TITLE 6 — STORMWATER DRAINAGE

SECTION 1.0 STORMWATER DRAINAGE: GENERAL PROVISIONS

1.1 PURPOSE

It is recognized that smaller streams and drainage channels serving the County may not have sufficient capacity to receive and convey stormwater runoff resulting when land use changes from open or agricultural use to a more urbanized use. It is further recognized that deposits of sediment from developments during and after construction can reduce capacities of storm sewers and drainage systems and result in damages to receiving lakes and streams.

Therefore, it shall be the policy of the Henry County Drainage Board (Drainage Board) that the storage and controlled release of stormwater runoff shall be required of all new development, any redevelopment and other new construction in the County. The release rate of stormwater from developed lands shall not exceed the release rate from the land area in its present land use.

Because topography and the availability and adequacy of outlets for stormwater runoff vary with almost every site, the requirements for stormwater drainage tend to be an individual matter for any project. It is recommended that each proposed project be discussed with the County Surveyor's Office at the earliest practical time in the planning stage.

1.2 CONFLICTING ORDINANCES

The provisions of this Ordinance shall be deemed as additional requirements to minimum standards required by other ordinances of the County. In the case of conflicting requirements, the most restrictive shall apply.

1.3 COMPLIANCE WITH OTHER ORDINANCES

In addition to the requirements of this Ordinance, compliance with the requirements set forth in other applicable ordinances with respect to submission and approval of Primary and Secondary Subdivision plats, improvement plans, building and zoning permits, construction inspections, appeals and similar matters and compliance with applicable State of Indiana statutes and regulations shall be required.

1.4 DISCLAIMER OF LIABILITY

The degree of protection required by this Ordinance is considered reasonable for regulatory purposes and is based on historical records and scientific methods of study. Larger storms may occur or stormwater runoff depths may be increased by man-made or natural causes. This Ordinance does not imply that land uses permitted will be free from stormwater damage. This Ordinance shall not create liability on the part of the County or any officer or employee thereof for any damage that may result from reliance on this Ordinance or on any administrative decision lawfully made thereunder.

1.5 CORRECTIVE ACTION

Nothing herein contained shall prevent the County from taking such other lawful action as may be necessary to prevent or remedy any violation. All costs connected therewith shall accrue to the person or persons responsible.

1.6 REPEALER

All ordinances or parts thereof in conflict with the provisions of this Ordinance are repealed.

1.7 WHEN EFFECTIVE

This Ordinance shall become effective after its final passage, adoption and publication as required by law.

1.8 EXEMPT PROJECTS

Any residential (major or minor), commercial or industrial Subdivision or construction project thereon that has had its Drainage Plan approved by the Drainage Board prior to the effective date of this Ordinance shall be exempt from all the requirements of this Ordinance.

SECTION 2.0 STORMWATER DRAINAGE: DEFINITIONS

For the purpose of this Ordinance, the following definitions shall apply:

Capacity of a Storm Drainage Facility	The maximum flow that can be conveyed or stored by a storm drainage facility without causing damage to public or private property.
Channel	A natural or artificial watercourse that periodically or continuously contains moving water or that forms a connecting link between two (2) bodies of water. It has a defined bed and banks that serve to confine the water.
Compensatory Storage	An artificial volume of storage within a floodplain used to balance the loss of natural flood storage capacity when artificial fill or structures are placed within the floodplain.
Contiguous	Adjoining or in actual contact with.
Culvert	Any conduit installed for the purpose of directing and controlling the flow of surface waters; a pipe, box or small slab-top structure having limited waterway area, as distinguished from a bridge structure.
Detention Basin	A facility constructed or modified to redirect the flow of stormwater to a prescribed maximum rate and to detain concurrently the excess waters that accumulate behind the outlet.
Detention Basin, Dry Bottom	A basin designed to be completely dewatered after having provided its planned detention of runoff during a storm event.
Detention Basin, Wet Bottom or Retention Basin	A basin designed to retain a permanent pool of water after having provided its planned detention of runoff during a storm event.
Detention Storage	The temporary detaining or storage of stormwater in storage basins, on rooftops, in roads, streets, parking lots, school yards, parks, open spaces or other areas under predetermined and controlled conditions, with the rate of drainage therefrom regulated by appropriately installed devices.
Drainage Area	The area from which water is carried off by a drainage system; a watershed or catchment area.

Drainage Board	The Drainage Board of Henry County, Indiana, and any subordinate employee to whom they shall specifically delegate a responsibility authorized by this Ordinance.
Drainage System, Major	A drainage system carrying runoff from an area of one (1) or more square miles.
Drainage System, Minor	A drainage system carrying runoff from an area of less than one (1) square mile.
Drainage System, Stormwater	All means, natural or man-made, used for conducting stormwater to, through or from a drainage area to any of the following: conduits and appurtenant features, canals, channels, ditches, streams, culverts, roads or streets and pumping stations.
Duration	The time period of a rainfall event.
Erosion	Wearing away of the land by running water, waves, temperature changes, ice or wind.
Flood Elevation	The elevation at all locations delineating the maximum level of high waters for a flood of given return period and rainfall duration.
Flood or Floodwaters	The water of any watercourse that is above the banks of the watercourse and/or the water of any lake that is above and outside the banks thereof.
Flood Hazard Area	Any floodplain, floodway, floodway fringe or any combination thereof that is subject to inundation by the Regulatory Flood or any floodplain as delineated as Zone A on a Flood Hazard Boundary Map.
Flood Protection Grade	The elevation of the lowest floor of a building. If a basement is included, the basement floor is considered the lowest floor.
Flood, Regulatory	That flood having a peak discharge that can be equaled or exceeded on the average of once a one hundred (100) year period calculated by a method that is acceptable to the Indiana Department of Natural Resources. This Regulatory Flood is equivalent to a flood having a probability of occurrence of one (1) percent in any given year.
Floodplain	The area adjoining the river or stream that has been or may hereafter be covered by floodwaters.
Floodway	See Floodway, Regulatory.
Floodway Fringe	That portion of the floodplain lying outside the fllodway that is inundated by the Regulatory Flood.
Floodway, Regulatory	The channel of a river or stream and those portions of the floodplains adjoining the channel that are reasonably required to carry and discharge the peak flow of the Regulatory Flood of any river or stream. A permit from the Indiana Department of Natural Resources is required for construction in the Floodway. (See Section 4.0.) When such permit is issued, then the regulatory flood peak discharge should be calculated by a method that is acceptable to the Indiana Department of Natural Resources.

Footing Drain	A drain pipe installed around the exterior of a basement wall foundation to relieve water pressure caused by high groundwater elevation.
Grade	The inclination or slope of a channel, canal, conduit, etc., or natural ground surface, usually expressed in terms of the percentage the vertical rise or fall bears to the corresponding horizontal distance.
Impact Areas	Areas defined and mapped by the Drainage Board that are unlikely to be easily drained because of one (1) or more factors, including, but not limited to, any of the following: soil type, topography, land where there is no adequate outlet, a floodway or floodplain, land within seventy-five (75) feet of each bank of any regulated drain or within seventy-five (75) feet from the centerline of any regulated tile ditch.
Impervious	A term applied to material through which water cannot pass or through which water passes with difficulty.
Inlet	An opening into a storm sewer system for the entrance of surface stormwater runoff, more completely described as a storm sewer inlet.
Junction Chamber	A converging section of conduit, usually large enough for a person to enter, used to facilitate the flow from one (1) or more conduits into a main conduit.
Manhole	A storm sewer structure through which a person may enter to gain access to an underground storm sewer or enclosed structure.
Manhole, Drop	A manhole having a vertical drop pipe connecting the inlet pipe to the outlet pipe. The vertical drop pipe shall be located immediately outside the manhole.
Off-Site	Everything not on-site.
On-Site	Located within the controlled area where runoff originates.
Outfall	The point or location where storm runoff discharges from a sewer or drain. Also applies to the outfall sewer or channel that carries the storm runoff to the point of outfall.
Peak Flow	The maximum rate of flow of water at a given point in a channel or conduit resulting from a particular storm or flood.
Radius of Curvature	Length of radius of a circle used to define a curve.
Rainfall Intensity	The cumulative depth of rainfall occurring over a given duration, normally expressed in inches per hour.
Reach	Any length of river, stream or storm sewer.
Regulated Area	All of the land under the jurisdiction of the Planning Commission.
Release Rate	The amount of stormwater released from a stormwater control facility per unit of time.

Return Period	The average interval of time within which a given rainfall event will be equaled or exceeded once. A flood having a return period of one hundred (100) years has a one (1) percent probability of being equaled or exceeded in any one (1) year.
Runoff Coefficient	A decimal fraction relating the amount of rain that appears as runoff and reaches the storm drainage system to the total amount of rain falling. A coefficient of five-tenths (0.5) implies that fifty (50) percent of the rain falling on a given surface appears as stormwater runoff.
Sediment	Material, of soil in origin, transported, carried or deposited by water.
Siphon	A closed conduit or portion of which that lies above the hydraulic grade line, resulting in a pressure less than the atmospheric pressure and requiring a vacuum within the conduit to start flow. A siphon utilizes atmospheric pressure to effect or increase the flow of water through a conduit. An inverted siphon is used to carry stormwater flow under an obstruction such as a sanitary sewer.
Spillway	A waterway for the escape of excess water in or about a hydraulic structure.
Stilling Basin	A basin used to slow water down or dissipate its energy.
Storage Duration	The length of time that water may be stored in any stormwater control facility, computed from the time water first begins to be stored.
Storm Sewer	A closed conduit for conveying collected stormwater.
Storm Sewer, Lateral	A storm sewer that has inlets connected to it but has no other storm sewer connected.
Stormwater Runoff	The water derived from rains falling within a tributary basin, flowing over the surface of the ground or collected in channels or conduits.
Tributary	Any watercourse contributing stormwater from upstream land areas.
Urbanization	The development, change or improvement of any parcel of land consisting of one (1) or more lots for residential, commercial, industrial, institutional, recreational or public utility purposes.
Watercourse	Any river, stream, creek, brook, branch or natural or man-made drainageway in or into which stormwater runoff or floodwaters flow either regularly or intermittently.
Watershed	See Drainage Area.

SECTION 3.0 STORMWATER DRAINAGE: STORMWATER CONTROL POLICY

It is recognized that smaller streams and drainage channels serving the County may not have sufficient capacity to receive and convey stormwater runoff resulting from continued urbanization. Accordingly, the storage and controlled release rate of excess stormwater runoff shall be required for any development, redevelopment or new construction located within the County.

The release rate of stormwater from development, redevelopment or new construction may not exceed the stormwater runoff from the land area in its present state of development. The Developer must submit detailed computations of runoff before and after development, redevelopment or new construction to the Drainage Board that demonstrate that runoff will not be increased.

These computations must show that the peak runoff rate after development for the one hundred (100) year return period storm of critical duration will not exceed the ten (10) year return period pre-development peak runoff rate. The critical duration storm is that storm duration that requires the greatest detention storage.

Computations for areas up to and including six thousand (6,000) acres may be based on the methods of Chart A below; typical runoff coefficients are listed herein. For areas larger than six thousand (6,000) acres, hydrograph techniques and/or computer drainage modeling methods may be used. Hydrograph techniques and computer drainage modeling methods used to determine storm water runoff shall be proven methods, subject to approval of the Drainage Board.

Chart A
Computation Formulas for Computing Stormwater Runoff
for
Areas Up to and Including 6,000 Acres

Acreage	Method	Formula	Notes
0 ≤ 20	Rational (logical)	$Q = ACI$	1 & 2
0 ≤ 80	McMath (empirical)	$Q = ACI\sqrt[5]{S/A}$	2
0 ≤ 6,000	TR-55 (analytical)	$Q = \frac{(P - Ia)^2}{(P - Ia) + S}$	1 & 3

Notes
References:
1. HERPICC, Stormwater Drainage Manual, H-94-6, July 1994
2. Seelye, Elwyn E., Data Book for Civil Engineering Design, 3rd Edition, Chapter 18 – Drainage
3. U.S. Soil Conservation Service, Urban Hydrology for Small Watersheds, Technical Release 55, June 1986.

SECTION 4.0 STORMWATER DRAINAGE: PERMITS FOR CONSTRUCTION IN THE FLOODWAY

Chapter 318 of the Acts of 1945, State of Indiana, as amended, Sections 17 and 19, requires Indiana Department of Natural Resources approval of any construction in a floodway and of any works for flood control. This includes bridges, dams, levees, dikes, floodwalls, wharves, piers, dolphins, booms, weirs, bulkheads, jetties, groins, excavations, fills or deposits of any kind, utility lines or any other building, structure or obstruction. Also, any ditch work (new construction, deepening or modification) within one-half (0.5) mile of a freshwater lake of ten (10) acres or more in area.

The approval of the Indiana Department of Natural Resources, in writing, must be obtained before beginning construction. Applications for approval should be submitted to:

Department of Natural Resources
Division of Water
402 West Washington Street, Room W264
Indianapolis, Indiana 46204

All Applications should be made on the standard Application form provided by the Indiana Department of Natural Resources and should be accompanied by plans, profiles, specifications and other data necessary for the Idniana Department of Natural Resources to determine the effect of the proposed construction upon the floodway and on flood control in the state.

Application made to and approval granted by the Indiana Department of Natural Resources does not in any way relieve the Owner of the necessity of securing easements or other property rights and permits and/or approvals from affected property owners and local, state and federal agencies.

The engineering staff of the Indiana Department of Natural Resources Division of Water is available to discuss and offer suggestions regarding requirements in the design of structures in floodways. High water marks have been set on many of the streams in the state, and information is available from the Division of Water on actual and/or potential flooding. Information regarding bench marks set to Mean Sea Level Datum, General Adjustment of 1929, is available from the Division of Water, Surveying and Mapping Section.

Applications are considered by the Indiana Department of Natural Resources at regular meetings, usually held each month. After the Application and plans have been approved by the Indiana Department of Natural Resources, a certificate of approval is forwarded to the Applicant.

A fee is charged by the Indiana Department of Natural Resources for approvals under the Flood Control Act.

Unless stated otherwise in the approval, construction is considered to be a permanent development, and no renewals of the approval are necessary, except in the cases where temprary approvals are granted for temporary construction. The right is reserved to require addtional data where necessary.

SECTION 5.0 STORMWATER DRAINAGE: INFORMATION REQUIREMENTS

The following information provided by a professional engineer or land surveyor registered by the State of Indiana engaged in stormwater drainage design shall be submitted to the Drainage Board at the time of Application for a Building Permit for any development, redevelopment or construction on real estate within the Regulated Area.

5.1 TOPOGRAPHIC AND SOILS MAPS

A soils map of the proposed development, indicating soils names and their hydrologic classifications, must be provided when the Soil Conservation Service (SCS) methods are used. In addition, a topographic map of the land to be subdivided and such adjoining land the topography of which may affect the layout or drainage of the development must be provided. The contour intervals shall be one (1) foot when slopes are less than four (4) percent and shall be two (2) feet when the slope exceeds four)4_ percent. On this map, the following shall be shown:

1. The location of streams and other floodwater runoff channels, the extent of the floodplains at the established one hundred (100) year flood elevation where available (regulatory floodway) and the limits of the floodway, all properly identified;

2. The normal shorelines of lakes, ponds, swamps and detention basins, their floodplains and lines of inflow and outflow, if any;

3. The location of regulated drains, farm drains, inlets and drain outfalls, if any of record;

4. Storm, sanitary and combined sewers and outfalls, if any of record;

5. Septic tank systems and outlets, if any of record; and

6. Seeps, springs, flowing and other wells that are visible or of record.

5.2 PRELIMINARY DRAINAGE PLANS

A comprehensive plan, in preliminary form (or in combined preliminary and final form), designed to handle safely the stormwater runoff and to detain the increased stormwater runoff, must be provided. The plan shall provide or be accompanied by maps or other descriptive materials indicating the feasibility of the Drainage Plan and showing the following:

1. The extent and area of each watershed affecting the design of detention facilities, as shown on USGS Quadrangle Maps or other, more detailed maps as required by the Drainage Board;

2. The preliminary layout and design of proposed storm sewers, the outfall and outlet locations and approximate elevations, the receiving stream or channel and its one hundred (100) year return period water elevation;

3. The location and design of the proposed road or street system, especially including depressed pavements used to convey or temporarily store overflow from the heavier rainstorms and the outlets for such overflow;

4. The locations, cross sections and profiles of exiting streams and floodplains to be maintained and new channels to be constructed;

5. The materials, elevations, waterway openings and the basis for design of proposed culverts and bridges;

6. Existing detention ponds and basins to be maintained, enlarged or otherwise altered and new ponds or basins to be built and the basis of their design;

7. The estimated depth and amount of storage required in the new ponds or basins;

8. The estimated location and percentage of impervious surfaces existing and expected to be constructed when the development is completed; and

9. Any interim plan that is to be incorporated into the development pending completion of the development and the Final Drainage Plan.

5.3 VALLEY CROSS SECTION

One (1) or more typical cross sections must be provided showing all existing and proposed channels or other open drainage facilities carried to a point above the one hundred (100) year high water elevation, the elevation of the existing land and the proposed changes thereto, together with the high water elevations expected from the one hundred (100) year storm under the controlled conditions called for by this Ordinance and the relationship of structures, roads, streets and other facilities.

5.4 SITE PLAN

A plan drawn to scale showing dimensions of the site with existing and proposed storm drainage facilities must be provided.

5.5 FINAL DRAINAGE PLANS

Upon approval of the Preliminary Drainage Plans by the Drainage Board, Final Drainage Plans shall be submitted to the Drainage Board. The final plans shall provide or be accompanied by calculations, maps and/or other descriptive materials showing the following:

1. The extent and area of each watershed tributary to the drainage channels in the development;

2. The road or street storm sewers and other storm drains to be built, the basis of their design, outfall and outlet locations and elevations, the receiving stream or channel and its high water elevation and the functioning of the drains during high water conditions;

3. The parts of the proposed road or street system where the pavements are planned to be depressed sufficiently to convey or temporarily store overflow from storm sewers and over-the-curb runoff resulting from the heavier rainstorms and the outlets for such overflow;

4. Existing streams and floodplains to be maintained and new channels to be constructed, their locations, cross sections and profiles;

5. Proposed culverts and bridges to be built, their materials, elevations, waterway openings and basis of design;

6. Existing detention basins and ponds to be maintained, enlarged or otherwise altered and new basins or ponds to be built and the basis of their design;

7. The estimated location and percentage of impervious surfaces existing and expected to be constructed when the development is completed;

8. The slope, type and size of all sewers and other waterways; and

9. For all detention basins, a plot or tabulation of storage volumes with corresponding water surface elevations and a plot or tabulation of the basin outflow rates for those water surface elevations.

5.6 SUBMISSION AND CONSIDERATION OF PLANS

Preliminary and Final Drainage Plans and/or construction plans shall be submitted to the Drainage Board fifteen (15) working days prior to their regularly scheduled meeting. All preliminary plans, final plans and/or construction plans in compliance with the standards of this Ordinance shall be approved by the Drainage Board. The Drainage Board and/or the County Surveyor shall stamp such approval on a copy of such plans and deliver the same to the Applicant. The Drainage Board shall approve or disapprove any preliminary plans, final plans and/or construction plans within forty-five (45) working days of submission unless the Applicant consents to a continuance or extension. All approvals and disapprovals with written reasons shall be incorporated into the Drainage Board minutes.

The County Surveyor is authorized to review engineering summaries of projects and, based upon the same, grant exemptions from any and all requirements of this Ordinance and/or waive any requirements of this Ordinance. Any Applicant may appeal the decision of the County

Surveyor to the Drainage Board, which shall also be authorized to grant exemptions from any and all requirements of this Ordinance at its discretion.

SECTION 6.0 STORMWATER DRAINAGE: DETERMINATION OF RUNOFF QUANTITIES

Runoff quantities shall be computed for the area of the parcel under development plus the area of the watershed flowing into the parcel under development. The quantity of runoff that is generated as the result of a given rainfall intensity may be calculated as follows:

A. For areas up to and including twenty (20) acres in area, the Rational Method may be used. In the Rational Method, the peak rate of runoff, "Q," in cubic feet per second, is computed as:

$Q = ACI$

where:

C = runoff coefficient, representing the characteristics of the drainage area and defined as the ratio of runoff to rainfall;

I = average intensity of rainfall in inches per hour for a duration equal to the time of concentration (tc) for a selected rainfall frequency; and

A = tributary drainage area in acres.

Guidance to selection of the runoff coefficient "C" is provided by Tables 1 and 1A, which show values for different types of surface and local soil characteristics. The composite "C" value used for a given drainage area with various surface types shall be the weighted average value for the total area calculated from a breakdown of individual areas having different surface types.

Table 2 provides runoff coefficients and inlet times for different land use classifications. In the instance of undeveloped land situated in an upstream area, a coefficient or coefficients shall be used for this area in its present or existing state of development.

Rainfall intensity shall be determined from the rainfall frequency curves shown in Figure 1C. The time of concentration (tc) to be used shall be the sum of the inlet time and flow time in the drainage facility from the most remote part of the drainage area to the point under consideration. The flow time in the storm sewers may be estimated by the distance in feet divided by velocity of flow in feet per second. The velocity shall be determined by the Manning Formula.

Inlet time is the combined time required for the runoff to reach the inlet of the storm sewer. It includes overland flow time and flow time through established surface drainage channels such as swales, ditches and sheet flow across such areas as lawns, fields and other graded surfaces. It may be computed by using Figure 2.

B. For areas up to and including eighty (80) acres in area, the McMath (empirical) Method may be used. In the McMath Method, the peak rate of runoff, "Q" in cubic feet per second is computed as:

$$Q = ACI\sqrt[5]{S/A}$$

C. For areas up to and including six thousand (6,000) acres, the TR-55 (analytical) Method may be used. In the TR-55 Method, the peak rate of runoff, "Q," in cubic feet per second, is computed as follows:

$$Q = \frac{(P - Ia)^2}{(P - Ia) + S}$$

D. The runoff rate for areas in excess of 6,000 acres shall be determined by methods described in Section 12.6.

Table 1
Suburban Runoff Coefficients [1, 2]

Type of Surface	Runoff Coefficient "C"
Asphalt	0.80
Concrete	0.80
Roof	0.80
Lawns (Sandy)	
Flat (0-2% slope)	0.08
Rolling (2-7% slope)	0.12
Steep (greater than 7% slope)	0.16
Lawns (Clay)	
Flat (0-2% slope)	0.16
Rolling (2-7% slope)	0.20
Steep (greater than 7% slope)	0.28

1. The coefficients of this tabulation are applicable to storms of five (5) to ten (10) year frequencies. Coefficients for less frequent higher intensity storms shall be modified as follows:

Return Period (Years)	Multiply "C" By
25	1.10
50	1.20
120	1.25

2. For use in Rational and McMath Methods.

Table 1A
Rural Runoff Coefficients [1, 2]

Type of Surface	Runoff Coefficient "C"
Woodland	
Flat (0-5% slope)	0.32
Rolling (5-10% slope)	0.40
Steep (greater than 10% slope)	0.48
Pasture	
Flat (0-5% slope)	0.32
Rolling (5-10% slope)	0.36
Steep (greater than 10% slope)	0.40

Table 1A
Rural Runoff Coefficients [1, 2]
(continued)

Type of Surface	Runoff Coefficient "C"
Cultivated	
Flat (0-5% slope)	0.48
Rolling (5-10% slope)	0.56
Steep (greater than 10% slope)	0.64

1. The coefficients of this tabulation are applicable to storms of five (5) to ten (10) year frequencies. Coefficients for less frequent higher intensity storms shall be modified as follows:

Return Period (Years)	Multiply "C" By
25	1.10
50	1.20
120	1.25

2. For use in Rational and McMath Methods.

Table 2
Runoff Coefficients By Land Use and Typical Inlet Times [1, 2, 3]

Land Use	Runoff Coefficients			Inlet Times (minutes)
	Flat [4]	Rolling [5]	Steep [6]	
Commercial (CBD)	0.76	0.76	0.80	5
Commercial (Neighborhood)	0.54	0.60	0.64	
Industrial	0.63	0.70	0.77	5-10
Garden Apartments	0.54	0.60	0.66	
Churches	0.54	0.60	0.66	
Schools	0.31	0.35	0.39	10-15
Semi-Detached Residential	0.45	0.50	0.55	
Detached Residential	0.40	0.45	0.50	
Quarter Acre Lots	0.36	0.40	0.44	
Half Acre Lots	0.31	0.35	0.39	
Parkland	0.18	0.20	0.22	To Be Computed

1. The coefficients of this tabulation are applicable to storms of five (5) to ten (10) year frequencies. Coefficients for less frequent higher intensity storms shall be modified as follows:

Return Period (Years)	**Multiply "C" By**
25	1.10
50	1.20
120	1.25

2. For use in Rational and McMath Methods.

3. Interpolation, extrapolation and adjustment for local conditions shall be based on engineering experience and judgment.

4. Flat terrain = 0-2% slopes.

5. Rolling terrain = 2-7% slopes

6. Steep terrain = greater than 7% slopes.

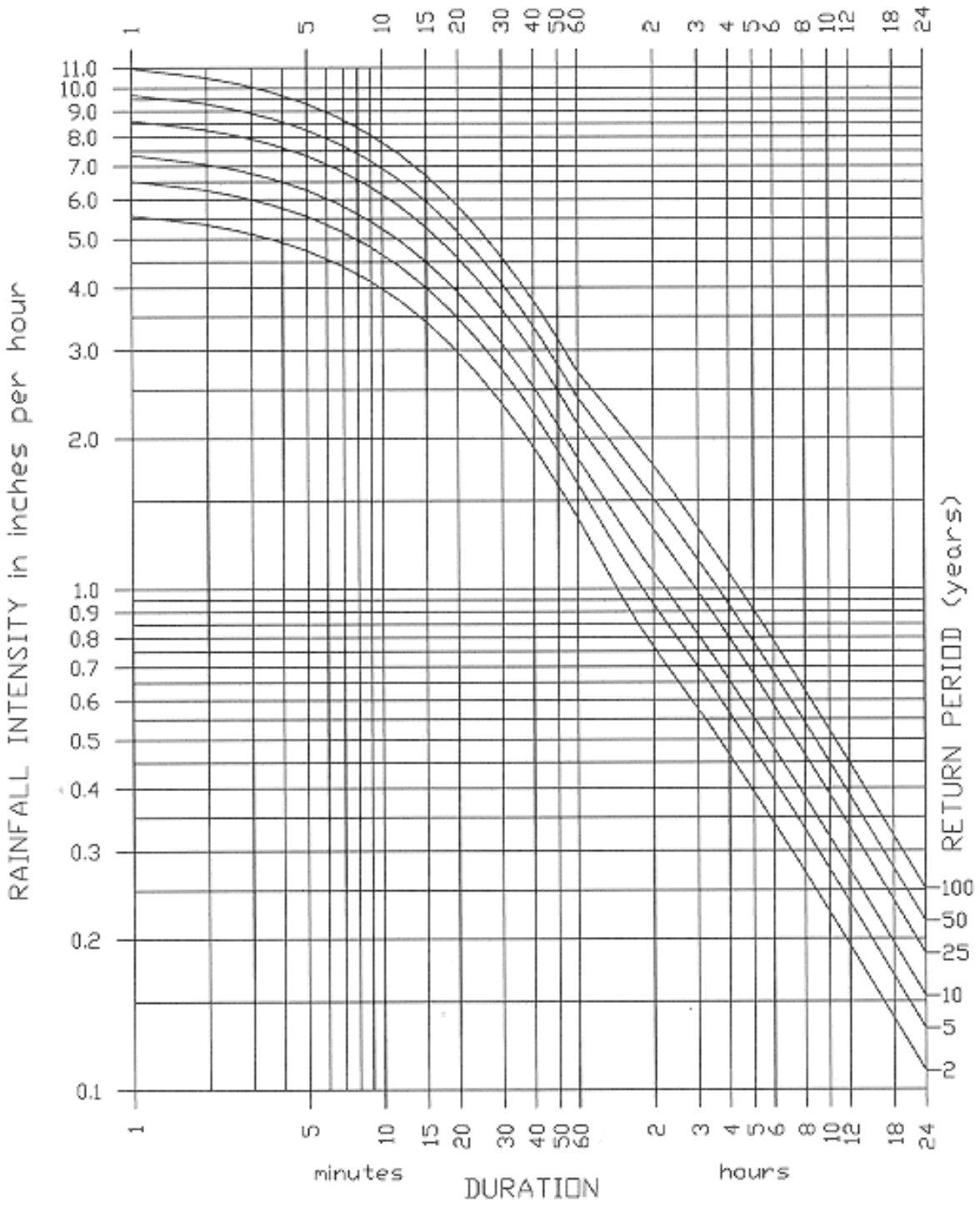
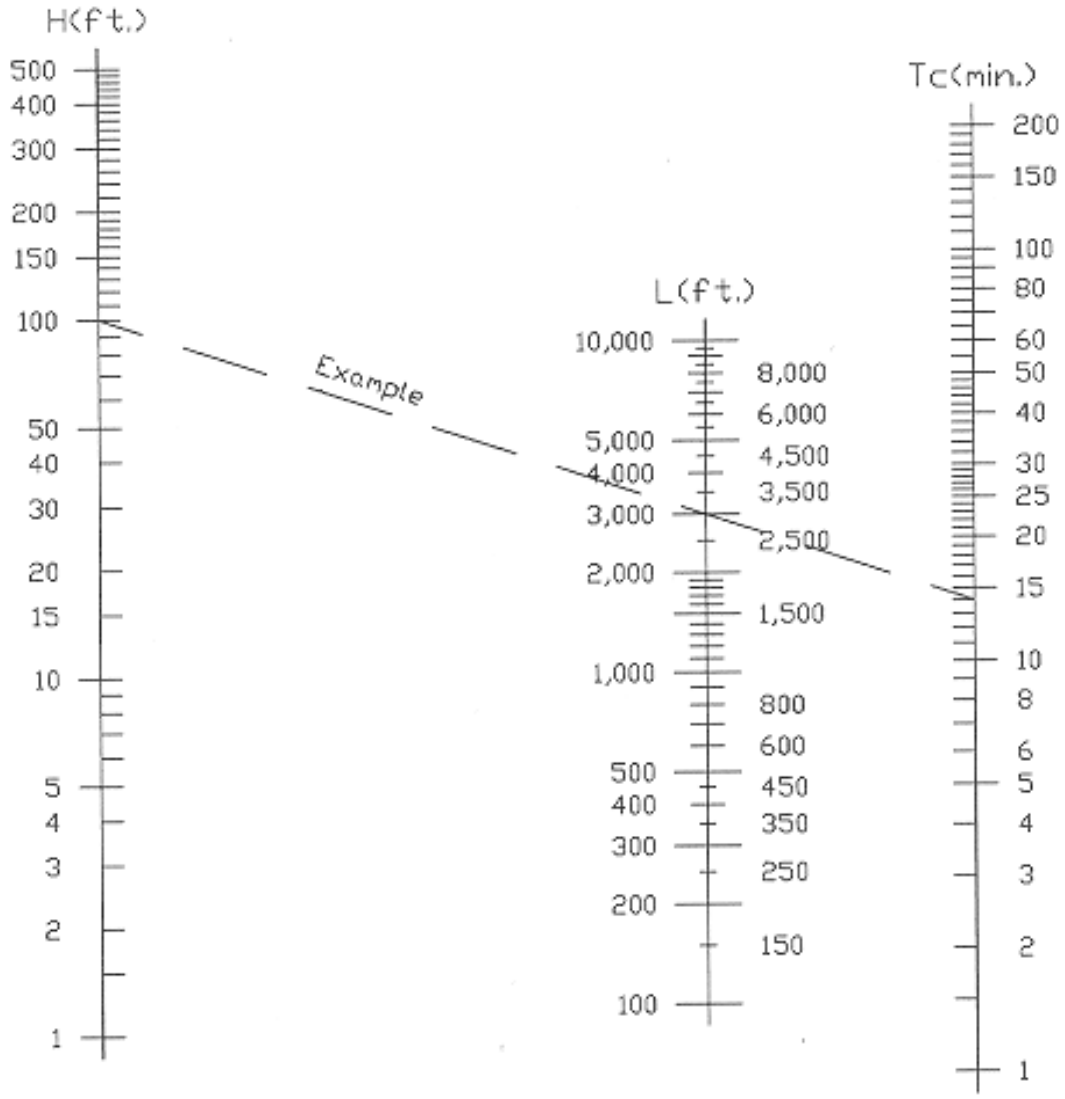


Figure 1C Rainfall Intensity - Duration - Frequency Curves
Henry County, Indiana

EXAMPLE

Height = 100 feet
Length = 3,000 feet
Time of Concentration (Tc) = 14 minutes



NOTE:

Use nomograph Tc for natural basins with well defined channels, for overland flow on bare earth, and for mowed grass roadside channels.
For overland flow, grassed surfaces, multiply Tc by 2.
For concrete channels, multiply Tc by 0.2.
For overland flow, concrete or asphalt surfaces, multiply Tc by 0.4.

Figure 2 Nomograph for Determining Time of Concentration

SECTION 7.0 STORMWATER DRAINAGE: AMOUNT OF RUNOFF TO BE ACCOMMODATED BY VARIOUS PARTS OF DRAINAGE FACILITY

Various parts of a drainage facility must accommodate runoff water as follows:

A. The minor drainage system, such as inlets, catch basins, road or street gutters, swales, sewers and small channels that collect stormwater, must accommodate peak runoff from a ten- (10-) year return period storm. Rainfall duration shall be equal to the time Of concentration or one (1) hour if the time of concentration is less than one (1) hour. A first quartile distribution shall be used for computer modeling. These minimum requirements must be satisfied:

1. The allowable spread of water on Collector Trafficways is limited to maintaining two (2) clear ten- (10-) foot moving lanes of traffic. One (1) lane is to be maintained on Local Roads or Streets.

2. Open channels carrying peak flows greater than thirty (30) cubic feet per second shall be capable of accommodating peak runoff for a fifty- (50-) year return period storm within the drainage easement.

3. Culverts shall be capable of accommodating peak runoff from a fifty- (50-) year return period storm when crossing under a road that is part of the Indiana Department of Highways rural functional classification system and is classified as a major or minor collector road.

B. Major drainage systems are defined in Section 2.0 and shall be designed in accordance with Indiana Department of Natural Resources Standards as described in Section 4.0.

SECTION 8.0 STORMWATER DRAINAGE: STORM SEWER DESIGN STANDARDS

All storm sewers, whether private or public, and whether constructed on private or public property, shall conform to the design standards and other requirements contained herein.

8.1 MANNING EQUATION

The hydraulic capacity of storm sewers shall be determined using Manning's Equation:

$$V = \frac{1.486}{n} R^{\frac{2}{3}} S^{\frac{1}{2}}$$

V = mean velocity of flow in feet per second
R = the hydraulic radius in feet
S = the slope of the energy grade line in feet per foot
n = roughness coefficient

The hydraulic radius, “R,” is defined as the cross sectional area of flow divided by the welted flow surface or welted perimeter. Typical “n” values and maximum permissible velocities for storm sewer materials are listed in Table 3. Roughness coefficient “n” values for other sewer materials can be found in standard hydraulics texts and references.

8.2 MIMIMUM SIZE

The minimum size of all storm sewers shall be twelve (12) inches. An orifice plate or other devices, subject to the approval of the Drainage Board, shall control rate of release for detention storage where the twelve- (12-) inch pipe will not limit the rate of release as required.

8.3 GRADE

Storm sewer grade shall be such that, in general, a minimum of two (2) feet of cover is maintained over the top of the pipe. Pipe cover less than the minimum may be used only upon approval of the Drainage Board. Uniform slopes shall be maintained between inlets, manholes and inlets to manholes. Final grade shall be set with full consideration of the capacity required, sedimentation problems and other design parameters. Minimum and maximum allowable slopes shall be those capable of producing velocities of two and one-half (2.5) and fifteen (15) feet per second, respectively, when the sewer is flowing full.

8.4 ALIGNMENT

Storm sewers shall be straight between manholes insofar as possible. Where long radius curves are necessary to conform to road or street layout, the minimum radius of curvature shall be no less than one hundred (100) feet for sewers forty-two (42) inches and larger in diameter. Deflection of pipe sections shall not exceed the maximum deflection recommended by the pipe manufacturer. The deflection shall be uniform and finished installation shall follow a smooth curve.

Table 3
Typical Values of Manning's "n"

Material	Manning's "n"	Desirable Maximum Velocities
Closed Conduits		
Concrete	0.013	15 f.p.s
Vitrified clay	0.013	15 f.p.s
Brick	0.015	15 f.p.s
Cast Iron	0.013	15 f.p.s
Circular Corrugated Metal Pipe, Annular Corrugations, 2-2/3 x 1/2 in.		
Unpaved	0.024	7 f.p.s
25% paved	0.021	7 f.p.s
50% paved	0.018	7 f.p.s
100% paved	0.013	7 f.p.s
Circular Corrugated Metal Pipe, Helical, 2-2/3 x 1/2 in., Unpaved Corrugations		
12-inch	0.011	
18-inch	0.013	
24-inch	0.015	
36-inch	0.018	
48-inch	0.020	
60-inch or larger	0.021	
Corrugated Polyethylene, Smooth	0.012	15 f.p.s
Interior Pipe		
Concrete Channels	0.013	

Table 3
Typical Values of Manning's "n"
(continued)

Material	Manning's "n"	Desirable Maximum Velocities
Open Channels		
Concrete, Trowel Finish	0.013	
Concrete, Broom or Float Finish	0.015	
Gunite	0.018	
Riprap, Placed	0.030	
Riprap, Dumped	0.035	
Gabion	0.028	
New Earth (Uniform, Sodded, Clay)	0.025	
Existing Earth (Fairly Uniform, with Some Weeds)	0.030	
Dense Growth of Weeds	0.040	
Dense Weeds and Brush	0.040	
Swale with Grass	0.035	

8.5 MANHOLES

A. Manholes shall be installed to provide access tp continuous underground storm sewers for the purpose of inspection and maintenance. Manholes shall be provided at the following locations:

1. Where two (2) or more storm sewers converge;

2. At the point of beginning (PC) or at the end of a curve (PT) and at the point of reverse curvature (PRC);

3. Where pipe size changes;

4. Where an abrupt change in alignment occurs;

5. Where a change in grade occurs; and

6. At suitable intervals in straight sections of sewer.

B. The maximum distance between storm sewer manholes shall be as follows:

Size of Pipe (inches)	Maximum Distance (feet)
12 through 42	400
48 and larger	600

8.6 INLETS

Inlets or drainage structures shall be utilized to collect surface water through grated openings and convey it to storm sewers, channels or culverts. Inlet design and spacing shall be in accordance with Section 7-400 of the Indiana Department of Highways Road Design Manual, Volume 1 or other approved design procedure. The inlet grate opening provided must be adequate to pass the design ten (10) year flow with fifty (50) percent of the sag inlet areas clogged. An overload channel from sag inlets to the overflow channel or basin shall be provided at sag inlets, so that the maximum depth of water that might be ponded in the street sag shall not exceed seven (7) inches.

SECTION 9.0 STORMWATER DRAINAGE: WORKMANSHIP AND MATERIALS

9.1 WORKMANSHIP

The specifications for the construction of storm sewers shall not be less stringent than those set forth in the latest edition of the Indiana Department of Highways "Standard Specifications," additionally, ductile iron pipe shall be laid in accordance with American Water Works Association (AWWA) C-600 and clay pipe shall be laid in accordance with American Society of Testing

$$Q = AV = A\frac{1.486}{n}R^{\frac{2}{3}}\ S^{\frac{1}{2}}$$

Materials (ASTM) C-12.

9.2 MATERIALS

Storm sewer manholes and inlets shall be constructed of masonry, cast in place concrete or precast reinforced concrete. Material and construction shall conform to the Indiana Department of Highways "Standard Specifications," Section 720.

Pipe and fittings used in storm sewer construction shall be extra-strength clay pipe (ASTM C-70), ductile iron pipe (AWWA C-151) or concrete pipe (ASTM C-76). Other pipe and fittings not specified herein may be used only when specifically authorized by the Drainage Board. Pipe joints shall be flexible and watertight and shall conform to the requirements of Section 719.02, Materials, of the latest edition of the Indiana Department of Highways' "Standard Specifications," Section 720.

9.3 SPECIAL HYDRAULIC STRUCTURES

Special hydraulic structures required to control the flow of water in storm runoff drainage systems include junction chambers, drop manholes, inverted siphons, stilling basins and other special structures. The use of these structures shall be limited to those locations justified by prudent planning and by careful and thorough hydraulic engineering analysis.

SECTION 10.0 STORMWATER DRAINAGE: OPEN CHANNEL DESIGN STANDARDS

All storm sewers, whether private or public, and whether constructed on private or public property, shall conform to the design standards and other requirements contained herein.

10.1 MANNING EQUATION

The waterway for channels shall be determined using Manning's Equation:

$$Q = AV = A\frac{1.486}{n}R^{\frac{2}{3}}\ S^{\frac{1}{2}}$$

Where:

Q = Discharge in cubic feet per second (cfs);
A = Waterway area of channel in square feet; and
V, R, S and n are as explained in Section 8.1.

10.2 CHANNEL CROSS SECTION AND GRADE

The required channel cross section and grade are determined by the design capacity, the material of which the channel is to be constructed and the requirements for maintenance. A minimum depth may be required to provide adequate outlets for subsurface drains and tributary ditches or streams. The channel grade shall be such that the velocity in the channel is high enough to prevent siltation but low enough to prevent erosion. Velocities less than one and one-half (1.5) feet per second should be avoided because siltation will take place and ultimately reduce the channel cross section. The maximum permissible velocities in vegetal-lined channels are shown in Table 4. Developments through which the channel is to be constructed must be considered in design of the channel cross section.

Table 4
Maximum Permissible Velocities
in
Vegetal-Lined Channels*

Cover	Slope Range[2] (percent)	Permissible Velocity[1] Erosion Resistant Soils (feet per second)	Permissible Velocity[1] Easily Eroded Soils (feet per second)
Bermudagrass	0-5	8	6
	5-10	7	5
	more than 10	6	4
Bahia Buffalograss Kentucky bluegrass Smooth brome Blue grama	0-5 5-10 more than 10	7 6 5	5 4 3
Grass mixtures	0-5[2]	5	4
Reed canarygrass	5-10	4	3
Lespediza sericea Weeping lovegrass Yellow bluestem Redtop Alfalfa Red fescue	0-5[3]	3.4	2.5
Common lespediza[4, 5] Sudangrass[4]	0-5	3.5	2.5

1. Use velocities exceeding five (5) feet per second only where good covers and proper maintenance can be obtained.

2. Do not use on slopes steeper than ten (10) percent except for vegetated side slopes in combination with a stone, concrete or highly resistant vegetative center section.

3. Do not use on slopes steeper than five (5) percent except for vegetated side slopes in combination with a stone, concrete or highly resistant vegetative center section.

4. Annuals: Use on mild slopes or as temporary protection until permanent covers are established.

5. Use on slopes steeper than five (5) percent is not recommended.

* From Soil Conservation Service, SCS-TP-61, Handbook of Channel Design for Soil & Water Conservation.

10.3 SIDE SLOPES

Earthen channel side slopes shall be no steeper than a ratio of two (2) to one (1). Flatter slopes may be required to prevent erosion and for ease of maintenance. Where channels will be lined, side slopes shall be no steeper than a ratio of one and one-half (1.5) to one (1) with adequate provisions made for weep holes. Side slopes steeper than one and one-half (1.5) to one (1) may be used for lined channels, provided that the side lining and structural retaining wall are designed and constructed with provisions for live and dead load surcharge.

10.4 CHANNEL STABILITY

A. Characteristics of a stable channel are:

   1. It neither aggrades or degrades beyond tolerable limits;

   2. The channel banks do not erode to the extent that the channel cross section is changed appreciably;

   3. Excessive sediment bars do not develop;

   4. Excessive erosion does not occur around culverts, bridges or elsewhere; and

   5. Gullies do not form or enlarge due to the entry of uncontrolled surface flow to the channel.

B. Channel stability shall be determined for an aged condition and the velocity shall be based on the design flow or the bank full flow, whichever is greater, using “n” values for various channel linings as shown in Table 3. In no case is it necessary to check channel stability for discharges greater than that from a one hundred- (100-) year return period storm.

C. Channel stability must be checked for conditions immediately after construction. For this stability analysis, the velocity shall be calculated for the expected flow from a ten- (10-) year return period storm on the watershed or the bank full flow, whichever is smaller. The “n” value for newly constructed channels in fine-grained soils and sands may be determined in accordance with the National Engineering Handbook 5, Supplement B, Soil Conservation Service, and shall not exceed 0.025.

   The allowable velocity in the newly constructed channel may be increased by a maximum of twenty (20) percent to reflect the effects of vegetation to be established under the following conditions:

1. The soil and site in which the channel is to be constructed are suitable for rapid establishment and support of erosion controlling vegetation;

2. Species of erosion controlling vegetation adapted to the area and proven methods of establishment are shown; and

3. The channel design includes detailed plans for establishment of vegetation on the channel side slopes.

10.5 DRAINAGE OF WATERWAYS

Vegetated waterways that are subject to low flows of long duration or where wet conditions prevail shall be drained with a tile system or by other means such as paved gutters. Tile lines may be outletted through a drop structure at the end of the waterway or through a standard tile outlet.

10.6 ESTABLISHMENT OF NEW REGULATED DRAIN

When the Drainage Board determines it is necessary to establish a new Regulated Drain, each Developer must provide the necessary information and meet the requirements of the 1965 Indiana Drainage Code, as amended, for the establishment of a new Regulated Drain. The Drainage Board shall determine the necessary easements for adequate maintenance of any new Regulated Drain.

10.7 APPURTENANT STRUCTURES

The design of channels will provide all structures required for the proper functioning of the channel and the laterals thereto and travelways for operation and maintenance. Recessed inlets and structures needed for entry of surface and subsurface flow into channels without significant erosion or degradation shall be included in the design of channel improvements. The design is also to provide the necessary flood gates, water level control devices and any other appurtenance affecting the functioning of the channels and the attainment of the purpose for which they are built.

The effect of channel improvements on existing culverts, bridges, buried cables, pipelines and inlet structures for surface and subsurface drainage on the channel being improved and laterals thereto shall be evaluated to determine the need for modification or replacement. Culverts and bridges that are modified or added as part of channel improvement projects shall meet reasonable standards for the type of structure and shall have a minimum capacity equal to the design discharge or governmental agency design requirements, whichever is greater.

10.8 DISPOSITION OF SPOIL

Spoil material resulting from clearing, grubbing and channel excavation shall be disposed of in such a manner as will:

A. Minimize overbank wash;

B. Provide for the free flow of water between the channel and floodplain unless the valley routing and water surface profile are based on continuous dikes being installed;

C. Not hinder the development of travelways for maintenance;

D. Leave the right-of-way in the best condition feasible, consistent with the project purposes, for productive use by the Owner;

E. Improve the aesthetic appearance of the site to the extent feasible; and

F. Be approved by the Indiana Department of Natural Resources or the U.S. Army Corps of Engineers (whichever is applicable) if deposited in the floodway.

SECTION 11.0 STORMWATER DRAINAGE: CONSTRUCTION AND MATERIALS

11.1 CONSTRUCTION

Specifications shall be in keeping with the current standards of engineering practice and shall describe the requirements for proper installation of the project to achieve its intended purpose.

11.2 MATERIALS

Materials acceptable for use as channel lining are:

A. Grass;

B. Revetment riprap;

C. Concrete;

D. Hand-laid riprap;

E. Precast cement concrete riprap;

F. Grouted riprap; or

G. Gabions.

Other lining materials shall receive specific approval of the Drainage Board. Materials shall comply with the latest edition of the Indiana Department of Highways “Standard Specifications.”

SECTION 12.0 STORMWATER DRAINAGE: STORMWATER DETENTION

12.1 ACCEPTABLE DETENTION METHODS

The increased stormwater resulting from a proposed development should be detained on-site by the provision of appropriate wet or dry bottom reservoirs, by storage on flat roofs, parking lots, streets, lawns or other acceptable techniques. Measures that retard the rate of overland flow and the velocity in runoff channels shall also be sized to store excess flows from storms with a one hundred- (100-) year return period.

Control devices shall limit the discharge to a rate no greater than that prescribed by this Ordinance. (See Sections 12.5 and 12.6.)

12.2 DESIGN STORM

Design of stormwater detention facilities shall be based on a return period of once in one hundred (100) years. The storage volume and outflow rate shall be sufficient to handle stormwater runoff from a critical duration storm, as defined in Sections 12.5 and 12.6. Rainfall depth-duration-frequency relationships and density-duration-frequency relationships shall be those given in Tables 5 and 5A.

Table 5
Rainfall Depths for Various Return Periods
and
Storm Durations for Henry County

	Return Period (years)					
	2	5	10	25	50	100
Duration	Depth (inches)					
5.mins.	0.40	0.46	0.52	0.61	0.69	0.78
10 mins.	0.66	0.78	0.88	1.02	1.15	1.30
15 mins.	0.85	1.00	1.12	1.32	1.48	1.67
20 mins.	0.99	1.16	1.31	1.53	1.72	1.94
30 mins.	1.17	1.37	1.54	1.81	2.04	2.30
40 mins.	1.28	1.49	1.68	1.97	2.22	2.50
50 mins.	1.34	1.57	1.77	2.07	2.34	2.63
1 hr.	1.36	1.62	1.82	2.14	2.41	2.71
90 mins.	1.37	1.67	1.94	2.36	2.74	3.17
2 hrs.	1.52	1.85	2.15	2.62	3.04	3.52
3 hrs.	1.73	2.10	2.44	2.96	3.44	3.99
4.hrs.	1.86	2.27	2.63	3.20	3.71	4.30
5 hrs.	1.96	2.39	2.77	3.37	3.91	4.53
6 hrs.	2.04	2.49	2.88	3.51	4.07	4.72
7 hrs.	2.11	2.57	2.98	3.62	4.20	4.87
8 hrs.	2.17	2.64	3.06	3.72	4.31	5.00
9 hrs.	2.22	2.70	3.13	3.80	4.41	5.12
10 hrs.	2.26	2.75	3.19	3.88	4.50	5.22
12 hrs.	2.34	2.84	3.29	4.01	4.65	5.39
14 hrs.	2.40	2.92	3.38	4.12	4.77	5.54
16 hrs.	2.45	2.98	3.45	4.21	4.88	5.66
18 hrs.	2.50	3.04	3.53	4.29	4.97	5.77
20 hrs.	2.54	3.09	3.59	4.36	5.06	5.87
24 hrs.	2.61	3.18	3.69	4.49	5.21	6.04

Table 5A
Rainfall Intensities for Various Return Periods
and
Storm Durations for Henry County

	Return Period (years)					
	2	5	10	25	50	100
Duration	Intensity (inches per hour)					
5.mins.	4.75	5.56	6.26	7.33	8.26	9.31
10 mins.	3.98	4.66	5.25	6.15	6.93	7.61
15 mins.	3.41	3.99	4.50	5.27	5.93	6.69
20 mins.	2.97	3.48	3.92	4.59	5.17	5.83
30 mins.	2.34	2.74	3.09	3.62	4.07	4.59
40 mins.	1.91	2.24	2.53	2.96	3.33	3.76
50 mins.	1.61	1.89	2.12	2.49	2.80	3.16
1 hr.	1.38	1.62	1.82	2.14	2.41	2.71
90 mins.	0.92	1.12	1.29	1.57	1.82	2.12
2 hrs.	0.78	0.93	1.08	1.31	1.52	1.76
3 hrs.	0.58	0.70	0.81	0.99	1.15	1.33
4.hrs.	0.47	0.57	0.66	0.80	0.93	1.08
5 hrs.	0.39	0.48	0.55	0.67	0.78	0.91
6 hrs.	0.34	0.41	0.48	0.58	0.68	0.79
7 hrs.	0.30	0.37	0.43	0.52	0.60	0.70
8 hrs.	0.27	0.33	0.38	0.47	0.54	0.63
9 hrs.	0.25	0.30	0.35	0.42	0.49	0.57
10 hrs.	0.23	0.27	0.32	0.39	0.45	0.52
12 hrs.	0.19	0.24	0.27	0.33	0.39	0.45
14 hrs.	0.17	0.21	0.24	0.29	0.34	0.40
16 hrs.	0.15	0.19	0.22	0.26	0.31	0.35
18 hrs.	0.14	0.17	0.20	0.24	0.28	0.32
20 hrs.	0.13	0.15	0.18	0.22	0.25	0.29
24 hrs.	0.11	0.13	0.15	0.19	0.22	0.25

12.3 ALLOWABLE RELEASE RATE

The allowable release rate of stormwater originating from a proposed development shall not exceed the amount specified in Section 3.0, Stormwater Control Policy, and as described in Sections 12.5 and 12.6.

In the event the natural downstream channel or storm sewer system is inadequate to accommodate the release rate provided above, then the allowable release rate shall be reduced to that rate permitted by the capacity of the receiving downstream channel or storm sewer system and additional detention as determined by the Drainage Board shall be required to store that portion of the runoff exceeding the capacity of the receiving sewers or waterways.

If more than one (1) detention basin is involved in the development of the area upstream of the limiting restriction, the allowable release rate from any one (1) detention basin shall be indirect proportion to the ratio of its drainage area to the drainage area of the entire watershed upstream of the restriction.

12.4 DRAINAGE SYSTEM OVERFLOW DESIGN

Drainage systems shall have adequate capacity to convey the stormwater runoff from all upstream tributary areas through the development under consideration for a storm of one hundred- (100-) year design return period calculated on the basis of the upstream land in its present state of development. An allowance, equivalent to the reduction in flow rate provided, shall be made for upstream detention when such upstream detention and release rate have previously been approved by the Drainage Board and evidence of its construction can be shown.

12.5 DETERMINATION OF STORAGE VOLUME: RATIONAL METHOD

For areas of eighty (80) acres or less, the Rational Method and/or McMath Method may be used to determine the required volume of stormwater storage. The following eleven- (11-) step procedure may be used to determine the required volume of storage. Other design methods may also be used, subject to approval of the Drainage Board, and as described in Section 12.6.

Table 6
Determination of Storage Volume: Rational Method

Step	Procedure
1	Determine total drainage area in acres ("A").
2	Determine composite runoff coefficient ("C_U") based on existing land use (undeveloped).
3	Determine time of concentration ("tc") in minutes, based on existing conditions.
4	Determine rainfall intensity ("I_U") in inches per hour, based on time of concentration and using Figure 1 or from data given in Table 5A for the ten- (10-) year return period.
5	Compute runoff based on existing land use (undeveloped) and ten- (10-) year return period: $Q_U = C_U I_U A$
6	Determine composite runoff coefficient ("C_d") based on developed conditions and a one hundred- (100-) year return period.
7	Determine the one hundred- (100-) year return period rainfall intensity, ("I_d") for various storm durations ("t_d") up through the time of concentration for the developed area using Table 5A.
8	Determine developed inflow rates ("Q_d") for various storm durations ("t_d") measured in hours: $Q_d = C_d I_d A$
9	Compute a storage rate ("S_{td}") for various storm durations ("t_d") up through the time of concentration of the developed area: $S_{td} = Q_d - Q_U$
10	Compute required storage volume ("S_R") in acre-feet, for each storm duration, ("t_d"). This assumes a triangular hydrograph of duration ($2*t_d$) hours with the peak flow of S_{td} at td hours: $S_R = S_{td} (t_d/12)$
11	Select the largest storage volume computed in Step 10 for detention basin design.

12.6 DETERMINATION OF STORAGE VOLUME: OTHER METHODS

Methods other than the Rational Method and/or McMath Method for determining runoff and routing of stormwater may be used to determine the storage volume required to control

stormwater runoff. The procedures or methods used must receive the prior approval of the Drainage Board. The ILLUDAS, TR-20 and TR-55 models are approved by the Drainage Board in analysis of the runoff and routing of stormwater. The use of these models or other approved procedures can be defined in a seven- (7-) step procedure to determine the required storage volume of the detention basin.

Table 7
Determination of Storage Volume: Other Methods

Step	Procedure
1	Calibrate the hydrologic/hydraulic model that is to be used for prediction of runoff and routing of stormwater.
2	For each storm duration listed in Table 5, perform Steps 3 through 6.
3	Determine the ten- (10-) year, undeveloped peak flow. Denote this flow by Q_U^{10}.
4	Determine the one hundred- (100-) year runoff hydrograph("H_d^{100}") for developed conditions.
5	Determine the hydrograph that must be stored ("H_S^{100}") by subtracting a flow up to Q_U^{10} from the hydrograph H_d^{100} found in Step 4.
6	Determine the volume of water to be stored ("V_S") by calculating the area under the one hundred- (100-) year hydrograph H_S^{100}.
7	The detention basin must be designed to store the largest volume ("V_S") found for any storm duration analyzed in Step 6.

12.7 GENERAL DETENTION BASIN DESIGN REQUIREMENTS

Basins shall be constructed to detain temporarily the stormwater runoff that exceeds the maximum peak flow rate authorized by this Ordinance. The volume of storage provided in these basins, together with such storage as may be authorized in other on-site facilities, shall be sufficient to control excess runoff from the one hundred- (100-) year storm.

The following design principles shall be observed:

A. The maximum volume of water stored and subsequently released at the design release rate shall not result in a storage duration in excess of forty-eight (48) hours unless additional storms occur within the period.

B. The maximum planned depth of stormwater stored without a permanent pool shall not exceed four (4) feet.

C. All stormwater detention facilities shall be separated by not less than fifty (50) feet from any building or structure to be occupied.

D. All excavated excess spoil may be spread so as to provide for aesthetic and recreational features such as sliding hills, sports fields, etc. Slopes no steeper than four- (4-) foot horizontal to one- (1-) foot vertical for safety, erosion control, stability and ease of maintenance shall be permitted.

E. Safety screens having a maximum opening of four (4) inches shall be provided for any pipe or opening to prevent children or large animals from crawling into the structures.

F. Danger signs shall be mounted at appropriate locations to warn of deep water, possible flooding conditions during storm periods and other dangers that exist. Fencing shall be provided if deemed necessary by the Drainage Board.

G. Outlet control structures shall be designed to operate as simply as possible and shall require no maintenance and/or attention for proper operation. They shall limit discharges into existing or planned downstream channels or conduits so as not to exceed the predetermined maximum authorized peak flow rate.

H. Emergency overflow facilities such as weirs or spillways shall be provided for the release of exceptional storm runoffs or in emergency conditions should the normal discharge devices become totally or partially inoperative. The overflow facility shall be of such design that its operation is automatic and does not require manual attention.

I. Grass or other suitable vegetative cover shall be provided throughout the entire basin area. Grass should be cut regularly at approximately monthly intervals during the growing season or as required.

J. Debris and trash removal and other necessary maintenance shall be performed on a regular basis to assure continued operation in conformance to design.

K. A report shall be submitted to the Drainage Board describing:

1. The proposed development;

2. The current land use conditions;

3. The method of hydraulic and hydrologic analysis used, including any assumptions or special conditions;

4. The results of the analysis; and

5. The recommended drainage control facilities.

Hydraulic and hydrologic calculations, including input and output files, shall be included as appendices to the report.

12.8 DRY BOTTOM DETENTION BASIN DESIGN REQUIREMENTS

Detention basins that will not contain a permanent pool of water shall comply with the following requirements:

A. Provisions shall be incorporated to facilitate complete interior drainage of dry bottom basins, to include provisions of natural grades to outlet structures, longitudinal and transverse grades to perimeter drainage facilities, paved gutters or the installation of subsurface drains.

B. The detention basin shall, whenever possible, be designed to serve a secondary or multipurpose function. Recreational facilities, aesthetic qualities (open spaces) or other types of use shall be considered in planning the detention facility.

12.9 WET BOTTOM DETENTION BASIN DESIGN REQUIREMENTS

Where part of a detention basin will contain a permanent pool of water, all the items required for detention storage shall apply except that the system of drains with a positive gravity outlet required to maintain a dry bottom retention basin will not be required. A controlled positive outlet will be required to maintain the design water level in the wet bottom detention basin and provide required detention storage above the design water level. However, the following additional conditions shall apply:

A. Basins designed with permanent pools or containing permanent ponds shall have a water area of at least one-half (.5) acre. If fish are to be maintained in the pond, a minimum depth of approximately ten (10) feet shall be maintained over at least twenty-five (25) percent of the pond area. The remaining pond area shall have no extensive shallow areas, except as required by Subsection C below.

B. In excavated ponds, the underwater side slopes in the pond shall be stable. In the case of valley storage, natural slopes may be considered to be stable.

C. A safety ledge four (4) to six (6) feet in width is required and must be installed in all ponds approximately thirty (30) to thirty-six (36) inches below the permanent water level. In addition, a similar maintenance ledge twelve (12) to eighteen (18) inches above the permanent water line shall be provided. The slope between the two (2) ledges shall be stable and of a material such as stone or riprap that will prevent erosion due to wave action.

D. A safety ramp exit from the pond is required in all cases and shall have a minimum width of twenty (20) feet and exit slope of six (6) horizontal to one (1) vertical. The ramp shall be of a material that will prevent its deterioration due to vehicle use and/or wave action.

E. Periodic maintenance is required in ponds to control weed and larval growth. The pond shall also be designed to provide for the easy removal of sediment that will accumulate during periods of pond operation. A means of maintaining the designed water level of the pond during prolonged periods of dry weather is also required.

F. For emergency use, basin cleaning or shoreline maintenance, facilities shall be provided or plans prepared for auxiliary equipment to permit emptying and drainage.

G. Facilities to enhance and maintain pool water quality shall be provided, if required to meet applicable water quality standards. Design calculations to substantiate the effectiveness of these aeration facilities shall be submitted with final engineering plans. Agreements for the perpetual operation and maintenance of aeration facilities shall be prepared to the satisfaction of the Drainage Board.

12.10 ROOF TOP STORAGE

Detention storage requirements may be met in total or in part by detention on flat roofs. Details of such designs are to be included in the Building Permit Application and shall include the depth and volume of storage, details of outlet devices and downdrains and elevations of emergency overflow provisions.

12.11 PARKING LOT STORAGE

Paved parking lots may be designed to provide temporary detention storage of stormwaters on all or a portion of their surfaces. Outlets will be designed so as to empty the stored waters slowly. Depths of storage must be limited to a maximum depth of seven (7) inches so as to prevent damage to parked vehicles and so that access to parked vehicles is not impaired. Ponding should, in general, be confined to those portions of the parking lots farthest from the area served.

12.12 FACILTY FINANCIAL RESPONSIBILITY

The construction cost of stormwater control systems and facilities as required by this Ordinance shall be accepted as part of the cost of land development. If general public use of the facility can be demonstrated, negotiations for public participation in the cost of such development may be considered.

12.13 FACILTY MAINTENANCE RESPONSIBILITY

Maintenance of detention/retention facilities during construction and thereafter shall be the responsibility of the Developer/Owner. Assignment of responsibility for maintaining facilities serving more than one (1) lot or holding shall be documented by appropriate covenants to property deeds, unless responsibility is formally accepted by a public body, and shall be determined before the Final Drainage Plans are approved.

Stormwater detention and retention basins may be donated to the County or other unit of government designated by the County for ownership and permanent maintenance, providing:

A. The County or other governmental unit is willing to accept responsibility;

B. The facility has been designed and constructed according to all applicable provisions of this Ordinance;

C. All improvements have been constructed, approved and accepted by the County for the land area served by the drainage basin;

D. Retention ponds containing a permanent pool of water have all slopes between the riprap and high water line sodded and the remaining land area hydroseeded; are with electrically driven aeration devices, if required to maintain proper aerobic conditions and sustain aquatic life; have a four- (4-) foot wide crushed limestone walkway at the high water line entirely around the body of water; provide suitable public access acceptable to the responsible governmental agency; and have the high water line not closer than fifty (50) feet to any property line; and

E. Dry detention ponds shall have all slopes, bottom of the basin and areas above the high water line hydroseeded and shall have the high water line not closer than fifty (50) feet to any development boundary.

12.14 INSPECTIONS

Representatives of the County will inspect all public and privately owned detention storage facilities not less than once every two (2) years. A certified inspection report covering physical conditions, available storage capacity and operational condition of key facility elements will be provided to the Owner.

12.15 CORRECTIVE MEASURES

If deficiencies are found by the inspector, the Owner of the detention/retention facility will be required to take the necessary measures to correct such deficiencies. If the Owner fails to do so, the County will undertake the work and collect from the Owner using lien rights, if necessary.

12.16 JOINT DEVELOPMENT OF CONTROL SYSTEMS

Stormwater control systems may be planned and constructed jointly by two (2) or more Developers as long as compliance with this Ordinance is maintained.

12.17 INSTALLATION OF CONTROL SYSTEMS

Runoff and erosion control systems shall be installed as soon as possible during the course of site development. Detention/retention basins shall be designed with an additional six (6) percent of available capacity to allow for accumulation resulting from development and to permit the

pond to function for reasonable periods between cleanings. Basins should be designed to collect sediment and debris in specific locations so that removal costs are kept to a minimum.

12.18 DETENTION FACILITIES IN FLOODPLAINS

If detention storage is provided within a floodplain, only the net increase in storage volume above that which naturally existed on the floodplain shall be credited to the development. No credit will be granted for volumes below the elevation of the regulatory flood at the location unless compensatory storage is also provided.

12.19 OFF-SITE DRAINAGE PROVISIONS

When the allowable runoff is released in an area that is susceptible to flooding, the Developer may be required to construct appropriate storm drains through such area to avert increased flood hazard caused by the concentration of allowable runoff at one (1) point instead of the natural overland distribution. The requirement of off-site drains shall be at the discretion of the Drainage Board.

SECTION 13.0 STORMWATER DRAINAGE: CERTIFICATIONS REQUIRED

After completion of the project and before final approval and acceptance can be made, professionally prepared and certified record drawings shall be submitted to the Drainage Board for review. These plans shall include all pertinent data relevant to the completed storm drainage system and shall include:

A. Pipe size and pipe material;

B. Invert elevations;

C. Top rim elevations;

D. Lengths of all pipe structures;

E. Data and calculations showing detention basin storage volume; and

F. Certified statement on plans stating the completed storm drainage system substantially complies with construction plans as approved by the Drainage Board.

All such submitted plans shall be reviewed for compliance within thirty (30) days after submission to the Drainage Board or County Surveyor. If notice of non-compliance is not given within thirty (30) days of submission of the plans, the plans shall be construed as approved and accepted.

SECTION 14.0 STORMWATER DRAINAGE: CHANGES IN PLAN

Any revision, significant change or deviation in the detailed plans and specifications after formal approval by the Drainage Board shall be filed in duplicate with and approved by the Drainage Board prior to implementation of the revision or change. Copies of the revisions or changes, if approved, shall be attached to the original plans and specifications.

SECTION 15.0 STORMWATER DRAINAGE: DETERMINATION OF IMPACT DRAINAGE AREAS

The Drainage Board is authorized, but is not required, to classify certain geographical areas as Impact Drainage Areas and to enact and promulgate regulations that are generally applied. In determining Impact Drainage Areas, the Drainage Board shall consider such factors as topography, soil type, capacity of existing regulated drains and distance from adequate drainage facility. The following areas shall be designated as Impact Drainage Areas, unless good reason for not including them is presented to the Drainage Board:

A. A floodway or floodplain as designated by the Indiana Department of Natural Resources;

B. Land within seventy-five (75) feet of each bank of any regulated drain; and

C. Land within seventy-five (75) feet of the centerline of any regulated drain tile.

Land where there is not an adequate outlet, taking into consideration the capacity and depth of the outlet, may be designated as an Impact Drainage Area by resolution of the Drainage Board. Special requirements for development within any Impact Drainage Area shall be included in the resolution.

SECTION 16.0 STORMWATER DRAINAGE: OTHER REQUIREMENTS

16.1 SUMP PUMPS

Sump pumps installed to receive and discharge groundwaters or other stormwaters shall be connected to the storm sewer where possible or discharged into a designated storm drainage channel. Sump pumps installed to receive and discharge floor drain flow or other sanitary sewage shall be connected to the sanitary sewers. A sump pump shall be used for one (1) function only, either the discharge of stormwaters or the discharge of sanitary sewage.

16.2 DOWN SPOUTS

All down spouts or roof drains shall discharge onto the ground or be connected to the storm sewer. No down spouts or roof drains shall be connected to the sanitary sewers.

16.3 FOOTING DRAINS

Footing drains shall be connected to storm sewers where possible or designated storm drainage channels. No footing drains or drainage tiles shall be connected to the sanitary sewers.

16.4 BASEMENT FLOOR DRAINS

Basement floor drains shall be connected to the sanitary sewers.