drainage. To ensure that property owners do not alter or fill drainage swales, easements will be required over areas deemed necessary by the Township, as stipulated in Part II, Section IX.

V. SOIL EROSION, SEDIMENTATION AND POLLUTION CONTROL

Discharge of sediment or other polluting materials to a waterway that is under jurisdiction of the Drain Commissioner either within or outside of the development, will be considered pollution to a county drain, and hence a violation of section 280.423 of the Michigan Drain Code. Under the Michigan Drain Code, pollution of a county drain is a criminal

misdemeanor, punishable by fine or imprisonment.

A. SOIL EROSION/SEDIMENTATION CONTROL

All erosion control measures will be regularly inspected and maintained.

1. DURING CONSTRUCTION

- a. The development plan should be fitted to the topography and soil so as to create the least erosion potential.
- b. An approved soil erosion permit from the local enforcing agent, as well as a National Pollution Discharge Elimination System (NPDES) permit where applicable, will be required.
- c. Sediment should not be permitted to leave the site. Recommended procedures to achieve this goal are as follows:
 - i. Wherever feasible, natural vegetation should be retained and protected
 - ii. The smallest practical area of raw land should be exposed at any one time (i.e. only areas under active construction).
 - iii. The entire site should be planted with temporary vegetation immediately after mass grading operations.
 - iv. Temporary vegetation and/or mulching should be used to protect critical areas exposed during development.
 - v. Sediment basins where needed should be installed and maintained by the proprietor.
 - vi. The permanent, final vegetation and structures should be installed as soon as practicable in the development.
- d. Areas within open drain rights-of way that have been cleaned, reshaped or disturbed in any manner will be stabilized with seed and mulch or sod as quickly as possible.
- e. All storm sewer facilities that are or will be functioning during construction will be protected, filtered, or otherwise treated to prevent sediment from entering the system. Construction activities will be complete before the construction of any stormwater management facilities susceptible to clogging (e.g. infiltration trenches).

2. PERMANENT EROSION CONTROL MEASURES

- a. Before entering any natural water course, protected wetland, county drain or other body of water, best management practices will be utilized to remove pollutants, including sediment, from stormwater runoff. Pollutant removal methods will include capture and treatment of the "first flush" and "bankfull" (1.5-year) storm events, as previously described in Section II.A.1.d. (Part 2, p.3).
- b. Headwalls, grouted riprap or other stabilization measures will be provided where necessary to prevent erosion. Permanent erosion protection will be placed at bends, drain inlets and outlets, and other locations as needed in all open ditches. Outlets to ditches will be placed at the average low water elevation of the water course.
- c. Ditches with steep grades or unstable soils will be protected by sod, vegetative erosion control, geotextile fabric, rip rap or other means to prevent scour. Every effort should be made to reduce the velocity of flow as much as possible at all storm drain outlets. Outlet velocities will be non-erosive.
- d. All detention/retention basins will be permanently stabilized to prevent erosion.

B. OTHER POLLUTION CONTROL

- 1. Discharge of runoff that may contain oil, grease, toxic chemicals, or other polluting materials is prohibited. Measures will be employed to reduce and trap pollutants and meet any prevailing federal, state, or local water quality requirements.
- 2. In commercial and industrial developments where large amounts of oil and grease may accumulate, appropriate methods for separating pollutants will be required. When used, oil and grit separator will be installed off-line or in locations where flow velocities have been determined to be lower than scouring velocity in a 10 year storm. Where off-line facilities are proposed, a maintenance program, including an identified method and site for waste disposal, is required.
- 3. For sites where chemicals may be stored and used (e.g. certain commercial and industrial developments) a spill response plan must be developed that clearly defines the emergency steps to be taken in the event of an accidental release of harmful substances to the stormwater system.
- 4. Structures designed to remove trash and other debris from stormwater will be installed as required on stormwater management facilities prior to their outlet.
- 5. Additional water quality protection measures may be required depending on the nature and location of the development and the receiving waters.

VI. BUFFER STRIPS

Buffer strips should be established adjacent to all surface waters through deed restrictions or provisions of master condominium agreements. Buffer strips are defined as zones where construction, paving, and chemical application is prohibited. Plantings capable of filtering stormwater should be established or preserved. Widths shall be determined on a case by case basis, based on such considerations as slope, soils, and size of drainage area.

VII. FLOODPLAINS

It is the responsibility of the developer to demonstrate that any activity proposed within a 100-year floodplain will not diminish flood storage capacity. In certain instances an analysis to determine the 100-year floodplain may be required. Compensatory storage will be required for all lost floodplain storage.

VIII. EASEMENTS

- A. Wording relative to easement information shown on the final development plan will be as specifically required by the Township. If a county drain is to be established under the Michigan Drain Code, related easement language will be depicted on final mylar plans and exhibit B condominium drawings as follows:
“_____ private easement to Washtenaw County Drain Commissioner for drainage.”

In addition, language will be included in the deed restrictions for the development and/or condominium master deed as shown in Appendix L.

- B. The location and purpose of drainage easements should be clearly described in development deed restrictions or condominium master deeds.

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

- C. If a utility is to be located within the right-of-way of any county drain or drainage easement, it will be located such that It will not significantly increase the expense of maintaining the drainage facility.
- D. Retention/detention basins or other stormwater management facilities will have sufficient easements for maintenance purposes. Easements will be sized and located to accommodate access and operation of equipment, spoils deposition, and other activities identified in the development’s stormwater system maintenance plan.
- E. Easement widths will be sized by the Township and be situated in such a way as to

allow maximum maintenance access (for example, by offsetting them from the centerline). In general, easement widths will conform to the following:

1. Open channels and water courses: A minimum of 50 feet total width. Additional width may be required in some cases, including but not limited to: water courses with floodplains delineated by FEMA; sandy soils, steep slopes, at access points from road crossings.
2. Back lot drainage (open swales): minimum of 30 feet total width.
3. Enclosed storm drains: A minimum of 20 feet will be required, situated in such a way as to allow maximum maintenance access. Additional width will be required in some cases, including but not limited to pipe depth exceeding 4 feet from the top of pipe, sandy soils and steep slopes.

F. Drain fields (septic areas) shall not be located within drainage easements.

IX. SAFETY CONSIDERATIONS

A. Drainage system components, especially all ponds, will be designed to protect the safety of all persons coming in contact with the system. The following criteria will apply:

1. The side slopes of all detention basins should not exceed 5:1 (horizontal to vertical), and will be as gradual as practicable to prevent accidental falls into the basin and for stability and ease of maintenance. If steeper slopes are proposed, continuous fencing at least 5 feet in height shall be provided. Fencing materials shall meet with the approval of the Township. Side slopes of open channels will not be steeper than 3:1.
2. Velocities throughout the surface drainage system will be controlled to safe levels taking into consideration rates and depths of flow.
3. All wet detention basins will have a level safety ledge at least 4 feet in width and one foot below the normal water depth, and other design and landscaping features as may be needed to provide for protection of the public.
4. Signs may be required, to alert residents to use limitations of any stormwater basin if the Township will have permanent maintenance jurisdiction.

B. For sites where chemicals may be stored and used (e.g., certain commercial and industrial developments), a spill response plan will be developed which clearly defines the emergency steps to be taken in the event of an accidental release of large quantities of harmful substances into the drainage system.

X. STORMWATER MANAGEMENT SYSTEM MAINTENANCE PLANS

- A. Property deed restrictions (or condominium master deed documents) will specify the following timeframe for action to address needed maintenance of stormwater management facilities. Deed restrictions (or condominium documents) will also specify that, should the private entity fail to act within this timeframe, the responsible governmental entity may perform the needed maintenance and assess the costs against the property owners within the development or condominium association:
1. Routine maintenance of stormwater management facilities will be completed within 30 days of receipt of written notification that action is required, unless other acceptable arrangements are made with the supervising governmental entity.
 2. Emergency maintenance will be completed within 36 hours of written notification.
- B. The proprietor may fulfill his or her obligation to ensure that a governmental entity will be responsible for drainage system maintenance by establishing a county drainage district, or any other similar mechanism approved by the Township, to provide for the permanent maintenance of stormwater management facilities and necessary funding.
- If a County Drain is not established, the proprietor will submit evidence of a legally binding agreement with another governmental agency responsible for maintenance oversight.
- C. A legally binding maintenance agreement will be executed before final project approval is granted. The agreement should be referenced on the property deed (or condominium master deed document) so that it is binding on all subsequent property owners.
- D. Maintenance plans will be submitted with all construction plans and included in the bylaws of all developments and site condominiums and will include the following information:
1. The maintenance plan shall include an estimated annual maintenance budget itemized in detail by task. The financing mechanism shall also be described.
 2. A copy of the final approved drainage plan for the development that delineates the facilities and all easements, maintenance access, and buffer areas.
 3. A listing of appropriate tasks defined for each component of the system described, and a schedule for their implementation. The following areas will be covered:
 - a. Maintenance of facilities such as pipes, channels, outflow control structures and pumps.
 - b. Debris removal from catch basins, channels and dry and wet basins.

- c. Dredging operations for both channels and basins to remove sediment accumulation.
 - 4. The party responsible for performing each of the various maintenance activities described, which will be recorded with final approved plans and plans.
 - 5. A detailed description of the procedure for both preventative and corrective maintenance activities. The preventative maintenance component will include:
 - a. periodic inspections, adjustments and replacements
 - b. record-keeping of operations and expenditures
 - 6. Provision for the routine and non-routine inspection of all components within the system described:
 - a. Wet weather inspections of structural elements, (including inspection for sediment accumulation in detention basins) should be conducted annually, with as-built plans in hand. These should be carried out by a professional engineer reporting to the responsible agency or owner.
 - b. Housekeeping inspections, such as checking for trash removal, should take place at least annually.
 - c. Emergency inspections on an as-needed basis, upon identification of severe problems, should be carried out by a professional engineer.
 - 7. A description of ongoing landscape maintenance needs. Landscaping shall consist of low maintenance and/or native plant species. The viability of plantings will be monitored by the proprietor for at least one year after establishment and plantings will be replaced as needed. The Township is not responsible for landscape maintenance.
 - 8. Provision for the maintenance of vegetative buffers by homeowner's associations, conservation groups or a public agency. Buffers will be inspected annually for evidence of erosion or concentrated flows through or around the buffer.
- E. The stormwater drainage system will be designed to minimize and facilitate maintenance. (See **X** for design considerations)
 - 1. Riser pipes placed near or within pond embankments.
 - 2. Easily accessible trash racks.
 - 3. Alternate outflows for wet detention basins that can be used to completely drain the pool for sediment removal (pumping may be considered if drainage

by gravity is not feasible).

4. Sediment forebays for localizing sediment deposition and removal.
 5. Access for heavy equipment.
 6. On-site area for spoil deposition, wherever possible.
- F. Infiltration Systems, including porous pavement, must be aggressively maintained and protected from clogging by sediment (including the maintenance of grass buffer strips). In the event of clogging by accumulated sediments, partial or total reconstruction of infiltration facilities may be required.

Porous pavement shall be vacuum swept and jet hosed at least four times per year to remove any grit or sediment trapped in the pores of the open-graded asphalt. Evidence of a regular service contract for performing this activity will be required.