CITY OF ROCHESTER HILLS

ENGINEERING DESIGN STANDARDS

CHAPTER 4

Stormwater Management

A. Purpose

In order to protect the health, safety, and general welfare of the residents of the City of Rochester Hills, comply with Rochester Hills' MS4 general permit No. MIG619000, as well as to protect, sustain, and enhance the surface and ground water resources of the City of Rochester Hills, drainage and stormwater management practices shall be utilized as directed herein to achieve the following objectives:

1. Accommodate site development and redevelopment in a manner that protects public safety and is to the extent practicable consistent with (or re-establishes) the natural hydrologic characteristics of each watershed and sustains ground water recharge, stream baseflows, stable stream channel (geomorphology) conditions, the carrying capacity of streams and their floodplains, ground water and surface water quality, and aquatic living resources and their habitats.

2. Protect water quality by removing and/or treating pollutants prior to discharge to ground and surface waters throughout the City of Rochester Hills, and to protect, restore, and maintain the chemical, physical, and biological quality of ground and surface waters.

3. Reduce flooding impacts and prevent a significant increase in surface runoff rates and volumes, predevelopment to post-development, which could worsen flooding downstream in the watershed, enlarge floodplains, erode stream banks and create other flood-related health-welfare-property losses; in general, to preserve and restore the natural flood-carrying capacity of streams and their floodplains.

4. Ensure effective long-term operation and maintenance of all permanent stormwater management facilities.

B. Applicability

The following construction projects shall be regulated by these standards:

1. Land development, including but not limited to plats, single family detached site condos, commercial developments, industrial developments, and all other developments that are subject to site plan review and approval.

2. Redevelopment of existing improved land

   a. Redevelopment projects that change or alter the existing developed surface of one acre or more; or

b. Redevelopment that disturbs less than an acre but increases the impervious surface area by 10% or greater; flood protection and channel protection standards need to be met, at a minimum, for the increased impervious surface area.

c. Redevelopment of less than one acre, but disturbs greater than 50 % of the site and involves a site plan approval and use change;

d. Redevelopment that involves removal and/or installation of site storm sewer and/or detention system.

e. Redevelopment projects that change or alter the existing developed surface of less than one acre where the downstream conditions show evidence of negative impacts from excessive stormwater discharge rate. This in particular applies to existing developed sites that have no flood protection and/or channel protection controls.

f. If the proposed site use does not meet the above five types of redevelopment but is of a Heavy Traffic and Pollutant Load or Moderate Traffic and Pollutant Load as defined in Subsection 4.3.2 B2 "Catch Basin and Inlets," then the post development water quality standards apply.

   Exception:

   i. If the redevelopment is part of a larger development with a private regional stormwater system that includes detention and there is no net increase in impervious surface with the redevelopment.

   ii. An alternate method acceptable to the City Engineer is proposed that will address post development water quality and the channel and flood protection objectives of the City of Rochester Hills.

C. Stormwater Management Plan

For all activities regulated by these Standards in accordance with the above sub-section, B. Applicability, the Applicant shall submit a stormwater management plan and report prepared by a Professional Engineer licensed in the State of Michigan, which shall contain, but not be limited to, the following:

1. Suitable maps and drawings showing all existing natural and constructed drainage facilities affecting the subject property.

2. Hydrologic (watershed) and water feature boundaries, including all areas flowing to the proposed project, existing streams (including first order and intermittent streams), springs, lakes, ponds, or other bodies of water within the project area.

3. Sufficient topographical information with elevations to verify the location of all ridges, streams, etc. (two-foot contour intervals within the project's boundaries and for proposed offsite improvements.

4. Notes pertaining to and locations of existing standing water, areas of heavy seepage, springs, wetlands, streams, and hydrologically sensitive areas.

5. A drainage area map showing all sub-watershed areas, runoff coefficients, acreage of drainage area, general type of soils with hydrologic soil group (HSG) noted, estimated permeability in inches per hour, location and results of all soil tests and borings, and proposed stormwater management system in plan view shall be included with the plans.

6. 100-year flood elevations for any Special Flood Hazard Areas on or within one hundred feet (100') of the property.

7. Description of current and proposed ground cover and land use. The total area and runoff coefficient for each drainage area noted.

8. A plan of the proposed stormwater drainage system attributable to the activity proposed, including runoff calculations, stormwater management practices to be applied both during and after development, and the expected project time schedule.

9. The design computations for all proposed stormwater drainage systems, including storm-drain pipes, inlets, runoff control measures and culverts, drainage channels, and other features, facilities, and stormwater management practices

10. A grading plan, as required under *Chapter 5* of the City of Rochester Hills Engineering Design Standards; including all areas of disturbance, of the subject activity. The total area of disturbance shall be noted in square feet and acres.

11. A plan of the erosion and sedimentation procedures to be utilized as required under *Chapter 11* of the City of Rochester Hills Engineering Design Standards and/or as required by the Oakland County Water Resources Commission (OCWRC).

12. A route delineation of all concentrated flow (that is, flow other than overland sheet flow).

13. The effect of the project (in terms of runoff volumes and peak flows) on adjacent properties and on any other stormwater collection system that may receive runoff from the project site and specifics of how erosion and flooding impacts to adjacent properties will be avoided or otherwise mitigated.

14. An operation and maintenance plan consistent with the requirements of Section E of this chapter. Such a plan should clearly explain how the proposed facilities operate and the functions they serve.

15. The name of the development, the name and address of the property owner and Applicant, and the name and address of the individual or firm preparing the plan.

16. A north arrow, submission date, scale and revision dates as applicable shall be included on each page of all plans submitted.

17. Construction details sufficient to completely express the intended stormwater design components consistent with these standards.

D. Stormwater Management Design Standards

1. Design Goals, Principles and Standards

   a. The post development peak discharge rate shall not exceed 0.2 cfs/acre for the 25-year storm event.

   b. The bankfull storm event or the 2-year 24-hour storm event shall be attenuated for at least 24 hours (i.e. the stormwater will be released over a minimum of 24 hours) as described in chapter pages 4-6 to 4-7 for Channel Protection (Bankfull).

2. Stormwater Runoff Calculation Methods

For parcels of land with an area of 120 acres or less, the Rational Formula (Q=CIA) shall be calculated as I = 175 / (T+25), for a 10-year frequency, one hour intensity storm, in which T is the time of concentration in minutes and I is the intensity in inches per hour. The initial T is generally 20 minutes for residential areas and 15 minutes for high runoff areas, such as commercial and office space. All composite runoff coefficients shall be based on the values shown in the table below. The slopes listed for the semi-pervious surfaces are the proposed finished slope of the tributary area.

Type of Surface	**Runoff Coefficient (c)**		
Water Surfaces	1.00		
Roofs	0.95		
Asphalt or concrete pavements	0.95		
Gravel, brick, or macadam surfaces	0.85		
Green Roofs (< 4 in)*	0.50		
Green Roofs (4 – 8 in)*	0.30		
Green Roofs (9 –20 in)*	0.20		
Green Roofs (> 20 in)*	0.10		
Porous asphalt or concrete pavements**	0.10		
Paving stones (a.k.a. unit pavers)**	0.10 – 0.70 (as specified by manufacturer)		
Grass Pavers (a.k.a. turf blocks)**	0.15 – 0.55		
Semi-pervious; lawns, parks, playgrounds	Slope <4%	Slope 4%-8%	Slope >8%
Hydrologic Soil Group A	0.15	0.20	0.25
Hydrologic Soil Group B	0.25	0.30	0.35
Hydrologic Soil Group C	0.30	0.35	0.40
Hydrologic Soil Group D	0.45	0.50	0.55

* Referenced from The State of Minnesota Sustainable Building Guidelines – Version 2.0, Worksheet S-1

** Referenced from the Massachusetts Low Impact Development Toolkit, Fact Sheet #6.

More precise methodologies for predicting runoff such as runoff hydrographs are widely available, and may be required by the City of Rochester Hills Engineering Division for sizing the drainage systems on large sites and/or smaller sites that are deemed potentially problematic. –Use of an alternate method can be proposed for review and approval by the City Engineer.

3. Stormwater Management Practices-Sizing Criteria

   The following sizing criteria shall be followed at all sites required to meet the standards of Section B - Applicability.

   a. Stormwater Recharge and Infiltration

      Impervious and disturbed surfaces from development alter the natural hydrologic cycle by discharging stormwater directly to streams, rather than allowing it to infiltrate through the soils and into groundwater as it did before development. This increases flooding and reduces the base flow to streams that is needed in the summer months when there is little precipitation. The increased runoff from impervious surfaces also increases stream temperatures, since pavement and other impervious surfaces absorb substantial amounts of heat in the summer due to their dark coloring and lack of shade, which is transferred to runoff passing over the surface. The result is runoff that is dramatically warmer than natural groundwater inflow would have been under a natural hydrologic cycle. The purpose of this criterion is to maintain existing recharge rates to preserve existing groundwater levels and stream base flows.

      i. All storms up to one half inch (½") must be captured and infiltrated on-site. The volume of water to be infiltrated shall be calculated using the following equation:

         $Re_v = 1{,}815\ (A)(C)$,
         Where:
         Re_v = recharge volume (ft^3)
         C = weighted runoff coefficient
         A = site area in acres
         1,815 = 0.5 inch (½") rainfall x 3,630 to convert ac-in to cf.

      ii. The maximum depth of an infiltration system shall be one and a half feet (1½') unless the infiltration rate is greater than one half inches (½") per hour, in such case, the system may be deeper and must be capable of infiltrating the recharge volume within a 48-hour period.

      iii. Recharge should not be concentrated to one area. It should be distributed to multiple areas throughout the site.

      iv. Site design should implement runoff reduction techniques such as those described in Appendix A.

      Exception to Subsection D.3.a Stormwater Recharge and Infiltration:
      Stormwater Recharge and Infiltration standards must be met except where it has been demonstrated, to the satisfaction of the City Engineer, that use of recharge and infiltration is not suitable for the site due to the soil conditions, ground water

conditions or risk of negative environmental impact, provided that an alternate method acceptable to the City Engineer is proposed that will address the recharge /stormwater volume reduction objectives of the City of Rochester Hills.

b. Post Development Water Quality

Development also impacts the water quality of streams, ponds, lakes and wetlands. As impervious area increases, the volume and velocities of stormwater increase, often resulting in erosion of soils. Pollutant deposits on the land surface also increase as the intensity of land use increases. These materials are then washed off by rain and runoff, increasing the pollutant load to receiving waters. Thus, it is important that stormwater management practices (SMP) are used to handle water quantity as well as treat water quality. The water quality volume should include the first flush of storms, as this is where the majority of pollutants are collected and discharged.

i. The water quality volume required to be treated shall be calculated as:

   WQv =3,630 (A)(C),
   Where:
   WQv = water quality volume (ft3)
   C = weighted runoff coefficient
   A = site area in acres
   3,630 = one inch (1") rainfall x 3,630 to convert ac-in to cf.

ii. The post development water quality stormwater Practice (SMP) shall be achieved through the inclusion of a mechanical separator, a sediment forebay, or an infiltration trench(es) designed to remove at least 80% Total Suspended Solids.

c. Channel Protection (Bankfull)

Many storm water management practices focus on controlling peak flow rates for larger storms, including the 10-year, 25-year, 50-year, and 100-year storms. This does not address the increased duration at which those high flows occur because of the increased volume of water from development compared to pre-development. For example, although the peak flows are kept the same, there is a much greater volume of water leaving the site under developed conditions and the streams have higher flows for longer durations than they did under predevelopment conditions. In addition, because the impervious development has limited recharge, base flow during non-storm event times is lower. The purpose of this criterion is to limit the total amount of time that a receiving stream exceeds an erosion-causing threshold, based on pre-developed conditions.

i. The volume and storage provided for controlling the bank full flood will be equal to or in excess of the runoff from a 2-year, 24-hour storm, which can be determined by:

   Cpv = 8,676(A)(C),
   Where:
   Cpv = channel protection volume (ft3)
   C = weighted runoff coefficient
   A = site area in acres

8,676 = 2.39 inch rainfall x 3,630 to convert ac-in to cf.

ii. The release rate from the bank full storage volume will be such that this volume will be stored not less than 24 nor more than 48 hours.

d. Flooding Protection (Overbank)

The goal of this criterion is to prevent flood damage to conveyance systems and infrastructure and reduce minor flooding caused by overbank floods. Overbank floods are defined as floods, which exceed the bankfull capacity of the channel and spill over to the floodplain where they can damage property and structures. The key management objective is to protect downstream structures (houses, businesses, culverts, bridge abutments, etc.) from increased flows and velocities from upstream development

i. The over bank flood protection volume shall be calculated to detain the volume of runoff from the entire site, resulting from a 25-year frequency storm.

ii. The allowable release rate from the over bank flood protection volume shall be 0.2 cfs per acre, but in no case shall exceed the capacity of the receiving stream or body of water. In the event that the receiving stream cannot properly convey the 0.2 cfs per acre design discharge, the discharge shall be limited to the existing capacity of the receiving stream. Hydraulic calculations shall be submitted showing the existing capacity of the receiving stream for review.

iii. In general, the Oakland County, "A Simple Method of Detention Basin Design" method by Glen Yrjanainen shall be used.

e. Extreme Flooding Protection

The site shall provide a safe overflow for the 100-year storm event.

f. Pretreatment

To prevent premature failure, the design of stormwater management practices (SMPs) shall include a pre-treatment device or method that will trap sand and sediments to avoid clogging the treatment mechanism. Infiltration of stormwater from the SMP into underlying soils and eventually groundwater aquifers is an important beneficial component of the device. Pre-treatment basins must be designed and located to be easily inspected and accessible to facilitate maintenance.

i. The pretreatment device shall be sized to accommodate a one-year storm event. The "Detention Time" method of design from the OCWRC Erosion Control Manual should be used to calculate the volume of storage.

g. Acceptable Storm Water Management Practices (SMP) Options

Rochester Hills encourages the design of storm water management systems that meet or exceed the site storm water storage requirements and also incorporate elements to improve aesthetic value, sustainability, and creativity. Detention basins with or without permanent water storage are preferred. Underground detention systems can be proposed for consideration but must identify a means of operating the underground facility to ensure that the required storage volume can be maintained. Above or underground storage basins that rely upon pumps for dewatering are least desirable and must be shown to be the only reasonable means of use for the development. Retention basins and infiltration trenches (items that do not have an outlet and rely on the underlying soil infiltration) can be proposed and must have sufficient soil borings information to demonstrate the level of ground permeability for dewatering the stored storm water.

4. Stormwater Conveyance System (Open Channel, Drainage Way, and Storm Sewers)

   a. General

      i. Applicants are encouraged to design conveyance systems that encourage infiltration and improve water quality wherever possible.

      ii. Wherever conveyance channels are necessary, drainage shall be maintained by an open channel with landscaped banks designed to carry the 10-year frequency rainfall event. All open channels shall be designed with one foot (1') of freeboard above the design water surface elevation of the design runoff condition.

      iii. Flood relief channels shall be provided and designed to convey the runoff from the 100-year frequency rainfall event, such that positive discharge of this runoff to an adequate receiving stream or conveyance system occurs without harmful affects.

      iv. Where drainage swales are used in lieu of or in addition to storm sewers, they shall be designed to carry the required runoff without erosion and in a manner not detrimental to the properties they cross. Drainage swales shall be provide a minimum of two percent (2%) but shall not exceed a grade of nine percent (9%). Drainage swales used strictly for conveyance are not the same as Open Vegetated Channels. Design standards for Open Vegetated Channels are provided in the following section.

      v. Use of grassed swales or open vegetated swales in lieu of curbing to convey, infiltrate and/or treat stormwater runoff from roadways is encouraged.

   b. Open Vegetated Channels

      i. Open Vegetated Channels are conveyance systems that are engineered to also perform as water quality and infiltration practices. Such systems can be used for the conveyance, retention, infiltration and filtration of stormwater runoff.

      ii. Open Vegetated Channels primarily serve a water quality function (WQv), they also have the potential to augment infiltration. Examples of such systems include, but are not limited to: dry swales, wets swales, and grass channels.

      iii. Open Vegetated Channels shall be designed to meet the following minimum standards:

The channel shall be designed to safely convey the ten-year frequency storm event with a freeboard of at least twelve inches (12”). Freeboard is the difference between the elevation of the design flow in the channel and the top elevation of the channel.

The peak velocity of the runoff from the ten–year storm shall be non-erosive for the soil and ground cover provided in the channel.

The longitudinal slope shall be no greater than four percent (4%) to qualify for water quality treatment.

Channels shall be trapezoidal in cross section.

Channels shall be designed with moderate side slopes of 1V:4H. Flatter side slopes may be necessary under certain circumstances.

The maximum allowable ponding time in the channel shall be less than 48 hours.

Channels (for example, dry swales) may require an underdrain in order to function and dewater.

Channels shall be designed to temporarily store the WQv within the system for a maximum period of forty-eight (48) hours and a minimum period of one (1) hour.

Landscape specifications shall address the grass species, wetland plantings (if applicable), soil amendment and hydric conditions present along the channel.

Accumulated sediment within the channel bottom shall be removed when twenty-five (25%) of the original WQv volume has been exceeded.

Check dams along the channel length may be warranted.
The bottom of dry swales shall be situated at least two feet (2’) above the seasonal high water table.

A minimum vertical clearance of five feet (5’) is required between open swale/ditch inverts and underground utilities unless special provisions are employed.

c. Natural Streams and Channels

i. Natural streams and channels are to be preserved. Natural swales and channels should be preserved, whenever possible.

ii. If channel modification must occur, the physical characteristics of the modified channel will duplicate the existing channel in length, cross-section, slope, sinuosity, and carry capacity.

d. Storm Sewers

i. Sizing/Hydraulics

Storm sewer systems shall be designed for a 10-year frequency rainfall event.

Storm sewer design velocities, capacities, and friction losses shall be based on Manning's equation.

$$Q = \frac{1.49\ AR^{2/3}S^{1/2}}{n}$$

Manning's coefficient for concrete pipe shall be n = 0.013. Minimum design velocity shall be two and a half feet (2½') per second, and maximum velocity shall be ten feet per second (10 fps) , with pipe flowing full.

Submerged systems are not allowed. Submerged systems are storm sewers that are entirely or in part below the outlet surface elevations and do not dewater.

Surcharging under design conditions is permitted provided the surcharged hydraulic grade line (HGL) is maintained at or lower than one foot (1') below the rim elevations of all upstream structures.

The hydraulic grade line must be calculated for the entire system. The hydraulic grade will be assumed to start at the elevation 0.80 x pipe diameter of the outlet pipe or the high water level (HWL), whichever is higher.

Minimum and maximum design slopes, for concrete pipe, shall be as follows:

Pipe Diameter (inches)	Minimum Slope (feet per 100 feet) > 2.5 fps	Maximum Slope (feet per 100 feet) < 10 fps
12	0.32	4.88
15	0.24	3.60
18	0.20	2.84
21	0.16	2.32
24	0.14	1.92
27	0.12	1.64
30	0.10	1.44
36	0.08	1.12
42	0.06	0.92
48	0.05	0.76
54	0.04	0.64
60	0.04	0.56

ii. Location

In-line catch basins on storm lines greater than eighteen-inches (18”) are prohibited.

Storm sewers shall generally be located on the same sides of streets as water mains, and generally within the street right-of-way, 7 ½ feet from Northerly and Easterly street right-of-way lines.

Easements for sewers not located within a street R.O.W. shall have a minimum width of twenty feet (20’), centered upon the sewer. Such easements shall be reserved with restrictions against use or occupation by other utilities, in any manner, which would restrict sewer maintenance or repair operations.

For subdivisions, storm sewers shall be located in the public road right-of-way or in easements adjacent to the public road right-of-way. Storm sewers shall not be located in rear yards except to pick up rear yard drainage or in unusual circumstances or for sump pump discharge lines.

The horizontal alignment of sewers which are not proposed to generally follow street, drive, or parking area pavements, shall parallel property lines or building lines, with clearance distances sufficient to accommodate the full width of the proposed easement.

Horizontal clearance between storm pipes and sanitary sewer and water lines shall be a minimum of ten feet (10’).

Horizontal separation from buildings shall be a minimum of ten feet (10’) or distance, which will allow a 1:1 slope to the base of the foundation, whichever is greater.
All storm sewers located beneath pavement or a traveled portion of a roadway shall have a minimum of three and a half feet (3½’) of cover.

Vertical separation distances between storm sewers and other buried storm sewers and other buried utility lines should be at least eighteen inches (18”).

e. Catch Basin and Inlets

Catch Basin outlet pipes located in pavement areas will incorporate a floatable trap device that captures floatable debris and oils, provides for pipe maintenance access, stainless steel hardware, oil and gas resistant gaskets, and is designed to prevent siphoning according to the following:

i. In “Heavy Traffic and Pollutant Load” areas a floatable trap outlet in every catch basin is required. This includes, but is not limited to, gas stations, convenience stores, fast foot restaurants, vehicle repair facilities, stores with “drive through” service (i.e. banks, drug stores, dry cleaners, coffee shops), loading docks, distribution facilities, hospitals, school bus loading areas, maintenance facilities, light industrial sites, “dumpster areas”, parking and roadway areas of shopping centers close to the stores, etc. The exception will be where a catch basin cannot be maintained. An oil-absorbing boom may also be required in structures that receive heavy hydrocarbon loading.

ii. In "Moderate Traffic and Pollutant Load" areas, floatable trap outlets will be located in catch basins so as surface water passes through no more than one (1) catch basin that does not have a floatable trap. This includes, but is not limited to, office buildings, multi-residential complexes, schools (other than bus areas), most shopping mall parking areas, mixed retail commercial facilities, municipal/government buildings, athletic/entertainment/recreational facilities, non-fast food restaurants, special event/remote parking areas, etc. The downstream structures (prior to discharge) are most critical, and oil-absorbing booms may be useful if heavier hydrocarbon loading is expected.

iii. In "Low Traffic and Pollutant Loading" areas, floatable trap outlets will be located so that surface water passes through no more than two (2) catch basins that do not have a floatable trap. This includes, but is not limited to, grassy or vegetated areas, single family residences, parks, parking for offices within residences, flow excess from permeable paving areas, etc.

NOTE: A large site may have different areas, just like it may have different runoff coefficients. For instance, a shopping mall may have a heavy traffic roadway and loading/unloading areas as well as a remote parking area. Therefore, apply the appropriate placement criteria to each area of the site to arrive at the total number of floatable trap equipped catch basins for the project.

Minimum sump depth is two-feet (2') for catch basins that do not require a floatable trap outlet.

Minimum sump depths for catch basins equipped with floatable trap outlets is thirty-six inches (36").
Surface water flows shall not exceed the intake capacity of the structure casting.

At all low points in gutters, and in swales and ditches, where applicable.

At the upstream curb return, if more than two hundred feet (200') downstream of a high point in the gutter.

At maximum intervals of six hundred feet (600') along a continuous slope.

Such that there is a maximum pavement length per structure as follows:

- 300 lineal feet for a catch basin or inlet at a low point; and
- Vane grates shall be provided on relief basins when the longitudinal slope of road is four percent (4%) or greater.

Such that, where low point exists in the gutter line, no more than two relief basins shall be used in either direction in advance of the low point, (i.e., 4 relief basins would be possible). When a total of two or more relief basins are used in such a system, a double catch basin will be placed at the low point.

At tee intersections, catch basins may only be installed at the property line extended, on the leg of the tee.

Drainage structures shall not be located in line with sidewalks.

Typically, depending on surface types, no more than one (1) acre of area should be tributary to one standard catch basin. Catch basins may be doubled in order to provide for additional capacity.

f. Manholes

i. Depending on pipe size, Manholes should be located at:

All changes in alignment

Points where the size of the sewer changes

Points where the grade of sewer changes

The junction of sewer lines

Street intersections or other points where catch basins or inlets are to be connected.

ii. Manhole spacing for storm sewers shall be as follows:

Diameter of Sewer	**Maximum Manhole Spacing**
12" – 18"	400 ft.
21" – 30"	450 ft.
36" & 42"	500 ft.
48"	550 ft.
54"& 60"	600 ft.
66" & larger	650 ft.

Where future connections to a manhole are anticipated, stubs with watertight bulkheads shall be provided.

g. Materials

i. Covers for Manholes, Catch Basins and Inlets

Manhole frame and cover shall be EJIW 1040, Type A cover, or equivalent.

Manhole and catch basin covers shall include "Dump no waste! Drains to Waterways" or approved similar message.

Catch basin and inlet frame and cover shall be as follows:

- EJIW 7045, or equal, for use with barrier curb and gutter, and with concrete pavement with integral curb.
- EJIW 7065, or equal, for use with mountable curb and gutter, and with concrete pavement with mountable integral curb.
- EJIW 7085, or equal, for use with B-2 or rolled curb.
- EJIW Type O Beehive Grate, or equal, for use on open ditch structures and catch basins located in swales in easements outside the public street right-of-way.
- Vane grates, EJIW 7010 with type M6 vane grate and T1 back, shall be provided when the longitudinal slope of road is four percent (4%) or greater.

ii. Pipe/Structure Type

Minimum pipe size for sewers, catch basin leads and inlet leads shall be twelve inches (12") nominal internal diameter.

Reinforced Concrete Sewer Pipe shall conform to the requirements of ASTM Designation: C76. Joints shall conform to the requirements of ASTM Designation. C443 Joints and Circular Concrete Sewer and Culvert Pipe, Using Rubber Gaskets. All catch basin leads and inlet leads shall be ASTM C76-Class IV pipe.

Roof and sump leads shall be Schedule 40 PVC or SDR 23.5.

Eccentric cones shall be provided on all structures, regardless of the material used (precast reinforced concrete, manhole block, or brick), to provide a true vertical face for placement of manhole steps. Manhole steps shall be steel, encased with polypropylene plastic, equivalent to M.A. Industries, Inc. PS1 or PS1-B, as appropriate. A minimum of four inch (4") and a maximum of twelve inch (12") HDPE or concrete grade rings shall be placed on the cone section of all precast concrete, and concrete block, structures.

h. Miscellaneous

i. Bar Grates

A pre-fabricated bar screen should be designed to be self-cleaning so as to minimize plugging with debris and be installed on all storm sewers eighteen inch (18") in diameter and larger. Except when dealing with an open channel to enclosed system (i.e. cross culvert), where it is a straight pass through transition, in such case, the city engineer shall determine if bar grates are necessary.

ii. Special Drainage Structures

Preliminary plans for special structures and appurtenances required for storm sewer systems shall be submitted to the City Engineer for review and comment, prior to their inclusion in the construction drawings.

iii. Pumps

Stormwater management systems incorporating pumps shall not be permitted. Variances of this requirement will be considered only as a measure of last resort, subsequent to demonstration that no alternative system designs are feasible. Where pumps are absolutely necessary, an alternate method of draining shall be provided.

iv. Taps

Connections must be made at manholes, except when the receiving storm sewer pipe is twenty-seven inch (27") or larger.

v. Roof Leads and Sump Lines

Sump pump discharge lines are required to be connected to an approved drainage system.

Residential roof leads are not permitted to discharge to the sanitary sewer or storm sewer system.

i. Plan Criteria

i. Plan and Profile General

All storm sewers shall be shown in Plan and Profile, with the profile generally shown below the plan view. All structures and end-sections shall be sequentially labeled in both plan and profile views.

Scale of plan portion of sheet shall be no smaller than one inch (1") = fifty feet (50'), with scale of profile portion of sheet one inch (1") = fifty feet (50') horizontal and one inch (1") = five feet (5') vertical.

All elevations shall be on U.S.G.S. datum.

ii. Plan View

Existing topography and all existing and planned surface and underground improvements in streets and easements in which sewer construction is proposed, and in contiguous areas if pertinent to design and construction.

Street names, street and easement widths, all other street and easement survey information, subdivision names, lot numbers and frontage dimensions, and permanent parcel numbers and frontage dimensions for all unplatted parcels.

Location, length, size, material type, and direction of flow of each section of proposed sewer between manholes.

Locations of all manholes and other sewer appurtenances and special structures, with proposed rim elevations for all inlets and catch basins.

Reference benchmarks, established at intervals not greater than 1,200 feet and convenient to the proposed construction, with identification, location, description and established elevation listed. Generally, at least two benchmarks shall be noted on each sheet.

A tabulated list of quantities of construction pay items appearing on that sheet.

iii. Profile View

Profile portion of sheet shall appear below companion plan portion, generally projected vertically, and shall show at least the following:

- Size, slope, type and class of pipe, and controlling invert elevations for each section of proposed sewer between manholes.
- Limits of special backfill requirements.
- Profile, over centerline of proposed sewer, of existing and proposed finished ground and pavement surfaces.
- Profile of hydraulic grade line staring at the elevation of 0.80 x pipe diameter of the outlet pipe or the HWL of the pond, whichever is greater.
- Location of existing and proposed utilities crossing the line of the sewer or otherwise affecting sewer construction.
- Location, by station, of every proposed manhole, with manhole number, invert elevation of all inlet and outlet pipes, and top of casting elevation.
- Show end section footing detail.

Manholes shall be identified by numbers assigned consecutively, and increasing in magnitude in the direction opposite to the direction of flow.

All catch basin and inlet leads shall be laid on slope no flatter than one percent (1%).

Types of covers and grates for structures shall be shown.

5. Stormwater Ponds/Basins

a. General

i. Wet ponds are preferred to extended dry basins.

ii. Stormwater Ponds/Basins shall be located on common-owned property in multi-ownership developments such as subdivisions and site condominiums, and not on private lots or condominium units.

iii. Stormwater Ponds/Basins shall discharge to a natural watercourse, established drainage system, or drainage area where a dedicated easement exists for the purpose of drainage. In no case shall a pond/basin or system discharge onto adjacent property without an easement or the property owner's permission.

iv. Sediment Forebay

- A sediment forebay should be used to isolate gross sediments as they enter the storm water storage facility and to simplify sediment removal. The sediment forebay should consist of a separate cell formed by an earthen berm.

- The sediment forebay shall be sized to contain the water quality volume and be a minimum of three feet (3') deep.

- Exit velocities from the forebay shall not be erosive.

- Direct maintenance access shall be provided to the forebay.

v. In-line detention ponds/basins are not permissible. Except in the event there is no practicable alternative or it is demonstrated that the use of an inline basin is an enhancement to the environment, it may be considered for approval by the City Engineer.

vi. Interior side slopes of dry basins should not exceed 1:6 (V:H), unless unfeasible, steeper slopes are permissible under the following conditions: Side slopes steeper than 1:6 (V:H) require a safety bench starting at the design surface water elevation (25 year), sloping inward at a maximum of 6% slope, and at a minimum width of 5'. The side slope, below the downward slope end of the safety bench, shall not be steeper than 1:3 (V:H). Chain link fence may be substituted for the safety bench. For the purpose of providing safety protection and maintenance access the minimum standard for fences is 6 feet high vinyl clad chain link with a locking access gate, 8 feet wide. Alternate types of fencing or safety protection accepted by the Planning Commission may be permitted, for aesthetic purposes, subject to approval by the Engineering Division.

vii. Stormwater management systems incorporating pumps shall not be permitted. Variances of this requirement will be considered only as a measure of last resort, subsequent to demonstration that no alternative system designs are feasible. Where pumps are absolutely necessary, an alternate method of draining shall be provided.

viii. A minimum one-foot (1') freeboard is required above the 25-year stormwater elevation on all stormwater ponds/basins.

ix. All ponds/basins must be designed with a 100-year storm overflow to control flooding. The overflow shall discharge to an existing drainage system. If a weir overflow is used sufficient erosion protection must be incorporated into the design. Calculations for the overflow design must accompany the plans.

x. The principal spillway will be sized to pass the maximum design flow tributary to the pond/basin.

xi. Vegetative Plantings Associated with Stormwater Ponds/Basins.

Ponds/basins and wetland designs will be accompanied by a landscaping plan that incorporates native plants and indicates how aquatic and terrestrial areas will be vegetated, stabilized, and maintained.

Whenever possible, native wetland plants should be encouraged in the pond/basin design, either along the aquatic bench, fringe wetlands, safety shelf and side slopes or within shallow areas of the pools

A permanent buffer strip of natural vegetation extending at least twenty-five feet (25') in width beyond the freeboard elevation will be maintained or restored around the perimeter of all stormwater ponds/basins. No lawn care chemicals shall be applied to the buffer area.

xii. Easements and Access

For all new residential development, the property in which the pond/basin is located upon must be contained in an easement reserved or dedicated for detention purposes only.

A minimum twenty-foot (20') wide maintenance access easement shall be provided.

At a minimum, a twelve-foot (12') wide gravel access drive shall be located within the above easement for maintenance purposes.

b. Pond/Basin Inlet/Outlet Design

i. Velocity dissipation measures will be incorporated into pond/basin designs to minimize erosion at inlets and outlets, and to minimize the resuspension of pollutants.

ii. To the extent feasible, the distance between inlet and outlets will be maximized. The length and depth of the flow path across ponds/basins shall be maximized by:

Increasing the length to width ratio of the entire design.

Increasing the dry weather flow path with the system to attain maximum sinuosity.

Inlets and outlets should be offset at opposite longitudinal ends of the basin.

iii. Storage shall be required for all site runoff. Detention is not required for flows originating offsite that flow through the site. The restrictor size, designed for onsite runoff storage, shall not be upsized to pass through offsite flows.

iv. The use of dual outlets, risers, V-notched weirs or other designs that assure an appropriate detention time for all storm events is required.

v. The outlet will be protected from clogging. Methods, such as a weir, or incorporating self cleaning trash racks, or using proprietary flow control devices (i.e. Hydro-Brakes and Reg-U-Flow) or other innovative designs shall be used. A reverse slope submerged orifice with trash rack or a hooded, broad crested weir is recommended options. If a reverse-slope pipe is used, an adjustable valve may be necessary to regulate flows and the invert of the pipe drawing from the pool should be at least eighteen inches (18") from the bottom to prevent sediment discharge.

vi. Where a pipe outlet or orifice plate is to be used to control discharge, it will have a minimum diameter of four inches (4"). If this minimum orifice size permits release rates greater than 0.2 cfs/acre, an alternative outlet design that incorporates self-cleaning flow resrictors will be required. Examples include perforated risers, proprietary flow control devices, and "V" notch orifice plates that provide the required release rate. Calculations verifying this rate will be required for approval.

vii. The hydraulic grade (H.G.) of the receiving waterway must be investigated to assure it is not higher than the pond/basin outlet H.G. If the H.G. of the receiving waterway is higher, the design engineer shall provide a method to allow a positive outflow at the required discharge rate.

viii. OCWRC SO-2 (Riser) detail and design standards shall be adhered to.

ix. The riser shall be placed near or within the embankment to provide for ready maintenance access.

x. Orifices used to maintain a permanent pool level shall withdraw at least one foot (1') below the surface of the water.

xi. Where feasible, a drain for completely de-watering wet ponds should be installed for maintenance purposes.

xii. All outlets will be designed to be easily accessible for heavy equipment required for maintenance purposes.

xiii. Anti-seep collars shall be installed on any piping passing through the sides or bottom of the pond/basin to prevent leakage throughout the embankment.

xiv. Storm sewers serving as an outlet for stormwater ponds/basins shall be designed in accordance with the standard requirements for other storm sewers in the design.

c. Wet Ponds

i. Facility Sizing

The volume of permanent pool shall equal or greater than twice the water quality volume.

ii. Pond Configuration

The wet basin shall be configured as a two-stage facility with a sediment forebay and a main pool.

The outlet should be located at the opposite and farthest end of the pond from the inlet.

The minimum length to width ratio shall be 3:1 where feasible. If it is not feasible to construct a pond with such dimensions, baffles or islands should be used to achieve the flow path length.

iii. Depth

The depth of the pond should be variable, with the average depth between three (3) and six (6) feet.

The deep section of the pool should have a minimum depth of three feet (3’). This prevents resuspension of sediments by wind turbulence.

The maximum depth of the permanent pool shall be ten feet (10’). Ponds deeper than this depth may be subject to stratification and promote anoxic conditions at the pond bottom, releasing sediment-bound pollutants into the water column.

iv. Pond Side Slopes/Benches

Interior side slopes of wet ponds should not exceed 1:6 (V:H), unless unfeasible, steeper slopes are permissible under the following conditions: Side slopes steeper than 1:6 (V:H) require two safety benches. One should start at the design surface water elevation (25 year). The other should extend from the wet pool elevation and slope inward to a maximum depth of 18 inches (also considered an aquatic bench). Both benches should be a maximum of 6 % slope and a minimum width of five-feet (5'). The aquatic bench should be landscaped with appropriate native plantings. Slopes below the safety/aquatic benches shall not be steeper than 1:3 (V:H). Chain link fence may be substituted for the safety bench located above the design surface elevation, which eliminates the need for the aquatic bench. Fences shall be a minimum of 6 feet (6’) high vinyl clad chain link with a locking access gate, 8 feet (8’) wide. Alternate types of fencing may be permitted, for aesthetic purposes, subject to approval by the Engineering Division.

d. Extended Detention Basins

i. A two-stage design is required, with separate outlet controls to detain both the first flush volume and larger rain events.

Lower Stage: The lower stage should contain a shallow, permanent pool designed to store and treat the water quality volume. This pool should be managed as a shallow marsh or wetland and average six to twelve inches (6”-12”) in depth. A sediment basin upstream for the lower stage must also be incorporated into the design.

Upper Stage: The upper stage should be sized for the 25-year storm event, as defined by the Oakland County Water Resources Commissioner (OCWRC), and should be graded to remain dry except during large storms.

- A low flow channel, constructed of natural permeable material (no cunettes permitted), stabilized against erosion, will be provided through the dry portion of the pond. This channel should have a minimum grade of one half percent (0.5%) and the remainder of the pond should drain toward this channel at a grade of at least one percent (1%). The low flow channel should end at the lip of the lower stage, where riprap or gabion baffles should be placed to prevent scour and resuspension of pollution particles.

6. Underground Detention Facilities

a. General

Underground detention is a less preferred method of meeting the City’s stormwater storage requirements, however, if the developer determines that underground detention is the development’s best alternative, the following design considerations will need to be addressed:

b. Design Considerations

i. Applicability

These standards are appropriate for all underground pipe or vault detention, whether intended to detain flood and/or channel protection volume, or temporarily store a portion of the water quality volume. Pipes or vaults may be located below vehicular or non-vehicular areas, and must be a minimum of ten feet (10’) horizontally from other utilities. Underground detention is generally not acceptable in single-family residential or multi-unit condominium developments. Approval by the City Engineer may be granted on an individual case basis in coordination with the Planning Department.

ii. Design Storm

The facility must be sized to provide storage for the channel protection volume, flood protection volume, and/or recharge volume, with safe conveyance of larger flows through the facility. In addition, the hydraulic grade (H.G.) of the receiving water way must be investigated to assure it is not higher than the pond/basin outlet

H.G. If the H.G. of the receiving waterway is higher, the design engineer shall provide a method to allow a positive outflow at the required discharge rate.

One (1) foot of freeboard is required.

iii. Groundwater

In general, underground storage should not be located in areas of shallow groundwater. In situations, where groundwater is encountered, additional design requirements may be necessary.

iv. Geotechnical Analysis

Soil borings must be performed in the location of the proposed detention facility in order to determine presence and location of fill materials, soil type, or groundwater. Borings must extend to a minimum of two feet (2') below a facility.

v. Pretreatment

Stormwater must be pretreated prior to entering the underground system.

The pretreatment BMP must be located so as to provide ease maintenance accessibility.

vi. Inspection accessibility

An adequate number of inspection manholes need to be provided to inspect all of the cells in the system.

c. Specifications and Details

i. Outlet Structure

The outlet structure shall be composed of concrete, and may be cast in place or precast. Precast structures must be monolithic, including the control weir. Structures must be designed for HS20 loading at a minimum. Direct access to both side of the control structure is required.

ii. Overflow Weir Sizing Criteria

The overflow weir in the control structure must be designed to safely pass larger flows through the facility.

iii. Low Flow Outlet Orifice

The low flow orifice may be no smaller than four inches (4") in diameter and must be protected by a trash rack. Expanded metal or perforated half-round CMP should be used. All trash racks must be removable. The surface area of the trash rack perforations must exceed the low flow orifice area by a ratio of at least 5:1. For orifice sizes.

iv. Storage Pipe

All storage pipes must be circular, and must be a minimum of forty-eight inches (48”) in diameter. Metal, HDPE, or concrete may be used. Crossover connections must be provided between storage pipes, and these must be a minimum of forty-eight inches (48”) in diameter, also. Pipes may not be closer together than one half (½) the inside pipe diameter or three feet (3’); whichever is greater. Minimum cover must be per the manufacture’s specifications, based on the design load and considering flotation where required. PH and resistivity test may be required if metal pipe is proposed, on a case-by-case basis, wherever soil acidity is a concern.

v. Metal Pipe

Metal storage pipe must be aluminized, Type 2, and must be designed for the appropriate loading (pipes may not be less than 14-gauge). Pipe ends must be matched and numbered by the manufacturer. Coupling bands must be per the City of Rochester Hills Engineering Construction Specifications, Materials – Storm Drain Pipe.

vi. Concrete Pipe

Concrete pipe must meet ASTM C76. Joints must meet ASTM C443.Only circular pipe may be used.

vii. HDPE Pipe

High Density Polyethylene pipe is acceptable for use in underground storage facilities. Concrete manholes must be used at all HDPE pipe connections. Pipe installation must comply with ASTM D2321.

viii. Concrete Vaults

Concrete vaults may be used for underground detention, with design approved by the Engineering Division on a case by case basis.

ix. Pipe Bedding

Must be per the bedding details on the storm system detail sheets or the manufactures specification/details, whichever is greater.

x. Access

All facility access manholes must be thirty-six inch (36”) diameter. Manhole steps shall be provided. Concrete manholes must be used for access to HDPE pipes. Manhole access is required at least in corners of the system and where necessary to allow proper jetting operations and entry for maintenance.

7. Manufactured Treatment Devices (MTD)

   a. General Performance and Design Specifications

      i. If a manufactured treatment device (MTD) is proposed to help achieve better stormwater quality, it must be capable of treating the peak stormwater quality flow rate, which is, the one inch (1.0") rain event which occurs within 15 minutes using the rational method. Use a 15-minute time of concentration for commercial sites and a 20-minute time of concentration for residential sites.

      ii. The MTD must remove eighty percent (80%) or more of OK 110 (110 um sized particles) based on test results indicated on the third party testing selection guide, provided in Section 4.3.5 (Plan Submittals, B).

      iii. Rain events larger than the 1 year, 15 minute rain event shall bypass without causing any resuspension of trapped sediments and without causing re-entrainment of floatable contaminants.

      iv. All MTDs should be configured as off-line units unless a detailed hydraulic analysis is provided. The analysis must demonstrate the up- and downstream pipes will have capacity and surcharging created by high rainfall storms will not result in loss of previously captured material.

      v. The treatment system must prevent oil and floatable contaminants from entering downstream piping during routine maintenance and during rain events. The use of a floatable trap should be used to meet this requirement.

      vi. Direct vehicular access must allow complete and unrestricted access to the entire bottom of the chamber from the top.

      vii. The private manufactured treatment device (MTD) should be located outside the City right-of-way.

      viii. There can be no points of constriction in the system to cause plugging or flooding.

      ix. System must be built to withstand HS-20 loads.

   b. Maintenance Guidelines

      i. The treatment system shall be maintained according to the manufacturer's recommendations. An Operations and Maintenance Manual (O&M manual) must be provided for review specific to the model. See notes below for information to include in the O&M manual.

         The following notes/maintenance items should be included in an Operations and Maintenance Manual (O&M manual):

            The maximum sediment depth should be clearly specified.

Graphical and written description of sediment measuring procedure. This should include the use of a dipstick tube equipped w/ a ball valve. (e.g. sludge judge).

Oil removal procedure during routine cleanout.

The O&M manual should specify if entry into the manufactured treatment device (MTD) should be considered an OSHA confined space and guidelines followed.

The inspection frequency should be according to the manufacturer recommendation and approved by the Engineering Division. In no case should it be less than six (6) months.

Off-line configurations must include inspection and maintenance of connecting manhole and diversion weir.

Detail drawing of proposed MTD should be included.

Note in manual to clean unit immediately if there is a hydrocarbon spill (e.g. gasoline or oil).

A note should be provided indicating disposal of all sediment must be in accordance with all federal, state and local requirements.

c. Plan Submittals

i. Calculations associated with the sizing and selection of the appropriate model for the selected type of treatment system shall be included in all plan submissions.

8. Construction Specifications

a. Storm Drain Pipe Materials

i. General

The purpose of this specification is to establish provisions for substitution of the storm drain pipe and joint that has been specified on the Plans. Substitutions may be approved by the Owner, provided the flow capability and pipe (external load supporting) strength is equal to or exceeds that of the pipe specified on the Plans.

Alternate type of storm sewer pipe is allowable under the following conditions:

- The development is non residential
- Location of the storm sewer is on private property.
- The alternate pipe must meet or exceed the performance requirements of this section.

- The City Engineer reserves the right to accept or reject the use of alternate pipe proposes in non-residential developments.

- Aluminized CSP will be permitted after an on site soil analysis indicates pH ranges of 5.0-9.0 and resistivity of 1500 ohm-cm and greater.

ii. Video Inspection

As a means of insuring proper installation of the storm sewer pipe, at the discretion of the City Engineer, the contractor shall video inspect, according to the city of Rochester Hills video inspection standards, up to 100% of the storm sewer pipe 12" and larger in diameter. If video inspection is required by the City Engineer the contractor shall provide 24 hours notice to the City of Rochester Hills prior to video inspection, so a representative may be present. Rochester Hills will be provided with a digital copy of the video inspection and log in accordance with the City of Rochester Hills video inspection standards.

Projects that the City Engineer may impose these requirements are:

- All public projects or projects being constructed on public property.

- Any project involving a development, subdivision, site condominium, condominium, or association.

- Any project the will result in more then one owner responsible for the operation and maintenance of the complete storm drainage system.

iii. Plastic Pipe Testing

All pipe shall be certified by the manufacturer to meet applicable ASTM specification requirements. Certification forms, together with a report of the test results, shall be provided the inspector with pipe deliveries and copies shall be forwarded to the Engineer or Owner.

Certification forms shall include project name, location, contractor and test lot number. Lot sizes shall be acceptable to the Engineer.

All pipefittings shall be suitably marked to provide manufacturer's name, lot or production number. ASTM Designation, PVC, nominal diameter, and SDR number, where applicable. Fittings, however, need not contain lot or production number. Pipe shall have a "home" mark. Truss Pipe with an absence of filler material at the ends greater than one-fourth (1/4") inch deep shall be subject to rejection or acceptable repair.

The completed installation shall at no point have out-of-round pipe deflections greater than 5%. Deflectometer or go/non-go gauging tests may be required prior to acceptance of pipelines, at the discretion of engineer. No more than 50% of installed lines will be mandrel tested unless deflection tests results are unsatisfactory.

b. Products

v. Reinforced Concrete Pipe

Shall be in accordance with ASTM C76 standards. Modified groove tongue joint with approved rubber gasket (current ASTM C443, except as such Specifications relate to infiltration limitations).

Lubricant, as supplied by the pipe manufacturer, shall be used on the groove and on the tongue in making up joints. The joints shall be coupled in accordance with the pipe manufacturer's requirements.

b. Reinforced Concrete Elliptical Culvert Storm Drain

Shall be in accordance with ASTM Designation C-507-79, Class HE-1 through HE-IV or VE-II through VE-VI.

Tongue and groove bituminous (DeWitt #10) joint with inside cement pointing.

c. Corrugated Steel Pipe

All corrugated steel pipe for storm sewers shall be Aluminized Type 2 formed with an external spiral rib. Hydraulic capacity must be equivalent to concrete pipe (N=0.013) for storm sewer calculations.

- For underground detention systems, pipe materials must be Aluminized Type 2, and may be either $2^2/_3$" X ½" corrugation, or 3" x 1" corrugation with gauge as specified by design engineer.

All corrugated steel pipe shall be joined together with a watertight circumferentially corrugated steel-coupling band furnished with two (2) rubber gaskets or bell and spigot end. Gasket shall be manufactured from an elastomeric material and shall meet the requirements of MTM 723.04, (MDOT): Where field jointing of non re-rolled end pipe is required. A 12" wide flat gasket with a minimum 12" wide flat or dimple band will be required. All pipe entering a concrete or block manhole shall be sealed with a minimum 12" wide external gasket. Additionally, all joints in storm sewers and underground detention systems will be wrapped with an 18" wide non woven (4 oz. min.) geotextile.
In underground detention systems, a 12" wide flat gasket with a flat band may be used as an alternate to rubber gasket system.

Gauge thickness shall be as specified on the plans, but in no case be less than the following:

18"-30" = 16ga; 36"-48" = 14 ga; 54"-60" = 12ga; 66"-78" = 10ga.

All pipe connections to the side wall of main-line corrugated steel pipe shall be of the diameter specified on the plans, and shall consist of similar steel pipe that connects or taps into the main-line pipe wall using a pre-fabricated steel saddle plate or factory welded connection.

c. Polyvinyl Chloride (PVC) Pipe

i. (4”) to (36”)

Material shall be PVC Composite (Contech Truss) Pipe - ASTM D-2680 or PVC Solid Plastic Pipe - ASTM D-3034, SDR 35 or PVC (Contech A2000) Pipe - ASTM F949. Pipe to be made of PVC compound having a minimum cell classification of 12454.

Gaskets for PVC pipe and fittings shall be of the elastomeric type. Gasket joints shall be installed in accordance with procedures specified by the pipe manufacturer. Joints shall meet the requirements of MTM 723.04 (MDOT). Care should be taken to insure all joints being pushed to the full home position and held tightly in home position during any grade or line adjustments.

Haunching, bedding, and backfill materials for pipe (4”-36”) shall be as shown on the detail sheet.

d. High Density Polyethylene (HDPE) pipe

i. (8” – 48”)

HDPE – ASTM F-2306; AASHTO M-294.

Joints to be bell and spigot with gaskets to be elastomeric type. Joint performance to meet the requirements of MTM 723.04 (MDOT).

Haunching, Bedding, and backfill materials for HDPE (8”- 48”) shall be as shown on the detail sheet and must consist of class I (crushed stone) meeting MDOT 21a,22a, or 6a gradation.

e. Manhole, Catch Basin and Inlet Block and Brick

Brick shall be made of clay or shale, and shall be whole, thoroughly and evenly burned, of close and uniform texture, free from cracks and warps, with true even faces and uniform in shape and size. Brick shall show a minimum average compressive strength of 2,000 pounds per square inch and an average absorption of water in twenty-four (24) hours of not more than 25% of the dry weight.

Concrete brick shall conform to the requirements for concrete building brick of ASTM C-55-75, Grade N-1.

Concrete block for manholes, catch basins, and inlets shall conform to ASTM C139-73 with the following exceptions:

The blocks shall be solid curved blocks with the inside and outside surfaces curved to the required radii. The blocks shall have tongue and groove or other approved type of joint at the ends so that the units interlock to form a strong, rigid structure. Curved blocks shall have the inside and outside surfaces parallel.

The nominal dimensions of the block shall be 18 inches maximum for length, 8 inches maximum for depth (height), and 6 inches minimum for width (thickness). The length shall be measured along the chord on the convex face of the block. The tolerances of ASTM C 129-73 shall apply. Where the specified wall thickness on the standard plans is 12 inches, a multiple block wall of two 6-inch wide blocks is permitted. All blocks in one structure shall be of the same height dimension. The blocks shall be designed for length so that only full length or half-length blocks are required to lay the circular wall of any one course.

Blocks intended for use in the cones or tops of manholes or other structures shall have such shape as may be required to form the structure as shown on the plans with inside and outside joints not to exceed 1/4 inch in thickness.

The mortar shall be composed of one (1) part of a combination of Portland Cement and hydrated lime and three (3) parts of fine aggregate, by volume. The combination of cement and lime shall consist of 90% of Portland Cement and 10% of hydrated lime, by volume. In lieu of the above combination of cement and lime, a standard brick mortar cement may be used if approved by the Engineer.

All Manhole, Catch Basin, or Inlet Structure Steps shall be M.A. Industries, Inc., Numbers PS-1-B or PS-2-PFS or approved equal.

f. Precast Manholes

All precast manhole sections and bases shall be 4000 lbs per square inch concrete as determined by core test or cylinders.

Unless otherwise noted on the drawings or in the Supplemental Specifications, precast reinforced concrete manhole sections shall meet the requirements of current ASTM C-478.

Precast manhole tees for forty-eight inch (48”) and larger storm drains shall be the same class pipe as that specified on the plans, but shall be a minimum ASTM C-76-79 Class IV. The manhole riser shall meet the requirements of current ASTM C-478.

g. Storm Drain Stubs

Four inch (4”) to ten inch (10”) diameter stubs shall be PVC Composite (Contech Truss) Pipe or PVC Solid Plastic Pipe as specified under Section 8, Construction Specifications, Item c, or approved alternate. Stubs twelve inches (12”) and larger shall be ASTM C76 Class IV Reinforced Concrete Pipe or as otherwise noted. Maximum pipe length of stubs shall be eight feet (8’).

E. Operation and Maintenance Responsibilities

1. General Responsibilities

a. The Owner/Developer of a property is responsible for the proper installation and initial function of the stormwater management system in accordance with the approved Stormwater Management Plan. All temporary soil erosion and sedimentation control measures shall be removed or converted to their permanent configuration in accordance with an approved erosion control plan. It is required that the Oakland County Water Resources Commissioner (OCWRC) determine and approve when sufficient stabilization has occurred on a site in order to convert to the permanent stormwater management facilities.

b. The Owner/Developer is responsible for the proper operation and maintenance of the stormwater management system during and after construction. An Operation and Maintenance Plan consistent with the requirements of Section E shall be prepared for review and approval by the engineering division. The operation and maintenance plan will become an exhibit to the operation and maintenance agreement. See Section 3 and 4 for further detail.

c. Approval and Transfer of Stormwater Operation and Maintenance (O&M) Responsibilities.

    i. The City of Rochester Hills requires that the stormwater management system is operated and maintained by the individual property owners or an owners/homeowners association or similar entity, or an organization capable of carrying out maintenance responsibilities. However, the Developer is responsible for O & M until:

        Evidence of final approval by OCWRC is received indicating the site has been sufficiently stabilized to convert to the permanent stormwater management system.

        The stormwater management system is cleaned and free of sediment, as well as defects and/or damage corrected.

        Evidence that the stormwater management system has been transferred to an association or relevant owner, as well as approval of the transfer by the City of Rochester Hills.

2. Ownership and Maintenance

All stormwater management systems identified within an approved Stormwater Management Plan shall be owned and maintained by one of the following entities:

a. Individual On Property Stormwater Management Systems

    i. Where individual on-property stormwater management systems are proposed, the land development plan shall contain a note designating the entity responsible for operation and maintenance of the on-property system consistent with an approved Operation and Maintenance Plan.

b. Owners, Homeowners or Condominium Association Ownership

Where an association is created to own and manage the stormwater management system, the subdivision and/or land development plan shall contain a note designating the entity responsible for construction and/or maintenance of the stormwater management system consistent with an approved Operation and Maintenance Plan.

3. Operation and Maintenance Plan

An Operation and Maintenance Plan shall be prepared to identify the ownership, operation and maintenance responsibilities and as-built conditions for all stormwater management systems. At a minimum, the operation and maintenance plan shall include the following:

a. Any obligations concerning perpetuation and/or maintenance of natural drainage or infiltration facilities, and other facilities identified within the Stormwater Management Plan. Ownership of and responsibility for operation and maintenance of stormwater management systems, including names and contact information, shall be required.

b. A description of the permanent stormwater management practices on the site, explaining how each practice is intended to function and operate over time. All drainage and access easements shall be depicted and any site restrictions to be recorded against the property shall be identified on the plan. All such easements and restrictions shall be perfected to run with the land and be binding upon the landowner and any successors in interest.

c. A description of the actions, budget and schedule for operating and maintaining the stormwater management system. This description should be written in a clear manner, consistent with the knowledge and understanding of the intended user.

d. A general description of operation and maintenance activities and responsibilities for systems held in common or on-property, including but not limited to: lawn care, vegetation maintenance, clean out of accumulated debris and sediment (including from grates, trash racks, inlets, etc.), liability insurance, maintenance and repair of stormwater management systems, landscaping and planting, payment of taxes and construction of any kind associated with the use, benefit and enjoyment of the facilities by the owners. In particular, a description of routine facility operation and day-to-day management requirements (as needed) and a description of routine maintenance actions and schedules necessary to ensure proper operation of stormwater management systems shall be submitted.

e. Assurances that no action will be taken by any property owner to disrupt or in any way impair the effectiveness of any stormwater management system, setting forth in deed restrictions the ability of the City of Rochester Hills to take corrective measures if it is determined, at any time, that stipulated permanent stormwater management systems have been eliminated, altered, or improperly maintained.

f. Parties responsible for the long term operation and maintenance of stormwater management systems shall make records of the installation and of all maintenance and repairs, and shall retain the records for at least ten (10) years. These records shall be submitted to the City of Rochester Hills as established by the Operation and Maintenance Plan or if otherwise required by the City of Rochester Hills.

4. Operation and Maintenance Agreement

   a. The owner of any land upon which permanent stormwater management systems and/or BMPs will be placed, constructed or implemented, as described in an approved Stormwater Management Plan and the Operations and Maintenance Plan, shall provide the City of Rochester Hills a Stormwater System Operations and Maintenance Agreement that includes:

      The Operations and Maintenance Plan, or a summary thereof,

      Legal Description of the development property and,

      Map of the development with the Stormwater System depicting components and access and/or drainage Easements.

      In cases where the predevelopment offsite drainage is dependent on draining through the development, the agreement shall provide for that right of flow.

   b. The Operation and Maintenance Agreement shall be submitted to the City Engineering Division, executed and in recordable form, acceptable to the City for acceptance and recording.

   c. Other items or conditions may be included in the Operation and Maintenance Agreement where determined necessary to guarantee the satisfactory operation and maintenance of all permanent stormwater systems and BMPs. The agreement shall be subject to the review and approval of the City of Rochester Hills.

APPENDIX A

Non-Structural Stormwater Management Practices AlternativeApproach for Managing Stormwater Runoff

Stormwater Discussion

Land development can dramatically alter the hydrologic cycle of a site, and ultimately, an entire watershed. Prior to development, native vegetation can either directly intercept precipitation or draw that portion that has infiltrated into the ground and return it to the atmosphere through evapotranspiration. Development can remove this beneficial vegetation and replace it with lawn or impervious cover, reducing the site's evapotranspiration and infiltration rates. Clearing and grading a site can remove depressions that store rainfall. Construction activities may also compact the soil and diminish its infiltration ability, resulting in increased volumes and rates of stormwater runoff from the site. Impervious areas that are connected to each other through gutters, channels, and storm sewers can transport runoff more quickly than natural areas. This shortening of the transport or travel time quickens the rainfall-runoff response of the drainage area, causing flow in downstream waterways to peak faster and higher than natural conditions. These increases can create new and aggravate existing downstream flooding and erosion problems and increase the quantity of sediment in the channel. Filtration of runoff and removal of pollutants by surface and channel vegetation is eliminated by storm sewers that discharge runoff directly into a stream. Increases in impervious area can also decrease opportunities for infiltration, which, in turn, reduce stream base flow and groundwater recharge. Reduced base flows and increased peak flows produce greater fluctuations between normal and storm flow rates, which can increase channel erosion. Reduced base flows can also negatively impact the hydrology of adjacent wetlands and the health of biological communities that depend on base flows. Finally erosion and sedimentation can destroy habitat from which some species cannot adapt.

In addition to increases in runoff peaks, volumes, and loss of groundwater recharge, land development often results in the accumulation of pollutants on the land surface that runoff can mobilize and transport to streams. New impervious surfaces and cleared areas created by development can accumulate a variety of pollutants from the atmosphere, fertilizers, animal wastes, and leakage and wear from vehicles. Pollutants can include metals, suspended solids, hydrocarbons, pathogens, and nutrients.

In addition to increased pollutant loading, land development can adversely affect water quality and stream biota in more subtle ways. For example, stormwater falling on impervious surfaces or stored in detention or retention basins can become heated and raise the temperature of the downstream waterway, adversely affecting cold water fish species such as trout. Development can remove trees along stream banks that normally provide shading, stabilization, and leaf litter that falls into streams and becomes food for the aquatic community.

Alternative Approach

The recommended alternative approach is to promote practices that will minimize post-development runoff rates and volumes, which will minimize needs for artificial conveyance and storage facilities. To simulate pre-development hydrologic conditions, forced infiltration is often

necessary to offset the loss of infiltration by creation of impervious surfaces. The ability of the ground to infiltrate depends upon the soil types and its conditions.
Preserving natural hydrologic conditions requires careful alternative site design considerations. Site design practices include preserving natural drainage features, minimizing impervious surface area, reducing the hydraulic connectivity of impervious surfaces, and protecting natural depression storage. A well-designed site will contain a mix of all those features. The following describes various techniques to achieve the alternative approach:

Preserving Natural Drainage Features. Protecting natural drainage features, particularly vegetated drainage swales and channels, is desirable because of their ability to infiltrate and attenuate flows and to filter pollutants. However, this objective is often not accomplished in land development. In fact, commonly held drainage philosophy encourages just the opposite pattern -- streets and adjacent storm sewers typically are located in the natural headwater valleys and swales, thereby replacing natural drainage functions with a completely impervious system. As a result, runoff and pollutants generated from impervious surfaces flow directly into storm sewers with no opportunity for attenuation, infiltration, or filtration. Developments designed to fit site topography also minimizes the amount of grading on site.

Protecting Natural Depression Storage Areas. Depressional storage areas have no surface outlet, or drain very slowly following a storm event. They can be commonly seen as ponded areas in farm fields during the wet season or after large runoff events. Traditional development practices eliminate these depressions by filling or draining, thereby obliterating their ability to reduce surface runoff volumes and trap pollutants. The volume and release-rate characteristics of depressions should be protected in the design of the development site. The depressions can be protected by simply avoiding the depression or by incorporating its storage as additional capacity in required detention facilities.

Avoiding introduction of impervious areas. Careful site planning should consider reducing impervious coverage to the maximum extent possible. Building footprints, sidewalks, driveways and other features producing impervious surfaces should be evaluated to minimiz***e*** impacts on runoff.

Reducing the Hydraulic Connectivity of Impervious Surfaces. Impervious surfaces are significantly less of a problem if they are not directly connected to an impervious conveyance system (such as storm sewer). Two basic ways to reduce hydraulic connectivity are routing of roof runoff over lawns and reducing the use of storm sewers. Site grading should promote increasing travel time of stormwater runoff, and should help reduce concentration of runoff to a single point in the development.

Routing Roof Runoff Over Lawns. Roof runoff can be easily routed over lawns in most site designs. The practice discourages direct connections of downspouts to storm sewers or parking lots. The practice also discourages sloping driveways and parking lots to the street. By routing roof drains and crowning the driveway to run off to the lawn, the lawn is essentially used as a filter strip.

Reducing the Use of Storm Sewers. By reducing use of storm sewers for draining streets, parking lots, and back yards, the potential for accelerating runoff from the development can be greatly reduced. The practice requires greater use of swales and may not be practical for some development sites, especially if there are concerns for areas that do not drain in a "reasonable" time. The practice requires educating local citizens and public works officials, who expect runoff to disappear shortly after a rainfall event.

Reducing Street Widths. Street widths can be reduced by either eliminating on-street parking or by reducing roadway widths. Municipal planners and traffic designers should encourage narrower neighborhood streets, which ultimately could lower maintenance.

Limiting Sidewalks to One Side of the Street. A sidewalk on one side of the street may suffice in low-traffic neighborhoods. The lost sidewalk could be replaced with bicycle/recreational trails that follow back-of-lot lines. Where appropriate, backyard trails should be constructed using pervious materials.

Using Permeable Paving Materials. These materials include permeable interlocking concrete paving blocks or porous bituminous concrete. Such materials should be considered as alternatives to conventional pavement surfaces, especially for low use surfaces such as driveways, overflow parking lots, and emergency access roads.

Reducing Building Setbacks. Reducing building setbacks reduces driveway and entry walks and is most readily accomplished along low-traffic streets where traffic noise is not a problem.

Constructing Cluster Developments. Cluster developments can also reduce the amount of impervious area for a given number of lots. The biggest savings is in street length, which also will reduce costs of the development. Cluster development clusters the construction activity onto less-sensitive areas without substantially affecting the gross density of development.

In summary, a careful consideration of the existing topography and implementation of a combination of the above mentioned techniques may avoid construction of costly stormwater control measures. Other benefits include reduced potential of downstream flooding, water quality degradation of receiving streams/water bodies and enhancement of aesthetics and reduction of development costs. Beneficial results include more stable base flows in receiving streams, improved groundwater recharge, reduced flood flows, reduced pollutant loads, and reduced costs for conveyance and storage.