

**TOWN OF PENDLETON, INDIANA
STORM DRAINAGE STANDARDS**

VERSION 1.0

MAY 1999

TABLE OF CONTENTS

	<u>Page</u>
Preface	
List of Figures	
List of Tables	
I. Purpose	1
II. Conflicting Ordinances	1
III. Compliance with Other Ordinances	1
IV. Definitions	2
V. Storm Water Control Policy	5
VI. Information Requirements	6
A. Topographic and Soils Maps	6
B. Preliminary Drainage Plan	7
C. Valley Cross Section	8
D. Site Plan	8
E. Final Drainage Plans	8
F. Submittal and Consideration of Plans	9
VII. Determination of Runoff Quantities	9
VIII. Amount of Runoff to be Accommodated by Various Parts of Drainage Facility	12
IX. Storm Sewer Design Standards	13
A. Manning Equation	13
B. Minimum Size	13
C. Grade	13
D. Alignment	14
E. Manholes	14
F. Inlets	14
X. Workmanship and Materials	15
A. Workmanship	15
B. Materials	15
C. Special Hydraulic Structures	15
XI. Open Channel Design Standards	15
A. Manning Equation	15

B.	Channel Cross Section and Grade	16
C.	Side Slopes	16
D.	Channel Stability	16
E.	Drainage of Waterways	17
F.	Appurtenant Structures	17
G.	Disposition of Spoil	18
XII.	Construction and Materials	18
A.	Construction	18
B.	Materials	18
XIII.	Storm Water Detention	18
A.	Acceptable Detention Methods	19
B.	Design Storm	19
C.	Allowable Release Rate	19
D.	Drainage System Overflow Design	19
E.	Determination of Storage Volume – Rational Method	20
F.	Determination of Storage Volume – Other Methods	20
G.	General Detention Basin Design Requirements	20
H.	Dry Bottom Basin Design Requirements	21
I.	Wet Bottom Basin Design Requirements	22
J.	Parking Lot Storage	23
K.	Facility Financial Responsibilities	23
L.	Facility Maintenance Responsibility	23
M.	Inspections	24
N.	Corrective Measures	24
O.	Joint Development of Control Systems	24
P.	Installation of Control Systems	24
Q.	Detention Facilities in Floodplains	25
R.	Off-site Drainage Provisions	25
XIV.	Certifications Required	25
XV.	Changes in Plan	25
XVI.	Determination of Impact Drainage Areas	26
XVII.	Other Requirements	26
A.	Sump Pumps	26
B.	Down Spouts	26
C.	Footing Drains	26
D.	Basement Floor Drains	27
XVIII.	Disclaimer of Liability	27
XIX.	Corrective Action	27

XX. Repealer	27
XXI. When Effective	27
XXII. Exempt Projects	27
XXIII. Updates	27

LIST OF TABLES

<u>Table</u>		<u>Page</u>
1	Values Used to Determine a Composite Runoff Coefficient	10
1A	Rural Runoff Coefficients	11
2	Urban Runoff Coefficients	11

AN ORDINANCE REGULATING STORM DRAINAGE

I. PURPOSE

The purpose of these drainage standards is to establish reasonable rules and regulations for development in the town of Pendleton, Indiana, in order to:

- A. Prevent additional harm due to periodic flooding, including loss of life and property and threats and inconveniences to public health, safety and welfare; and
- B. Assure that new development does not increase flood and drainage hazards to others, or create unstable conditions susceptible to erosion; and
- C. Create no new financial burden on the taxpayer for flood control projects, repairs to flood damaged public facilities and utilities, and for flood rescue and relief operations; and
- D. Protect, conserve and promote the orderly development of land and water resources; and
- E. Protect buildings and improvements to buildings from flood damage to the greatest extent possible; and
- F. Conserve the natural hydrologic, hydraulic, water quality and other beneficial functions of watercourses, floodplains and wetlands; and
- G. Prevent additional disruption of the economy and governmental services due to stormwater and flood drainage; and
- H. Maintain eligibility for the town of Pendleton in the National Flood Insurance Program by equaling or exceeding its requirements and thus make federally subsidized flood insurance available at reduced rates.

II. CONFLICTING ORDINANCES AND REGULATIONS

The provisions of these standards shall be deemed as additional requirements to minimum standards required by other ordinances of the town and/or county, state and federal regulations. In the case of conflicting requirements, the most restrictive shall apply.

III. COMPLIANCE WITH OTHER ORDINANCES

In addition to the requirements of these standards, compliance with the requirements set forth in other applicable ordinances with respect to submission

and approval of preliminary and final 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.

IV. DEFINITIONS

For the purpose of these standards, the following definitions shall apply:

- A. Base Flood Elevation – The elevation delineating the level of flooding from the 100-year frequency flood.
- B. Board – The town of Pendleton, Indiana, and any subordinate employee to whom they shall specifically delegate a responsibility authorized by this ordinance.
- C. 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.
- D. Channel – A natural or artificial watercourse which periodically or continuously contains moving water or which forms a connecting link between two bodies of water. It has a defined bed and banks which serve to confine the water.
- E. Contiguous – Adjoining or in actual contact with.
- F. Culvert – A closed conduit used for the passage of surface drainage water under a roadway, railroad, canal, or other impediment.
- G. Detention Basin – A facility constructed or modified to restrict the flow of stormwater to a prescribed maximum rate, and to temporarily detain concurrently the excess waters that accumulate behind the outlet.
- H. Detention Storage – The temporary storage of stormwater in detention basins which could include rooftops, streets, parking lots, school yards, parks, open spaces, or other areas under predetermined and controlled conditions. The release rate from the detention storage area is regulated by designed and installed devices.
- I. Drainage Area – The area from which water is carried off by a drainage system; a watershed or catchment area.
- J. Drop Manhole – 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.

- K. Dry Bottom Detention Basin – A basin designed to completely drain after providing detention of excess runoff during a storm event.
- L. Duration – The time period of a rainfall event.
- M. Flood Protection Elevation – The base flood elevation (100 year flood) plus two feet.
- N. Floodway – The channel of a river or stream and those portions of the floodplain adjacent to the channel which are reasonably required to convey the 100-year flood discharge without increasing the water surface elevation of the 100-year flood more than 0.1 feet at any point.
- O. Floodway Fringe – The area between the floodway and the boundary of the 100-year flood.
- P. Footing Drain – A drain pipe installed around the exterior of a basement wall foundation to relieve water pressure caused by high groundwater elevation.
- Q. 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.
- R. Impervious Area – A hard surface area that does not readily absorb water. Impervious surfaces would include pavement, parking lots, driveways, rooftops and other hard surfaces that do not absorb water.
- S. Inlet – An opening into a storm sewer system for the entrance of surface stormwater runoff, more completely described as a storm sewer inlet.
- T. Lateral Storm Sewer – A sewer that has inlets connected to it and empties into another storm sewer or channel.
- U. Major Drainage System – A drainage system carrying runoff from an area of one or more square miles.
- V. Manhole – Storm sewer structure through which a person may enter to gain access to an underground storm sewer or enclosed structure.
- W. Minor Drainage System – A drainage system having an area of less than one square mile.
- X. Off-site – Everything outside the developing right-of-way.

- Y. On-site – Located within the developing right-of-way where runoff originates.
- Z. Outfall – The point or location where storm runoff discharges from a sewer or drain. Also applies to the outfall sewer or channel which carries the storm runoff to the point of outfall.
- AA. 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.
- BB. Rainfall Intensity – The cumulative depth of rainfall occurring over a given duration, normally expressed in inches per hour.
- CC. Reach – Any length of river, channel or storm sewer.
- DD. Regulated Area – All of the land under the jurisdiction of the town of Pendleton, Indiana.
- EE. Regulatory Flood – That flood having a peak discharge that has a one percent probability of being equaled or exceeded in any given year, as calculated using a method that is acceptable to the Indiana Department of Natural Resources.
- FF. Release Rate – The amount of stormwater released from a stormwater control facility per unit of time.
- GG. 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 100 years has a one percent probability of being equaled or exceeded in any one year.
- HH. Runoff Coefficient – A decimal fraction relating the amount of rain which appears as runoff and reaches the storm drainage system to the total amount of rain falling. A coefficient of 0.5 implies that 50 percent of the rain falling on a given surface appears as stormwater runoff.
- II. Sediment – Material of soil and rock origin, transported, carried or deposited by water.
- JJ. Siphon – A closed conduit or portion of which lies above the hydraulic grade line, resulting in a pressure less than atmospheric 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 sanitary sewer.

- KK. Spillway – A waterway in or about a hydraulic structure, for the escape of excess water.
- LL. Storage Duration – The length of time that water may be stored in any storm water control facility, computed from the time water first begins to be stored.
- MM. Storm Sewer – A closed conduit for conveying collected stormwater.
- NN. Stormwater Drainage Facility – All means, natural or man-made, including conduits and appurtenant features, canals, channels, ditches, streams and culverts, used for conveying stormwater runoff.
- OO. 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.
- PP. Tributary – Any watercourse that flows into a larger watercourse.
- QQ. Watercourse – Any river, stream, creek, brook, branch, natural or man-made drainageway in or into which stormwater runoff or floodwaters flow.
- RR. Watershed – A geographic area from which water drains to a specific concentration point at the furthest downstream (lowest elevation) point.
- SS. Wet Bottom Retention Basin – A basin designed to retain a permanent pool of water after having provided its planned temporary detention of runoff during a storm event.

V. STORM WATER CONTROL POLICY

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

The release rate of stormwater from development, redevelopments, and new construction may not exceed the stormwater runoff from the land area in its present state of development, as explained below. The developer must submit to the town of Pendleton Board, detailed computations of runoff before and after development, redevelopment or new construction which demonstrate that runoff will not be increased.

These computations must show that the peak runoff rate after development for the 100 year return period storm of critical duration does not exceed the 10 year return period pre-development peak runoff rate, and the peak runoff rate after development for the 10 year return period storm does not exceed the two 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 100 acres may be based on the Rational Method; typical runoff coefficients are listed herein. For areas larger than 100 acres, runoff hydrograph and routing techniques must be used. Hydrograph and routing techniques used to determine stormwater runoff and detention requirements shall be proven methods, subject to approval of the town of Pendleton.

VI. INFORMATION REQUIREMENTS

The following information and data provided by an Indiana registered professional engineer shall be submitted to the town of Pendleton at the time of application for a building permit for any development, redevelopment or new construction on real estate which lies within the Regulated Area.

A. Topographic and Soils Maps

A soils map of the proposed development indicating soils names and their hydrologic classification must be provided when Soil Conservation Service (SCS) hydrologic methods are used. In addition, a topographic map of the land to be developed and such adjoining land whose topography may affect the layout or drainage of the development must be provided. The contour interval shall be one foot. On this map, the following shall be shown:

1. The location of streams and other stormwater runoff channels, the extent of the floodplains at the established 100 year flood elevation where available (regulatory floodway), and the limits of the floodway, all properly identified.
2. The normal shoreline 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 outfalls.
4. Storm, sanitary and combined sewers and outfalls.
5. Septic tank systems and outlets.

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

B. Preliminary Drainage Plan

A comprehensive plan showing that the stormwater drainage system is designed to convey the stormwater runoff and to detain the increased stormwater runoff in accordance with this ordinance must be provided. The comprehensive plan shall include maps and other descriptive materials showing the drainage plan and the following, as applicable:

1. The extent and area of each watershed affecting the design of detention and other drainage facilities as shown on USGS Quadrangle maps or other more detailed maps as required by the town of Pendleton.
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 100 year return period water surface elevation.
3. The location and design of the proposed 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 existing 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.
9. If the proposed development is part of a larger project that will be completed in the future, the calculations must include a master plan for the full site at ultimate development. The calculations

must show how the fully developed site will drain and how the interim drainage system built with the smaller project will be incorporated into the final drainage plan for the full site.

C. Valley Cross Section

One 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 100 year high water elevation; showing the elevation of the existing land and the proposed changes thereto, together with the high water elevations expected from the 100 year storm under the controlled conditions called for by this ordinance; and showing the relationship of structures, streets, and other facilities.

D. Site Plan

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

E. Final Drainage Plans

Upon approval of the preliminary drainage plans by the town of Pendleton, final drainage plans shall be submitted to the town of Pendleton. The final plans shall provide or be accompanied by calculations, maps and/or other descriptive material showing the following:

1. The extent and area of each watershed tributary to the drainage facilities in the development.
2. The 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 street system where 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 their 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 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 storm sewers and other waterways.
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.

F. Submittal and Consideration of Plans

Preliminary and final drainage plans and/or construction plans shall be submitted to the town of Pendleton for review by the town engineer. All preliminary plans, final plans and construction plans will be reviewed by the town engineer for compliance with the standards of this ordinance. Plans that are in compliance with the standards of this ordinance shall be approved by the town of Pendleton. The town of Pendleton shall stamp such approval on a copy of such plans and deliver the same to the applicant. All approvals and disapprovals with written reasons will be incorporated into the town of Pendleton minutes.

The town engineer is authorized to review engineering summaries of projects and based upon the same, make recommendations to the town of Pendleton regarding any exemptions or variance. The town of Pendleton may 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 town engineer to the town of Pendleton.

VII. 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 which is generated as the result of a given rainfall intensity may be calculated as follows:

- A. For areas up to and including 100 acres, the Rational Method may be used. In the Rational Method, the peak rate of runoff, Q, in cubic feet per second is computed as:

$$Q = CIA$$

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.

A = tributary drainage area in acres.

Values for the runoff coefficient “C” are shown in Table 1 and Table 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 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 assuming ultimate development of the land. The ultimate development of currently undeveloped land shall be determined by using the Comprehensive Land Use Plan for the Town of Pendleton, and also for Madison County, for areas outside the limits of the Town of Pendleton.

TABLE I

Values Used to Determine a Composite Runoff Coefficient⁽¹⁾

Type of Surface	Runoff Coefficient “C”
Asphalt	0.90
Concrete	0.95
Roof	0.95
Lawns	
Flat (0-2% Slope)	0.20
Rolling (2-7% Slope)	0.25
Steep (greater than 7%)	0.35

⁽¹⁾Adopted from HERPICC Stormwater Drainage Manual, July 1994, Table 3.2.3

TABLE IA
Rural Runoff Coefficients⁽¹⁾

Type of Surface	Runoff Coefficient "C"
Woodland	
Flat (0-5% Slope)	0.40
Rolling (5-10% Slope)	0.50
Steep (greater than 10%)	0.60
Pasture	
Flat	0.40
Rolling	0.55
Steep	0.60
Cultivated	
Flat	0.60
Rolling	0.70
Steep	0.82

⁽¹⁾Adopted from HERPICC Stormwater Drainage Manual, July 1994, Table 3.2.1

TABLE 2
Urban Runoff Coefficients⁽¹⁾

Land Use	Runoff Coefficients
Business (Downtown)	0.70 to 0.95
Business (Neighborhood)	0.50 to 0.70
Industrial	0.50 to 0.90
Apartment	0.50 to 0.70
Residential – Attached	0.60 to 0.75
Residential – Detached	0.40 to 0.60
Residential – Single Family	0.30 to 0.50
Residential – Suburban	0.25 to 0.40
Parks – Cemeteries	0.10 to 0.25

⁽¹⁾Adopted from HERPICC Stormwater Drainage Manual, July 1994, Table 3.2.2

Rainfall intensity shall be determined from the Intensity – Duration – Frequency Equation 2.2.13 using regional coefficients from Table 2.2.2 for Indianapolis. Equation 2.2.13 and Table 2.2.2 are found in the

HERPICC Stormwater Drainage Manual dated July 1994. The time of concentration (t_c) 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.

- B. The runoff rate for areas in excess of 100 acres shall be determined by methods described in Section XIII, subsection F.

VIII. 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, street gutters, swales, sewers and small channels which collect storm water must accommodate peak runoff from a 10-year return period storm. Rainfall duration shall be equal to the time of concentration or one hour if the time of concentration is less than one hour. A first quartile storm distribution shall be used for computer modeling. These minimum requirements must be satisfied.
 - 1. The allowable spread of water on collector streets is limited to maintaining two clear 10 foot moving lanes of traffic. One lane is to be maintained on local roads, while other access roads can have a water spread equal to one-half of their width.
 - 2. Open channels carrying peak flows greater than 30 cubic feet per second shall be capable of accommodating peak runoff for a 50 year return period storm within the drainage easement.
 - 3. Culverts shall be capable of accommodating peak runoff from a 50 year return period storm when crossing under a road which is part of the Indiana Department of Transportation Rural Functional Classification System and are classified as principal or minor arterial, major or minor collector roads.
 - 4. Major drainage systems are defined in Section IV, and shall be designed in accordance with Section VI.

IX. 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.

A. Manning Equation

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

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

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

Roughness coefficient (n) values for storm sewer materials can be found in standard hydraulics texts and references.

B. Minimum Size

The minimum size of all storm sewers shall be 12 inches. Rate of release for detention storage shall be controlled by an orifice plate or other devices, subject to approval of the town of Pendleton, where the 12 inch pipe will not limit rate of release as required.

C. Grade

Sewer grade shall be such that, in general, a minimum of two feet of cover is maintained over the top of the pipe. Pipe cover less than the minimum maybe used only upon approval of the town of Pendleton. 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 between three and 15 feet per second, respectively, when the sewer is flowing full.

D. Alignment

Storm sewers shall be straight between manholes and/or inlets.

E. Manholes/Inlets

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

1. Where two or more storm sewers converge.
2. Where pipe size changes.
3. Where a change in horizontal alignment occurs.
4. Where a change in pipe slope occurs.
5. At suitable intervals in straight sections of sewer.

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

F. 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 manufacturer's recommendations or other accepted engineering practices. The inlet grate opening provided must be adequate to pass the design 10 year flow with 50% of 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 would not exceed six inches or the maximum depth allowed in Section VIII, whichever is less.

X. WORKMANSHIP AND MATERIALS

A. Workmanship

The specifications for the construction of storm sewers shall not be less stringent than those set forth in the latest edition of the INDOT “Standard Specifications.”

B. Materials

Storm sewer manholes and inlets shall be constructed of cast in place concrete or precast reinforced concrete. Material and construction shall conform to the latest edition of the INDOT “Standard Specifications.”

Pipe and fittings used in storm sewer construction shall be in accordance with INDOT Design Memorandum 98-01.

C. 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.

XI. OPEN CHANNEL DESIGN STANDARDS

All open channels, whether private or public, and whether constructed on private or public land, shall conform to the design standards and other design requirements contained herein.

A. Manning Equation

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

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

A = Waterway area of channel in square feet

Q = Discharge in cubic feet per second (cfs)

V, R, S and n are explained in paragraph IXA.

B. Channel Cross Section and Grade

The required channel cross section and grade are determined by the design capacity, the material lining the channel, and the requirements for maintenance. A minimum depth may be required to provide adequate outlets for subsurface drains, 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 and maintain channel stability. Velocities less than 1.5 feet per second should be avoided because siltation will take place and ultimately reduce the channel capacity.

C. Side Slopes

Earthen channel side slopes shall be no steeper than 3 horizontal to 1 vertical. 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 1-1/2 to 1 with adequate provisions made for weepholes. Side slopes steeper than 1-1/2 to 1 may be used for lined channels provided that the side lining is designed and constructed as a structural retaining wall.

D. Channel Stability

1. Characteristics of a stable channel are:
 - a. It neither aggrades nor degrades beyond tolerable limits.
 - b. The channel banks do not erode to the extent that the channel cross section is changed appreciably.
 - c. Excessive sediment bars do not develop.
 - d. Excessive erosion does not occur around culverts, bridges, storm drains or channel outfalls, or elsewhere.
 - e. Gullies do not form or enlarge due to the entry of uncontrolled flow to the channel.
2. 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 appropriate "n" values for various channel linings. In no case is it necessary to check channel stability for discharges greater than that from a 100-year return period storm.
3. 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-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 20 percent to reflect the effects of vegetation to be established under the following conditions:

- a. The soil and site in which the channel is to be constructed are suitable for rapid establishment and support of erosion controlling vegetation.
- b. Species of erosion controlling vegetation are adapted to the area, and proven methods of establishment are shown.
- c. The channel design includes detailed plans for establishment of vegetation on the channel side slopes.

E. 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 outlet through a drop structure at the end of the waterway or through a standard tile outlet.

F. Appurtenant Structures

The design of channels will include all structures required for the proper functioning of the channel and laterals and shall include 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 effect of channel improvements on existing culverts, bridges, buried cables, pipelines and inlet structures for surface and subsurface drainage to the channel being improved and the channel laterals shall be evaluated to determine the need for modification or replacement. Culverts and bridges which 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.

G. Disposition of Spoil

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

1. Minimize overbank wash.
2. 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.
3. Not hinder the development of travelways for maintenance.
4. Leave the right-of-way in the best condition feasible, consistent with the project purposes, for productive use by the owner.
5. Be approved by the IDNR or U.S. Army Corps of Engineers (whichever is applicable) if deposited in the floodway.

XII. CONSTRUCTION AND MATERIALS

A. 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.

B. Materials

Materials acceptable for use as channel lining are:

1. Grass
2. Riprap
3. Concrete
4. Grouted Riprap
5. Gabions

Other lining materials shall receive specific approval of the town of Pendleton. Materials shall comply with the latest edition of the INDOT "Standard Specifications."

XIII. STORMWATER DETENTION

The following shall govern the design of any improvement with respect to the detention of stormwater runoff.

A. Acceptable Detention Methods

The increased stormwater runoff resulting from a proposed development shall be detained on-site by the provisions of appropriate wet or dry bottom reservoirs, by storage on parking lots, or other acceptable techniques. Measures which retard the rate of overland flow and the velocity in runoff channels may also be used to control the runoff rate. Detention basins shall be sized to store excess flows as explained in these standards.

Control devices shall limit the discharge to a rate no greater than that prescribed by these drainage standards.

B. Design Storm

Design of stormwater detention facilities shall be based on a return period of once in 100 years. The storage volume and outflow rate shall be sufficient to handle stormwater runoff from a critical duration storm, as defined in Section XIIE and XIIF.

C. Allowable Release Rate

The allowable release rate of stormwater originating from a proposed development shall not exceed the amount specified in Section V – Storm Water Control Policy.

In the event the natural downstream channel or storm sewer system is inadequate to convey 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 town of Pendleton shall be required to store that portion of the runoff exceeding the capacity of the receiving sewers or waterways.

D. 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 100 year design return period calculated on the basis of the upstream land in its ultimate 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 town of Pendleton and evidence of its construction can be shown.

E. Determination of Storage Volume – Rational Method

For areas of one hundred (100) acres or less, the Rational Method may be used to determine the required volume of stormwater storage. A procedure for calculating required stormwater storage using the Rational Method is included in the HERPICC Stormwater Drainage Manual.

F. Determination of Storage Volume – Other Methods

Runoff hydrograph and routing techniques shall be used for tributary drainage areas larger than 100 acres. The detention basin must be designed to store the largest volume calculated for storm durations up to 24 hours.

G. General Detention Basin Design Requirements

Basins shall be constructed to temporarily detain the stormwater runoff which 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 design storm.

The following design principles shall be observed:

1. The maximum volume of water stored and subsequently released at the design release rate shall not result in a storage duration in excess of 48 hours unless additional storms occur within the period.
2. The maximum planned depth of stormwater stored (without a permanent pool) shall not exceed four feet.
3. All storm water detention facilities shall be separated by not less than 50 feet from any occupied building or structure.
4. All excavated excess spoil may be spread so as to provide for aesthetic and recreational features. Slopes no steeper than 4 horizontal to 1 vertical for safety, erosion control, stability and ease of maintenance shall be permitted.
5. Safety screens having a maximum opening of 4 inches shall be provided for any pipe or opening to prevent children or large animals from crawling into the structures.

6. 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 town of Pendleton.
7. Outlet control structures shall be designed to operate as simply as possible and shall require little or no maintenance and/or attention for proper operation.
8. Emergency overflow facilities such as a weir or spillway 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.
9. 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.
10. Debris and trash removal and other necessary maintenance shall be performed on a regular basis to assure continued operation in conformance to design.
11. A report shall be submitted to the town of Pendleton describing (a) the proposed development; (b) the current land use conditions; (c) the method of hydraulic and hydrologic analysis used, including any assumptions or special conditions; (d) the results of the analysis; and (e) the recommended drainage control facilities. Hydraulic and hydrologic calculations, including input and output files, shall be included as appendices to the report.

H. Dry Bottom Basin Design Requirements

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

1. Provisions shall be incorporated to facilitate complete interior drainage of dry bottom basins, to include the provisions of natural grades to outlet structures, longitudinal and transverse grades to perimeter drainage facilities, paved gutters, or the installation of subsurface drains.
2. 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.

I. Wet Bottom 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 basin will not be required. A controlled positive outlet will be required to maintain the design water level in the wet bottom basin and provide required detention storage above the design water level. However, the following additional conditions shall apply:

1. Basins designed with permanent pools or containing permanent ponds shall have a water area of at least one-half acre. If fish are to be maintained in the pond, a minimum depth of approximately 10 feet shall be maintained over at least 25 percent of the pond area. The remaining pond area shall have no extensive shallow areas, except as required by subsection (3) below.
2. 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.
3. A safety ledge four to six feet in width is required and must be installed in all ponds approximately 30 to 36 inches below the permanent water level. In addition, a similar maintenance ledge 12 to 18 inches above the permanent water line shall be provided. The slope between the two ledges shall be stable and of a material such as stone or riprap which will prevent erosion due to wave action.
4. A safety ramp exit from the pond is required in all cases and shall have a minimum width of 20 feet and exit slope of 6 horizontal to 1 vertical. The ramp shall be of a material that will prevent its deterioration due to vehicle use and/or wave action.
5. 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 which 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.
6. Aeration facilities to enhance and maintain pond water quality shall be provided for all wet bottom basins. 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 town of Pendleton.

7. A dry hydrant shall be installed, if required by the Pendleton Fire Department. The dry hydrant shall meet the Pendleton Fire Department specifications and requirements.

J. Parking Lot Storage

Paved parking lots may be designed to provide temporary detention storage of stormwater 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 six inches to prevent damage to parked vehicles and so that access to parked vehicles is not impaired. Ponding should, in general, be confined to those positions of the parking lots farthest from the area served.

K. Facility Financial Responsibilities

The construction cost of storm water 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.

L. Facility Maintenance Responsibility

Maintenance of detention/retention facilities during construction and thereafter, shall be the responsibility of the land developer/owner. Assignment of responsibility for maintaining facilities serving more than one 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 town for ownership and permanent maintenance providing:

1. The town is willing to accept responsibility.
2. The facility has been designed and constructed according to all applicable provisions of this Ordinance.

3. All improvements have been constructed, approved and accepted by the town for the land area served by the drainage basin.
4. 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 equipped with electrically driven aeration devices, if required to maintain proper aerobic conditions and sustain aquatic life; have a four-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 75 feet to any property line.
5. Dry detention ponds shall have all slopes, bottom of the basin and area above the high water line hydroseeded; and shall have the high water line not closer than 50 feet to any development boundary.

M. Inspections

All public and privately owned detention storage facilities may be inspected by representatives of the town.

N. 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 town may undertake the work and collect from the owner using lien rights, if necessary.

O. Joint Development of Control Systems

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

P. 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 additional capacity to allow for sediment 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.

Q. 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.

R. 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 point instead of the natural overland distribution. The requirement of off-site drains shall be at the discretion of the town of Pendleton.

XIV. CERTIFICATION REQUIRED

After completion of the project and before final approval and acceptance can be made, a professionally prepared and certified “as-built” set of plans shall be submitted to the town of Pendleton for review. These plans shall include all pertinent data relevant to the completed storm drainage system and shall include:

1. Pipe size and pipe material
2. Invert elevations
3. Top rim elevations
4. Lengths of all pipe structures
5. Data and calculations showing detention basin and storm drain system design
6. Certified statement on plans stating the completed storm drainage system substantially complies with construction plans as approved by the town of Pendleton

All such submitted plans shall be reviewed for compliance within 30 days after submission to the town of Pendleton. If notice of non-compliance is not given within 30 days of submission of the plans, the plans shall be construed as approved and accepted.

XV. CHANGES IN PLAN

Any revision, change or deviation in the detailed plans and specifications after formal approval by the town of Pendleton shall be filed in duplicate with and approved by the town of Pendleton 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.

XVI. DETERMINATION OF IMPACT DRAINAGE AREAS

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

- A. A floodway or floodplain as designated by the Indiana Department of Natural Resources.
- B. Land within 75 feet of each bank of any regulated drain.
- C. Land within 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 town of Pendleton. Special requirements for development within any Impact Drainage Area shall be included in the resolution.

XVII. OTHER REQUIREMENTS

- A. 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 function only, either the discharge of stormwaters or the discharge of sanitary sewage.

- B. Downspouts

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

- C. Footing Drains

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

D. Basement Floor Drains

Basement floor drains shall be connected to the sanitary sewers.

XVIII. DISCLAIMER OF LIABILITY

The degree of protection required by this drainage standard is considered reasonable for regulatory purposes and is based on historical records, engineering and scientific methods of study. Larger storms may occur or stormwater runoff depths may be increased by man-made or natural causes. These drainage standards do not imply that land uses permitted will be free from stormwater damage. These drainage standards shall not create liability on the part of the town of Pendleton or any officer, employee, agent or contract employee thereof for any damage which may result from reliance on this drainage standard or on any administrative decision lawfully made thereunder.

XVIX. CORRECTIVE ACTION

Nothing herein contained shall prevent the town of Pendleton 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.

XX. REPEALER

All ordinances or parts thereof in conflict with the provisions of these drainage standards are repealed.

XXI. WHEN EFFECTIVE

These drainage standards shall become effective after their final passage, approval and publication of drainage standards and a drainage ordinance designating these drainage standards, as required by law.

XXII. EXEMPT PROJECTS

Any residential, commercial or industrial subdivision (major or minor) or construction project thereon, which has had its drainage plan approved by the town of Pendleton prior to the effective date of these standards shall be exempt from all of the requirements of these standards.

XXIII. UPDATES

These drainage standards may be updated and revised as required by the Pendleton town engineer or planning department, with approval by the town manager or town council.