SECTION 2 - DESIGN CRITERIA FOR STORMWATER MANAGEMENT SYSTEMS

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

2.1. Site Drainage - General Requirements

2.1.1. Stormwater Discharge

In no event shall the maximum design rate of discharge exceed that stated in Section 1.1.2.1.c, page 11.

It is the Owner's obligation to meet this standard. Should a stormwater system, as built, fail to comply with the rules herein, it is the Owner'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 Drain Commissioner's review and approval. Additional volume controls will be required in such cases as will acquisition of rights-of-way from downstream property owners receiving the stormwater flow.

2.1.2. General Guidelines

All runoff generated by proposed impervious surfaces, unless otherwise permitted by the Drain Commissioner, must be conveyed into a stormwater storage facility for water quality treatment and detention/retention prior to being discharged from the site. The following criteria will apply to the design of all stormwater retention and detention facilities.

1. In general, wet basins and stormwater marsh systems will be preferred to dry basins. Dry basins providing extended storage will be accepted when the development site's physical characteristics or other local circumstances make the use of a wet basin infeasible.

2. Providing safe retention/detention is the Owner's responsibility. Basin designs will incorporate gradual side slopes, topsoil, seeding and mulching, plantings per landscape plan if one is required, and safety shelves. Where further safety measures are required, the Owner is expected to include them within the proposed development plans. Additional information for basin design is found in Section 2.2.

3. For drainage systems proposed to be under the jurisdiction of the Drain Commissioner, detention and retention facilities shall be located on common-owned property (e.g., parks, outlots, etc.) in multi-ownership developments such as site condominiums and subdivisions and not on private lots or condominium units. For private drainage systems, the stormwater ordinance of the local unit will govern where these basins may be located.

4. Stormwater management systems incorporating pumps shall not be permitted. Variances from this rule will be considered only as a measure of last resort, subsequent to demonstration that no alternative system designs are technically feasible.

5. The development grading plan will be such that surface runoff is away from building envelopes and toward swales, ditches, or drainage structures, and designated natural retention/detention areas. Provision for drainage through properly graded stormwater conveyance systems will be made for all areas within the proposed development.

2.1.3. 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. Where available, the community flood insurance study shall be used. Compensatory storage will be required for all lost floodplain storage.

The Livingston County Drain Commissioner reserves the right to require additional storage for all areas that directly connect to a drain under the Commissioner's jurisdiction.

2.1.4. Easements

1. Easement information shown on the plat or site plan is specifically required by the Drain Commissioner's office. The location and purpose of drainage easements should be clearly described in subdivision deed restrictions or condominium master deeds.

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

2. 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 developments stormwater system maintenance plan.

3. Minimum easement widths for new stormwater systems are provided below. These easements shall 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:

   a. Open channels and water courses (e.g., a definable stream bed): 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.

   b. Back lot drainage (open swales): A minimum of 30 feet total width.

c. Easement widths for pipes shall conform to the following table. Burial depths are to the invert of the proposed pipe:

Burial (ft)	Easement Width
0-7	20 ft
7.1-12	30 ft
12.1-17	40 ft
>17.1	50 ft

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

2.2. Detention and Retention Systems

2.2.1. Minimum Volume Requirements

The Livingston County Drain Commissioner has partnered with Oakland County, Wayne County and Macomb County to unify the regional approach to stormwater volume management. This new approach looks at drainage from the perspectives of four requirements: Water Quality Control, Channel Protection Volume Control, Channel Protection Rate Control, and Flood Control Volume. A full breakdown of the way to apply these requirements can be shown in the examples of Appendix F**.**

1. Water Quality Volume Control (WQ)

$$V_{WQ} = 3{,}630 \times C \times A$$

Where:

C is the post-development runoff coefficient (Appendix G, Page 6.)
A is the contributing area in acres
V_{WQ} is the required volume in cubic feet.

a. Water Quality Volume Control is required for the runoff from the 1-inch rainfall event.

b. This requirement is considered met if the full CPVC can be met through infiltration onsite.

c. The requirement is also met by using a forebay with storage volume equal to 15% of the V_{WQ}, unless the infiltration requirement is being met within the detention basin, in which case the required forebay volume is equal to the full V_{WQ}.

d. Water Quality Rate Control, based on the 1 Year Frequency storm event, may be provided by a mechanical treatment device in lieu of the Water Quality Volume Control. The required 1 Year Frequency Storm Treatment rate equals: $R_{WQ} = CxAx(97/(Tc+30))$ where Tc = Storm Sewer flow time in minutes. The system must have an 80% reduction in Total Suspended Solids (TSS) or a maximum discharge concentration of 80 mg/L

2. Channel Protection Volume Control (CPVC)

a. The system will be designed to capture and infiltrate, the site runoff from the first 1.3 inch of rainfall. This is required for all sites to the Maximum Extent Practicable (MEP).

$$CPVC = 4{,}719 \times C \times A$$

Where:
C is the post-development runoff coefficient (Appendix G, Page 6)
A is the contributing area in acres
CPVC is the required volume in cubic feet

1. The Owner must submit evidence that a test pit has been used to determine soil infiltration. The minimum depth of this test pit is to be 10 feet below the proposed basin bottom elevation. This test pit is to be made in accordance with the standards detailed in Appendix E.

2. In instances that test pits are not possible, a geotechnical group can perform a core analysis, at the Drain Commissioner's discretion.

b. Provide adequate infiltration and/or storage/reuse BMPs, to the MEP, to provide the necessary CPVC. This may include (but is not limited to) bioretention, rain gardens, bio-swales, pervious pavement, cisterns, green roofs, and infiltration trenches.

1. When the in-situ infiltration rate is above 0.5 in/hr, supplemental measures are not required.

2. When in-situ infiltration rates are between 0.24 in/hr and 0.5 in/hr, soils are marginally suitable for infiltration BMP's, and supplemental measures are required. Supplemental measures may include subsoil amendment, or an underdrain located at the top of the storage bed layer to maximize infiltration. (The Drain Commissioner reserves the right to modify the infiltration requirement for sites with infiltration rates between 0.24 in/hr and 0.5 in/hr in the event of the site having excessive restrictions.)

3. When in-situ infiltration rates are less than 0.24 in/hr, infiltration is waived. When infiltration is waived, other volume reducing LID practices must be implemented to the MEP.

4. Infiltration BMP's shall completely dewater in less than 72-hours, consisting of 24-hour dewatering for the surface volume, and 48-hour dewatering of the void space (soil storage) volume. Water storage/reuse BMPs shall also be designed to fully dewater within 72-hours.

c. If infiltration is not feasible on the site, the system must still meet the WQ, CPRC and Flood Control requirements.

d. Infiltration testing results shall be shared with the Drain Commissioner prior to preliminary designs to determine if a predesign meeting is required.

3. Channel Protection Rate Control (CPRC)

CPRC = 6,897 x C x A

Where:
C is the post-development runoff coefficient (Appendix G)
A is the sites contributing area in acres
CPRC is the required extended detention volume in cubic feet

a. The system will capture and provide extended detention for the site runoff volume generated from a 1.9 in. rainfall event and release over 48 hours.

4. Detention and Flood Control Volume

a. The required detention and flood control volume shall be implemented to manage runoff from the 100-year frequency storm (see Atlas 14). Atlas 14 can be found on NOAA's Website. Additional information can also be found in Appendix J, page 1.

b. The allowable 100-year post-development peak flow rate (Q_{100P}) will be approved by LCDC and can be calculated one of two ways:

1. Using the Variable Release Rate (see following equations) in the limited situations where sufficient downstream capacity exists.

2. County determined peak flow rate based on known County Drain capacity limitations. A pre-design meeting is required for developments that discharge to County Drains. The typical maximum allowable discharge rate is 0.15 cfs/acre or less.

Q_{VRR}=1.1055-0.206ln (A)

Where:
Q_{VRR}=Allowable release rate in cfs/acre
A=Contributing area in acres

The variable release rate (cfs/acre) is capped at 1.0 cfs/acre for developments 2 acres or less. For all developments over 100 acres, the maximum allowable release rate is 0.15 cfs/acre.

$Q_{100P}=Q_{VRR} \times A$

Where:

Q_{100P}= Allowable 100-year post-development peak flow rate in cfs
A=Contributing area in acres

c. The required detention volume shall be calculated using all on-site contributing drainage areas. Volume stored within the forebay and extended detention area may be applied towards the required detention volume. Please refer to Appendix J, page 2 for typical detention basin profiles and stormwater design calculations.

The required 100-year detention volume (V_{100D}) is calculated as follows:

100-year peak runoff volume (V_{100R})

$V_{100R}=18985 \times C \times A$

Where:

C=Post-development runoff coefficient
A=Contributing area in acres
V_{100R}=Post-development 100-year runoff volume in cubic feet

100-year peak inflow rate (Q_{100IN})

$Q_{100IN} = C \times I_{100} \times A$

Where:

Q_{100IN}= 100-year post-development peak inflow rate in cfs
C= Post-development runoff coefficient
I_{100}= 100-year peak rainfall intensity in inches/hour
A= Contributing area in acres

100 -year peak rainfall intensity (I_{100})

$$\mathbf{I_{100}= 83.3 / (Tc + 9.17)^{0.81}}$$

Where:

I_{100} = 100-year peak rainfall intensity
Tc=Site-specific time of concentration for the development in minutes

Storage Curve Factor for the 100-year detention volume (R)

$R= [0.206 – 0.15 \ln (Q_{100P}/Q_{100IN})]$

Where:

R=Storage Curve Factor (dimensionless)
Q_{100P}= 100-year post-development peak flow rate in cfs

Q_{100IN}= 100-year post-development peak inflow rate in cfs

100-year detention basin size (V_{100D})

$V_{100D} = (V_{100R} \; x \; R) - V_{CP-P}$

Where:

V_{100D}= Required 100-year detention volume in cubic feet
V_{100R}= 100-year runoff volume in cubic feet
R= Storage Curve Factor (dimensionless)
V_{CP-P}= Provided CVPC volume in cubic feet

Key Rule: $V_{100D} \geq V_{ED}$

d. The adjusted 100-year detention basin volume shall be equal to or greater than the Extended Detention Volume (V_{ED}). The adjusted detention basin volume shall not be less than V_{ED}.

2.2.2. General Design Requirements

1. A minimum of one (1) foot of freeboard is required for all detention basins.

2. Basin Inlet / Outlet Design

a. Engineered velocity dissipation measures based on discharge flow rates and velocities will be incorporated into basin designs to minimize erosion at inlets and outlets, to minimize the re-suspension of pollutants, and to create sheet flow conditions where feasible.

b. 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:

1) increasing the length-to-width ratio of the entire design.

2) 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

c. The outlet will be well protected from clogging.

d. Sediment forebays (upper stage) will be provided at the inlet of all stormwater management facilities to provide energy dissipation and to trap and localize incoming sediments.

1) The forebay will be a separate basin, which can be formed by gabions or a compacted earthen berm and constructed with a minimum three (3) foot deep sediment sump.

2) For soils infiltrating greater than 0.5 inches per hour, any volume that is infiltrated or stored upstream of the forebay will count towards the Minimum Volume Requirements.

3) Direct maintenance access to the forebay for heavy equipment will be provided.

4) An adequate area for temporary staging of spoils, prior to ultimate disposal, shall be provided. This area shall be protected such that no runoff will be directed back into the stormwater management system or onto private property. For public drainage systems, an easement dedicated to the Drain Commissioner must be provided over the disposal area.

e. Riser Design

1) The use of a perforated standpipe-type riser structure (or a control structure with a weir and orifice plate/wall) is required to assure an appropriate detention time for all storm events.

2) Grates or trash racks shall be installed on the riser to prevent clogging. Grate openings shall be a maximum of four (4) inches.

3) When an orifice plate/wall is to be used to control discharge, the control structure will have a minimum diameter of four (4) feet.

4) The riser structure shall be placed near the basin embankment to provide for ready maintenance access.

5) The riser pipe shall be a minimum of 36 inches in diameter for riser pipes up to 4 feet in height. Riser pipes greater than 4 feet in height shall be a minimum of 48 inches in diameter. Riser pipes will be constructed with concrete bottoms.

f. Outlet Design

1) All outlets will be designed to be easily accessible for heavy equipment for maintenance purposes.

2) All outlets will be designed to discharge at an elevation within two (2) feet of the 100-year floodplain elevation for the receiving water body. Discharging at the “crest” of slopes will not be permitted.

3) Backwater on the outlet structure from the downstream drainage system shall be evaluated when designing the outlet.

4) Pumped outlets will not be permitted on public systems and discouraged on private systems. (Section 2.1.2 p. 19)

g. Overflow Spillway Design

1) All basins will have provisions for a defined overflow spillway, routed so that it can be picked up by the main outflow channel while not discharging directly over the outlet pipe. The overflow spillway will be set at an elevation at least 6 inches above the design high water elevation and shall convey the 10-year frequency storm flow from the basin.

2) The overflow spillway will be a minimum of 6 inches below the freeboard elevation of the basin.

3) If a standpipe is used to create the overflow spillway the standpipe will have a minimum diameter of 4 feet. No standpipe shall be less than 3 feet in diameter.

3. General Design Rules

a. Basin side slopes will be no steeper than one-foot-vertical to three-feet-horizontal (3:1). For basins proposed to be under the jurisdiction of the Drain Commissioner, slopes steeper than one-foot-vertical to five-feet-horizontal, will be permitted only with the installation of a four-foot-high chain link fence completely surrounding the detention facility. In such cases, a 12-foot-wide access gate shall be provided. Installation of fencing on private systems shall be governed by the stormwater ordinance of the local unit. In cases where the basins will not be designed to provide infiltration, a three-foot-deep permanent pool, or a minimum 0.5% slope from the basin inlets to the outlet structure pipe invert shall be provided.

b. Anti-seep collars should be installed on any piping passing through the sides or bottom of the basin to prevent leakage through the embankment.

c. 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 detention basin riser/outlet.

4. General Restrictions

a. The placement of retention/detention basins within a floodplain of a stream, creek, or lake is prohibited.

b. The use of underground retention/detention on new and existing developments is strongly discouraged, and prohibited on drains proposed to be under the jurisdiction of the Drain Commissioner. Exceptions may be granted if each of the following conditions exist:

1) A catastrophic property loss results in the need to rebuild an existing commercial facility that was not previously equipped with retention/detention, and the installation of an above-ground retention/detention facility would significantly reduce the available square footage for a replacement structure.

2) The provision of above-ground retention/detention on an existing commercial parcel less than 1 acres in size would preclude development of the property under its current zoning.

c. Retention/detention systems with designed underground infiltration chambers or galleries 10 ft or greater below the ground surface require review by the Livingston County Health Department prior to approval. The Livingston County Drain Commissioner's Office may prohibit any infiltration practice that is in a defined wellhead protection area or may negatively impact the quality of groundwater for existing wells in proximity to the site and/or the ability to construct new drinking wells in the future.

2.2.3. Retention Basin Design

A "no outlet" retention basin is only permissible subject to certain conditions that include, but are not limited to the following:

1. There is no other available positive outlet for the stormwater runoff from the property. Every effort should be made to provide a means to de-water the basin including downstream improvements.

2. The Volume of the Retention Basin is calculated either of the following two methods:

   a. Using the equation below, and providing twelve inches of freeboard over the design high water elevation:

      $V_{RB} = (18985 \times C \times A \times 2) - V_C$

      Where:
      V_{RB}= Total retention basin volume in cubic feet
      C= Composite runoff coefficient
      A= Contributing area in acres
      V_C= Volume of 100% upstream BMP Credit in cubic feet

   b. Calculating the volume generated by two inches of runoff over the tributary area to the proposed basin, and including three feet of freeboard over the calculated design high water elevation.

3. The permeability of the soils shall follow all requirements set forth for large BMPs with the exception of the following:

a. The Basin shall be able to dewater a 100-year storm (V_{100R}) within 72 hours based on the infiltration rates.
b. When calculating the volume of storage, no credit will be given for infiltration volume within the basin. However, infiltration volume from upstream BMPs may be credited towards the total retention volume required.

4. An infiltration trench is not considered an acceptable substitution for permeable soils.

5. The general requirements listed in section 3a (page 25) for detention basins shall be followed for retention basins. Furthermore, retention basins shall be designed with an infiltration gallery, which shall consist of a minimum of 2 standpipes connected by horizontal perforated plastic pipe (minimum 12" diameter) bedded in stone trenches at least two feet below the designed basin bottom elevation. The proposed gallery should cover at least 50% of the basin floor area.

6. An overflow route from the retention basin must be provided. Elevations of surrounding buildings, development or other features that would be impacted by a basin overflow must be indicated. The overflow route may not endanger any existing structures or features. Downstream drainage easement s may be required for the overflow route.

7. The proprietor must submit infiltration test pit results or infiltration results from a soil boring taken within the basin bottom area to a depth of 25 feet below existing ground or 20 feet below proposed basin bottom elevation. Note that infiltration test results from a soil boring will be reduced by a factor of two, in order to reflect reduced accuracy of estimated infiltration rates associated with soil borings in comparison to test pits.

8. The Drain Commissioner reserves the right to require additional storage up to that required by two consecutive 100 year storm events based on the results of soils data or the overflow assessment.

2.3. Stormwater Conveyance

The general stormwater conveyance design criteria is outlined in Appendix G. All structures will be constructed in accordance with governing specifications (Michigan Department of Transportation, EGLE, Livingston County Road Commission, or Livingston County Drain Commissioner). In the event of no other governing specifications, the latest edition of the Michigan Department of Transportation standards will be observed. Where possible natural streams should be preserved. Unless otherwise noted, most of these streams are under EGLE's jurisdiction.

1. Vegetated Swales/Open Ditches

a. Open ditch flow velocities will be neither siltative nor erosive. In general, the minimum acceptable velocity for the 10-year storm will be 1.5 ft./sec., and the maximum acceptable velocity will be 4.0 ft./sec. Where the above velocity is exceeded, the channel shall be protected by cobble paving or other means to prevent scour.

b. 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.

c. In general, a four-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 two (2) feet of clearance be allowed.

d. Bridge footings will be at least two (2) feet below the established drain bottom elevation. The elevation to be provided by the Livingston County Drain Commissioner.

2. 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. In no case shall the elevation of the hydraulic gradient exceed a point lying one (1) foot below the rim elevation of a manhole, catch basin, or inlet. Velocities are to be a minimum of 2.5 feet per second and a maximum of 10 feet per second.

b. Pipes shall be free flowing and self-draining. Therefore, no portion of a storm drainage system shall be permanently submerged.

c. Drainage structures will be located as follows:

1) To assure positive drainage of all areas of the subdivision not designated as stormwater retention or detention areas. Natural, small, undrained areas, or "potholes," are desirable and can be maintained as natural retention areas if the following apply:

a) An easement is designated for the entire "pothole" area up to and including the spillway elevation.

b) No portion of the easement shall be located within the building envelope.

c) Side slopes of the "pothole" are no greater than 3:1.

d) For drains proposed to be under the jurisdiction of the Drain Commissioner, restrictions relating to use of the low area are cited in the master deed/bylaws and seller's disclosure for the affected lots.

2) At all low points of streets and rear yards unless easements and overflow spillways protect rear yard swales. Drainage structure locations should be

clearly defined using road stationing with offsets, dimensions from property lines or a project coordinate system. If coordinates are used for this purpose, they should also be provided for the parcel's property corners.

3) Such that there is no flow across a street intersection.

4) For smaller enclosed pipes (12-24 inches), manholes will not be spaced more than 400 feet apart. Longer runs up to 600 feet may be allowed for larger sized pipe, but in all cases the Drain Commissioner must deem maintenance access adequate.

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 unless an easement is provided for the ponding area.

e. Discharge from enclosures shall be designed as follows:

1) All outlets will be designed so that velocities will be appropriate to, and will not damage, receiving waterways. Discharge points shall be no more than 2 feet above the ordinary highwater mark.

2) All outlets will be provided with flared end sections or headwalls.

3) Outlet protection shall employ engineered riprap design. Median riprap size, dimensions, and total quantity in square yards shall be determined based on the pipe size, design velocity, and discharge. All riprap shall be underlain with suitable geotextile fabric. A minimum of 10 square yards of 6" minimum size angular (round stone is not permitted) rip-rap shall be provided at all outlets (flared end sections). Other approved materials will be provided as necessary to prevent erosion.

4) The soils above and around the outlet will be compacted and stabilized to prevent piping around the structure. Riprap extending 2 feet above the ordinary high-water mark is recommended for all outlets.

f. In addition to criteria outlined in Appendix G, pipe will conform to the following:

1) Pipe joints will be such as to prevent excessive infiltration or exfiltration.

2) All materials will be of such quality of usable life expectancy of at least 50 years and shall conform to Michigan Department of Transportation, Livingston County Road Commission, and Livingston County Drain Commissioner Specifications. Materials shall also comply with all appropriate A.S.T.M. standards.

g. In areas where local ordinance requires sump pump leads to be connected into an enclosed system the stormwater conveyance system, shall be sized accordingly.

2.3.1. Channel and Pipe Sizing

1. The "Manning's" formula will be used to size the open channel or pipe.

$$Q = \left(\frac{1.49}{n}\right) AR^{\left(\frac{2}{3}\right)} S^{\frac{1}{2}}$$

Where: Q = flow, in cubic feet per second
A = cross sectional area, in square feet
n = Manning's coefficient of roughness (see Appendix G for reference)
R = hydraulic radius = A/P, in feet
P = wetted perimeter
S = slope of the bottom of the drain (see Appendix G for permissible slopes)

A minimum "n" of 0.035 will be used for the roughness coefficient of an open channel unless special treatment is given to the bottom and side slopes, such as sod installation, riprap, or paving.

If the Manning's formula is not used, the Drain Commissioner shall approve the alternative method used.

Under Michigan State Law (Act 451, P.A. Part 301 of 1994), crossroad pipes (e.g. culverts) draining 2 square miles or more must be reviewed and approved by the Michigan Department of Environment, Great Lakes, and Energy. This does not supersede review and approval by the Livingston County Drain Commissioner's office.

All storm sewer pipe, excluding crossroad pipes, shall have a minimum diameter of 12 inches. The minimum size of a crossroad pipe shall be 15 inches or equivalent pipe arch.

Crossroad pipes draining less than 2 square miles of upstream watershed will be sized by the Owner's Engineer and reviewed by the Livingston County Drain Commissioner's office.

Wing walls, headwalls, end sections and all other culvert extremities will be designed to assure the stability of the surrounding soil. Michigan Department of Transportation standard designs shall be observed unless special exemption is given. Animal guards shall be installed on all pipes larger than twelve (12) inches in diameter.

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 1 of the following methods:

- The "Manning's" formula
- The inlet headwater control/outlet tailwater control nomographs
- Other methods approved by the Drain Commissioner

2.4. Keeping a Site in Compliance (Long Term O&M)

Long-term Operations and Maintenance (O&M) requirements for County Stormwater Systems and Non-County Stormwater Systems are summarized below.

County Stormwater Systems

The following applicable MS4 Permit O&M requirements apply to all regulated County Stormwater Systems owned, operated and maintained by the Livingston County or the LCDC's office:

1. Prior to the start of any development or redevelopment activity meeting the criteria defined herein, the County shall obtain a Drain Permit from the LCDC's office. Coordination with the LCDC's Permitting Department is recommended at the conceptual stage of development projects to ensure that permit requirements are clearly identified early in the planning process.
2. To ensure consistent perpetual O&M of the site's stormwater system and to enhance water quality protection, prior to Drain Permit issuance, the LCDC's Permitting Department shall review and approve the County's site-specific Stormwater Management O&M Plan including the following requirements:
    a. Purpose of the plan.
    b. Drainage area description and details.
    c. Description of the stormwater system and its individual components.
    d. Specific short-term, intermediate and long-term maintenance tasks.
    e. Inspection and maintenance tasks, frequencies and responsibilities.
    f. Employee and contractor training requirements and responsibilities.
    g. Approved construction drawings including stormwater calculations, details, elevations and a location map, etc.
    h. The County shall submit an Annual Stormwater System O&M Summary, for their stormwater systems, to the LCDC's Permitting Department for County MS4 permit reporting. Individual County Departments are responsible for completing all O&M tasks and for maintaining detailed O&M tracking records (See Part I below) for their stormwater systems.

Non-County Stormwater Systems

The following applicable MS4 Permit O&M requirements apply to all regulated Non-County Stormwater Systems owned, operated and maintained by others, which directly connect to a County Stormwater System:

1. Prior to the start of any development activity meeting the site applicability criteria defined herein, a Drain Permit shall be obtained from the LCDC's Permitting Department. Coordination with the LCDC's Permitting Department is recommended at the conceptual stage of development projects to ensure that permit requirements are clearly identified early in the planning process.

2. To ensure consistent perpetual O&M of the site's stormwater system and to enhance water quality protection, prior to Drain Permit issuance, the LCDC's Permitting Department shall review and approve the site-specific Stormwater Management O&M Agreement between the community and property owner. A fully executed Stormwater Management O&M Agreement is required prior to issuance of the Drain Permit. This agreement shall consist of the following requirements:

   a. Legal Description: A legal description and reduced copy map to identify the land parcel(s) affected by this Agreement. This map shall be prepared for each site and must include a reference to a Subdivision Plat, parcel survey, or Condominium Master Deed, and a map to illustrate the affected parcel(s).

   b. Stormwater System Description and Map: A written description and location map of the entire stormwater system. This map must be prepared for each site and the scale of the map shall show necessary detail.

   c. Stormwater O&M Plan: The site-specific Stormwater O&M Plan shall include the following requirements:

      - Purpose of the plan.
      - Drainage area description and details.
      - Description of the stormwater system and its individual components.
      - Specific short-term, intermediate and long-term maintenance tasks.
      - Inspection and maintenance tasks, frequencies and responsibilities.
      - Employee and contractor O&M training requirements and responsibilities.
      - Approved construction drawings including stormwater calculations, details, elevations and a location map, etc.
      - Property owners are responsible for completing all O&M tasks and maintaining O&M records for their stormwater systems. Property Owners shall submit an Annual Stormwater System O&M Summary to their community for tracking and enforcement as required in the MS4 permit.
      - For properties with a direct stormwater connection to a regulated county stormwater system, the community shall submit the Annual Stormwater System O&M Summary to the LCDC's Permitting Department for LCDC's MS4 permit reporting requirement. **The community is responsible for maintaining detailed O&M records and for implementing local code enforcement requirements.**

   d. Memorandum of Stormwater Management Operations and Maintenance Agreement: This O&M Memorandum acknowledges a perpetual requirement of stormwater system operations and maintenance, which is recorded with the Register of Deeds to put any future property owners, or interest holders, on notice of the Stormwater System and the Stormwater O&M Plan. This O&M Memorandum references the required Stormwater Management O&M Agreement, which resides with the local community to ensure consistency and periodic updates as necessary. A copy of the recorded document shall be submitted to LCDC prior to closure of the Drain Permit.

Appendix K - Stormwater Management O&M Agreement is an approved **"**example" agreement, however, the LCDC office recognizes that community-specific O&M agreements, ordinances and programs may also be proposed and submitted to LCDC for approval. When developing alternative O&M programs for consideration, the community should reference EGLE's Post-Construction Stormwater Runoff Controls Program Compliance Assistance Document (available on EGLE's website)