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# 1. DRAINAGE ORDINANCE

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## 1.1 PURPOSE

The purpose of this ordinance is to provide for the health, safety, and general welfare of the citizens of North Vernon through the regulation of storm water runoff. This ordinance establishes guidelines for construction of residential and commercial properties within the jurisdiction of the North Vernon Common Council.

## 1.2 ABBREVIATIONS

<b>ASTM</b>	American Society of Testing Materials
<b>DGA</b>	Dense Graded Aggregate
<b>FEMA</b>	Federal Emergency Management Agency
<b>HAC</b>	Hot Asphalt Concrete
<b>INDOT</b>	Indiana Department of Transportation
<b>NGVD</b>	National Geodetic Vertical Datum
<b>NOAA</b>	National Oceanic and Atmospheric Administration
<b>NRCS</b>	USDA Natural Resources Conservation Service
<b>NVCC</b>	North Vernon Common Council
<b>RCP</b>	Reinforced Concrete Pipe

## 1.3 DEFINITIONS

**ASTM:** American Society for Testing Materials, an association that publishes standards and requirements for materials used in the construction industry.

**Blue Line Stream:** Any stream depicted blue in color, solid or dashed, on a USGS Quad Map.

**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.

**Catch Basin:** A chamber usually built at the curb line of a street for the admission of surface water to a storm sewer or sub-drain, having at its base a sediment sump designed to retain grit and detritus below the point of overflow.

**Channel:** A portion of 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.

**Contour:** An imaginary line on the surface of the earth connecting points of the same elevation.

**Contour Line:** A line on a map, which represents a contour or points of equal elevation.

**Crown of Pipe:** The elevation of the top of pipe.

**Culvert:** A closed conduit used for the conveyance of surface drainage water under a roadway, railroad, canal or other impediment.

**Datum:** Any level surface to which elevations is referred, usually using Mean Sea Level.

**Dense Graded Aggregate:** Indiana No. 9 Crushed Stone.

**Design Storm:** A selected storm event, described in terms of the probability of occurring once within a given number of years, for which drainage of flood control improvements are designed and built.

**Detention:** Managing storm water runoff by temporary holding and controlled release.

**Detention Basin:** A facility constructed or modified to restrict the flow of storm water to a prescribed maximum rate, and to detain concurrently the excess waters that accumulated behind the outlet.

**Detention Storage:** The temporary detaining of storm water in storage facilities, on rooftops, in streets, parking lots, school yards, parks, open spaces or other areas under predetermined and controlled conditions, with the rate of release regulated by appropriately installed devices.

**Detention Time:** The theoretical time required to displace the contents of a tank or unit at a given rate of discharge (volume divided by rate of discharge).

**Discharge:** Usually the rate of water flow. A volume of fluid passing a point per unit time commonly expressed as cubic feet per second, cubic meters per second, gallons per minute, or millions of gallons per day.

**Drainage Area:** The area draining into a stream at a given point. It may be of different sizes for surface runoff, subsurface flow and base flow, but generally the surface runoff area is considered as the drainage area.

**Drainage Improvement:** An activity within or adjacent to a natural stream or a man-made drain primarily intended to improve the flow capacity, drainage, erosion and sedimentation control, or stability of the drainage way.

**Drop Inlet:** A structure in which water drops through a vertical riser connected to a discharge conduit or storm sewer.

**Earth Embankment:** A man-made placement of soil, rock, or other material often used to form an impoundment.

**Easement:** A right of use over designated portions of the property of another for a clearly specified purpose.

**Emergency Spillway:** Usually a vegetated earth channel used to safely convey flood discharges around an impoundment structure.

**Flood Elevation:** The maximum level of high waters for a flood of a given return period and rainfall duration.

**Flood or Flood Water:** Water that overflows the banks of a lake or watercourse.

**Flood Hazard Area:** Any floodplain, floodway, floodway fringe, or any combination which is subject to inundation by the regulatory flood elevation or any floodplain as delineated by Zone A on the current Flood Hazard Boundary Map of the Federal Emergency Management Agency.

**Floodplain:** The area adjoining the river or stream that has been or may be covered by floodwaters. It consists of both the floodway and the floodway fringe.

**Floodway:** The channel of a river or stream and those portions of the flood plains adjoining the channel, which is reasonably required to, efficiently carry and discharge the peak flow of the regulatory flood of any river or stream.

**Floodway Fringe:** That portion of the floodplain lying outside the floodplain lying outside the floodway that is inundated by the regulatory flood.

**Grade:** (1) The slope of a road, a channel, or natural ground. (2) The finished surface of a canal bed, roadbed, top of embankment, or bottom of excavation; any surface prepared to a design elevation for the support of construction, such as paving or the laying of a conduit. (3) To finish the surface of a channel bed, roadbed, top of embankment, or bottom of excavation, or other land area to a smooth, even condition.

**Head:** (1) The height of water above any plane of reference. (2) The energy, either kinetic or potential, possessed by each unit weight of a liquid, expressed as the vertical height through which a unit would have to fall to release the average energy possessed. Used in various compound terms, such as pressure head or velocity head.

**Head Loss:** Energy loss due to friction, eddies, changes in velocity, elevation, or direction of Headwater. (1) The source of a stream. (2) The water upstream from a structure or point on a stream.

**Hydrograph:** A graph showing for a given point on a stream the discharge, stage (depth), velocity, or other property of water with respect to time.

**INDOT:** Indiana Department of Transportation. Generally used here to refer to specifications contained in the publication "INDOT Standard Specifications."

**NGVD:** A particular elevation datum known as the National Geodetic Vertical Datum of 1929 (NGVD 1929).

**Inlet:** An opening into a storm sewer system for the entrance of surface storm water runoff more completely described as a storm sewer inlet.

**Invert:** The inside bottom of a culvert or other conduit.

**Manhole:** Storm sewer structure through which a person may enter to gain access to a storm sewer or enclosed structure. A manhole may also be an inlet for the storm sewer system.

**Professional Land Surveyor:** A person licensed under the laws of the State of Indiana to practice land surveying.

**Professional Engineer:** A person licensed under the laws of the State of Indiana to practice professional engineering.

**Rainfall Intensity:** The rate at which rain is falling at any given instant, usually expressed in inches per hour.

**Rational Method:** A means of computing storm drainage flow rates (Q) by use of the formula  $Q = CIA$ , where C is a coefficient describing the physical drainage area, I is the rainfall intensity, and A is the area.

**Regulatory Flood:** A flood with a peak having a probability of occurrence of one (1) percent in any given year, which is commonly referred to as a one hundred (100) year flood as calculated by a method and procedure, which is acceptable to the Common Council. If a permit for construction in a floodway is required by the Indiana Department of Natural Resources, the regulatory peak discharge must be calculated by the method and procedure acceptable to the Common Council and the Indiana Department of Natural Resources.

**Regulatory Floodway:** The channel of a river or stream and those portions of the floodplain adjoining the channel which are reasonably required to carry and discharge the peak flow of the regulatory flood of any river or stream.

**Retention Facility:** A facility designed to completely retain a specified amount of storm water runoff without release except by means of evaporation, infiltration or pumping.

**Runoff:** That portion of precipitation that flows from a drainage area on the land surface, in open channels, or in stormwater conveyance systems.

**Sinkholes:** A sinkhole is any closed depression in a limestone region formed by the removal of water, surficial soil, rock or other material that is connected to a cavern or underground passage. The sinkhole drainage area shall include any area that contributes surface water directly to the sinkhole.

**Slope:** Degree of deviation of a surface from the horizontal, measured as a numerical ratio or percent. Expressed as a ratio, the first number is commonly the horizontal distance (run) and the second is the vertical distance (rise) - e.g., 2:1. However, the preferred method for designation of slopes is to clearly identify the horizontal (H) and vertical (V) components (Length (L) and Width (W) components for horizontal angles). Also note that according to international standards (Metric), the slopes are presented as the vertical or width component shown on the numerator — e.g., IV: 2H. Slope expressions in this handbook follow the common presentation of slopes - e.g., 2:1 with the metric presentation shown in parenthesis - e.g., (IV: 2H). Slopes can also be expressed in "percents". Slopes given in percents are always expressed as (100V/H) - e.g.; a 2:1 (IV: 2H) slope is a 50% slope.

**Soil:** The unconsolidated mineral and organic material on the immediate surface of the earth that serves as a natural medium for the growth of land plants. Also see Alluvial Soil, Clay, Cohesive soil, Loam, Permeability (soil), Sand, Silt, Soil horizon, Soil Profile, Subsoil, Surface Soil, Topsoil.

**Storm Event:** An estimate of the expected amount of precipitation within a given period of time. For example, a 10-yr. frequency, 24-hr. duration storm event is a storm that has a 10% probability of occurring in any one year. Precipitation is measured over a 24-hr. period.

**Storm Frequency:** The time interval between major storms of predetermined intensity and volumes of runoff - e.g., a 5-yr., 10-yr. or 20-yr. storm.

**Storm Sewer:** A sewer that carries storm water, surface drainage, street wash, and other wash waters but excludes sewage and industrial wastes. Also called a storm drain.

**Storm Water:** Any surface flow, runoff, and drainage consisting entirely of water from any form of natural precipitation, and resulting from such precipitation.

**Surface Runoff:** Precipitation that flows onto the surfaces of roofs, streets, the ground, etc. and is not absorbed or retained by that surface but collects and runs off.

**Time of Concentration (Tc):** The travel time of a particle of water from the most hydraulically remote point in the contributing area to the point under study. This can be considered the sum of an overland flow time and times of travel in street gutters, storm sewers, drainage channels, and all other drainage ways.

**Watershed Area:** All land and water within the confines of a drainage divide.

## 1.4 APPLICABILITY

This section shall apply to all developments requiring a permit or approval, from the Jennings County Plan Commission, or any other agency of Jennings County or North Vernon, subject to the following exceptions:

1. Projects that require only individual Improvement Location Permits for a single family dwelling, a two-family dwelling, or their accessory structures are not subject to these requirements.
2. Projects that are agricultural structures in locations included in current soil and water conservation plans that have been approved by the Jennings County Soil and Water Conservation District are also exempt from these requirements.
3. The provisions of this section shall be deemed as additional requirements to minimum standards required by other ordinances of the City. In the case of conflicting requirements, the most restrictive shall apply.
4. The Common Council may grant a waiver from any requirements of these regulations if there are exceptional circumstances applicable to the site such that strict adherence to the provisions of these regulations will result in unnecessary hardship and not fulfill the intent of these regulations.

## 1.5 RESPONSIBILITY FOR ADMINISTRATION

The North Vernon Utility Service Board shall administer, implement, and enforce the provisions of this ordinance. Any powers granted or duties imposed upon the USB may be delegated in writing by the USB to the enforcement personnel.

## 1.6 SEVERABILITY

The provisions of this ordinance are hereby declared to be severable. If any provision, clause, sentence, or paragraph of this Ordinance or the application thereof to any person, establishment, or circumstances shall be held invalid, such invalidity shall not affect the other provisions or application of this Ordinance.



## **1.7 ULTIMATE RESPONSIBILITY**

The standards set forth herein and promulgated pursuant to this ordinance are minimum standards.

## **1.8 NOTICE OF VIOLATION**

Whenever the USB finds that a person or developer has violated or failed to meet a requirement of this ordinance, the USB may order compliance by written notice of violation to the responsible person.

## **1.9 APPEAL OF NOTICE OF VIOLATION**

Any person receiving a Notice of Violation may appeal the determination of the USB. The notice of appeal must be received within 10 calendar days from the date of the Notice of Violation. Hearing on the appeal before USB shall take place within 30 calendar days from the date of receipt of the notice of appeal. The decision of the USB shall be final.

## **1.10 ENFORCEMENT MEASURES AFTER APPEAL**

If the violation has not been corrected pursuant to the requirements set forth in the Notice of Violation, or, in the event of an appeal, within five days of the decision of the USB, the USB may pursue all remedies provided for in this ordinance or by law.

## **1.11 INJUNCTIVE RELIEF**

It shall be unlawful for any person to violate any provision or fail to comply with any of the requirements of this ordinance. If a person has violated or continues to violate the provisions of this ordinance, the USB may seek any remedies available under any applicable law, including, but not limited to the following:

1. Preliminary or permanent injunction.
2. Stop work order.

Any person, firm, or corporation who shall violate or fail to comply with any of the provisions of this ordinance shall be liable for civil penalties to the USB up to \$2,500.00. Each day that the violation exists or continues shall be deemed a separate offense. Any such person, firm or corporation shall also reimburse the USB for all attorney's fee incurred in any enforcement action.

## **1.12 VIOLATIONS DEEMED A PUBLIC NUISANCE**

In addition to the enforcement processes and penalties provided, any condition caused or permitted to exist in violation of any of the provisions of this ordinance may be summarily abated or restored at the violator's expense, or a civil action to abate, enjoin, or otherwise compel the cessation of such nuisance may be taken.

### **1.13 REMEDIES NOT EXCLUSIVE**

The remedies listed in this ordinance are not exclusive of any other remedies available under any applicable federal, state or local law. It is within the discretion of other authorized enforcement agencies to seek cumulative remedies.

### **1.14 PERMITS FOR CONSTRUCTION IN A FLOODWAY**

The 1945 Flood Control Act (Indiana Code 13-2-22) of the State of Indiana prohibits the construction of abodes or residences in or on a floodway. Prior approval of the Indiana Department of Natural Resources is required for any type of construction, excavation, or filling in or on a floodway.

### **1.15 WETLANDS**

Landowners and/or developers must notify and make application to all appropriate state and federal agencies with authority for wetland protection. In cases where federal or state jurisdictional wetlands have been determined to exist, those wetland areas area boundaries must be indicated on preliminary and final drainage plans.

The Board will not make determinations of the accuracy of delineation or extent of jurisdictional wetlands. Approvals required by this ordinance may be deferred until wetland-related approvals have been obtained.

## 2. DESIGN METHODOLOGY FOR STORM SEWER

This chapter establishes the minimum required standards for the planning and design of drainage systems and storm water management facilities within North Vernon. All plans concerning drainage shall be prepared under the supervision of and certified by a Registered Land Surveyor or Professional Engineer licensed by the State of Indiana. It is assumed that practicing Engineers/Surveyors involved with preparing drainage plans have adequate knowledge of the recommended procedures; therefore, there is no attempt in the document to provide step-by-step calculation methodologies.

### 2.1 STORM SEWER DESIGN PARAMETERS

All storm sewers, whether private or public, and whether constructed on private or public property shall be designed to handle the flow for a minimum storm return period of 10 years (10 year storm). In addition, storm systems shall be designed to store the return period of 100 years (100 year storm). These design parameters will allow surface water to drain into the storm system and not allow water to stand outside the public right-of-way and easements.

The runoff calculation procedures to be utilized depends upon the size of the proposed development or project as follows:

1. If the total tributary area to an existing or proposed storm water facility project watershed is 100 acres or less, or storage design is required for a site containing one acre or less, the method of runoff calculation shall be the Rational Method.
2. If the total project drainage area is greater than 100 acres, or storage design is required for a site containing more than one acre, a discharge hydrograph must be calculated using the NRCS method or another method that has been approved by the North Vernon Utility Service Board (USB).
3. The Rational Method maybe used to design through drainage channel if the drainage area of the channel is 100 acres or less, otherwise, the channel shall be designed by NRCS runoff calculation methodology or another method that has been approved by the USB.

### 2.2 FREQUENCY/RETURN PERIOD

The elevation of the 100-year pre- and post- development discharge shall be checked for all drainage system designs to assure conformance with the guidelines of the FEMA Program. In the areas of the City not covered by a Flood Insurance Study, the Design Engineer or Land Surveyor must determine the pre-development 100-year Flood Elevation. The elevation for the 100-year post-development discharge shall be conveyed within the limits of the proposed easement.

## 2.3 RAINFALL DURATION

The minimum design storm duration for planning and design is dependent upon the runoff method used.

1. The Rational Method calculates peak discharge only (as opposed to developing a runoff hydrograph for an area). It makes a basic assumption that the design storm has constant rainfall intensity for a time period (storm duration) equaling the project area time of concentration.
2. The NRCS Method will utilize the NRCS Type II 24-hour rainfall distribution. The exception is for the design of detention/retention basins where the 6-hour storm is used.

## 2.4 RAINFALL DEPTH

Rainfall Intensity-Duration Curves for North Vernon shall utilize the National Oceanic and Atmospheric Administration (NOAA) Atlas 14 dataset.

## 2.5 SURFACE CONDITION DATA

Maps depicting the NRCS Hydrologic Soil Groups, Existing Land Use, and Projected Land Use for each watershed shall be evaluated to determine the appropriate surface condition factors for use in runoff calculations.

## 2.6 RUNOFF CALCULATIONS METHODS (DESIGN FLOW)

### 2.6.1 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 shall be calculated as follows:

For areas up to and including 100 acres and storage design required for a site containing one acre or less, 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 ( $T_c$ ) for a selected rainfall frequency.

$A$  = Tributary drainage area in acres.

The rainfall intensity factor,  $I$ , should be obtained from the NOAA Atlas 14 dataset.

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 using Manning's 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.

The time of concentration shall be determined by calculating the time for a particle of water to travel from the most hydrological remote point of the project area to the point of interest. Time of concentration to the first inlet or structure may be estimated by the Kirpich Equation ( $T_c = 0.0078 * L^{0.77} * s^{-0.385}$ ) where L equals length of travel in feet and S equals slope in foot per foot. Other methods to derive time of concentration such as TR-55, Kerby's Equation and the Kinematic Wave method will be acceptable. The minimum  $T_c$  shall not be less than 10 minutes. Manning's Equation should be used to estimate any in-pipe or channel travel.

Guidance to selection of the runoff coefficient "C" is provided by **Table 2**, which shows 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.

Soils groups are classified into four categories: A, B, C, and D. Soil types and their corresponding Hydraulic Soil Group can be found in standard hydraulics texts and references.

**Table 2-1. Runoff Coefficients Based on Land Use, Soil Groups and Slope Range (%)**

LAND USE	% IMP	A			B			C			D		
		0-2	2-7	7+	0-2	2-7	7+	0-2	2-7	7+	0-2	2-7	7+
Residential	25	.31	.35	.39	.33	.38	.43	.37	.41	.48	.40	.44	.52
	38	.42	.45	.45	.44	.48	.52	.47	.50	.56	.50	.53	.59
	65	.65	.67	.69	.66	.68	.71	.68	.70	.73	.69	.71	.75
	75	.73	.75	.77	.75	.76	.78	.76	.77	.79	.77	.78	.80
Commercial, Business	85	.82	.83	.84	.83	.84	.85	.84	.85	.86	.84	.85	.86
Industrial	72	.71	.73	.74	.72	.74	.76	.73	.75	.77	.75	.76	.79
Roofs, Driveways, Streets, etc.	100	.95	.95	.95	.95	.95	.95	.95	.95	.95	.95	.95	.95
Open Spaces, Lawns, Parks, etc.	0	.09	.15	.21	.13	.19	.26	.18	.23	.32	.22	.27	.37
Woodlands	0	.09	.15	.20	.13	.18	.23	.17	.22	.26	.20	.25	.30
Pasture, Grass, Farmland	0	.15	.20	.25	.18	.23	.30	.22	.26	.35	.25	.30	.40
Newly Graded, Disturbed		.65	.67	.69	.66	.68	.71	.68	.70	.73	.69	.71	.75

## **2.6.2 USDA Natural Resources Conservation Service Methods**

The NRCS Methods are required for runoff calculation procedures for project sites where the total project area is greater than 100 acres or the storage design required for a site is more than one acre.

## **2.6.3 Methods**

The NRCS methods also include the TR-20 and TR-55 Methods. Detailed descriptions, example calculations and worksheets for these methods are available in:

1. Project Formulation - Hydrology, Technical Release No. 20 User's Manual
2. Urban Hydrology for Small Watersheds Technical Release No. 55
3. A Guide to Hydrologic Analysis Using NRCS Methods.

## **2.6.4 Curve Number**

The curve number is similar to the Rational Method C-Factor in that it is based on the surface condition of the project site.

For through drainage systems, post developed curve numbers shall be based on a watershed as developed at the time of design.

## **2.6.5 Design Flows**

At a minimum, the facility must have the capacity to transport the 10-year post-development discharge except in unusual cases, such as retrofit projects. The USB shall determine design criteria for retrofit projects or other unusual cases. The water surface profile and through system capacity shall be checked for the 100-year post-development discharge. All drainage systems shall be capable of passing the 100-year design flow within the drainage easement. Additional facility specific requirements are found in the following portions of this ordinance.

## 3. STORM SEWER DESIGN STANDARDS

The Professional Engineer or Professional Land Surveyor shall refer to the Ten State Standards for design methodology for storm sewers. The exception being that all storm sewer systems will be designed for the 10-year event. The 100-year discharge elevation must be checked for all locations to avoid flood damage to adjacent structures. Manning's Equation is recommended to calculate pipe flow and velocity. The storm sewer hydraulic grade line for the 100-year event shall be contained within the storm sewer system.

### 3.1.1 Hydraulic Capacity

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

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

Q = Flow Rate (cfs)

R = Hydraulic Radius (ft)

S = Slope of the Energy Grade Line (ft/ft)

n = Manning's Roughness Coefficient

A - Cross-sectional area (ft<sup>2</sup>)

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

### 3.1.2 Minimum Size

To minimize the potential for pipes to become clogged, the minimum size of all storm sewers shall be 12 inches. This does not pertain to outlet structures for detention/retention basins. The rate of release for detention storage shall be controlled by an orifice plate or other devices, subject to approval of the North Vernon Utility Service Board (USB), where the 12-inch pipe will not limit the rate of release as required.

### 3.1.3 Grade

Sewer grade shall be such that, in general, a minimum of 18 inches of cover will be maintained over the top of the pipe when reinforced concrete pipe is used. Pipe cover less than the minimum may be used only upon approval of the USB. 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 15 feet per second, respectively, when the sewer is flowing full.

### 3.1.4 Alignment

In general, storm sewers shall be straight between structures. Where long radius curves are necessary to conform to street layout, the minimum radius of curvature shall be no less than 100 feet for sewers 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.

### 3.1.5 Manholes

Structures 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 an abrupt change in alignment occurs.
4. Where a change in grade occurs.
5. At suitable intervals in straight sections of sewer.
6. Pipe materials change.

The maximum distance between storm sewer manholes is shown in **Table 3-1**.

*Table 3-1. Manhole Distance*

Size of Pipe (in)	Maximum Distance (ft)
12 thru 42	400
48 and larger	600

### 3.1.6 Inlets

Inlets or drainage structures shall be utilized to collect surface water through grated openings and convey it to storm sewers, channels or culverts. Inlets contained within roadways shall be placed at low points with a maximum spacing of 400 feet from high points and addition inlets upstream and downstream. The inlet grate opening provided must be adequate to pass the design 10-year flow with 50% of the sag inlet areas clogged. Additional, positive drainage shall be designed in low areas to minimize property damage.

### 3.1.7 Workmanship and Materials

The specifications for the construction of storm sewers shall not be less stringent than those set forth in the latest revision of the Indiana Department of Highways' "Standard Specifications."

### 3.1.8 Materials

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

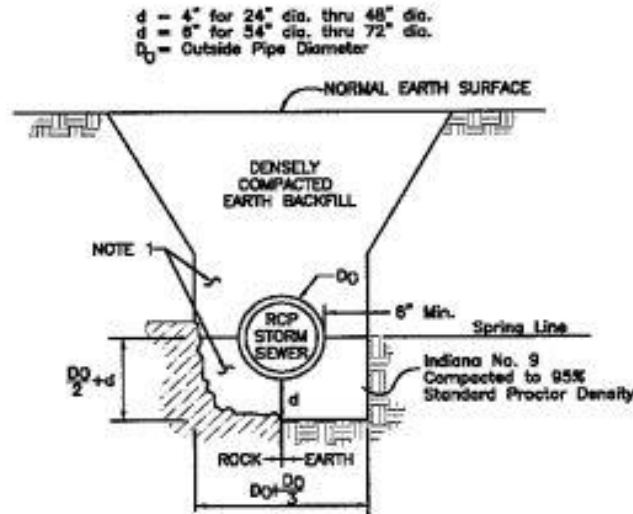
Pipe and fittings used in storm sewer construction must be reinforced concrete pipe (ASTM C-76). In areas where there is no anticipation of heavy loads (i.e. trucks, tractors, farm equipment), ADS and/or Hancor pipe can be installed using the manufacturer's specifications and proper bedding material.



Inlets contained within the roadways at the low points shall be Neenah type R - 3260 - A. Inlets in ditches shall be Neenah type R - 4353. Equivalent type inlets maybe used only with the approval of the City.

### 3.1.9 Pipe Bedding, Backfill and Surface Restoration:

All pipes must be bedded according to the detail below, but not limited to the following:



*Figure 3-1. Storm Sewer Trench and Bedding Detail*

1. Where pipe is installed in earth areas, not immediately adjacent to a street or road, place Indiana No. 9 crushed stone to the spring line for RCP. The remainder of the trench must be backfilled with selected earth materials, humped over the trench to allow for settling.
2. Where pipe is installed in a graveled area, the remainder of the trench must be backfilled with Indiana No. 9 to a point eight (8) inches below original grade.
3. Where pipe is installed in an asphalt street, driveway, or parking area, the remainder of the trench must be backfilled with Indiana No. 9 to the subgrade. The trench must then be trimmed back six (6) inches on each side and filled with 3000-psi concrete. After all construction is completed, the trench must be cleaned, primed and paved with a one (1) inch compacted thickness of INDOT HAC Surface to be flush with the surrounding area. All patch seams can only be saw cut, cut smooth, straight and tarred.
4. Where pipe is installed in a concreted area, the remainder of the trench must be backfilled with DGA to a point nine (9) inches below original grade. The trench must then be trimmed back six (6) inches along each side and filled with 3000-psi concrete flush with original grade. All patch seams must be saw cut only, smooth and straight.
5. All cutting of trenches in existing asphalt or concrete pavements must be done with a saw only to provide a straight, smooth joint when new paving is done.

6. In areas where rock is encountered, all rock shall be removed from the trench. Voids created by such removal shall be refilled with Indiana No. 9 crushed stone.
7. Before placing of the aggregate base course, the upper six inches of all subgrade and subbase shall be compacted to a minimum of ninety five (95) percent of maximum dry density as determined in accordance with AASHTO T99, as modified in 203.24.

## 4. OPEN CHANNEL DESIGN STANDARDS

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This section describes the technical criteria necessary to design storm water channels and ditches using conventional design procedures. These procedures shall be applied to roadside and rear yard ditches and highly urbanized channels. All blue line streams (especially in undisturbed areas) shall be designed using Natural Channel Design techniques, if possible. This criterion represents minimum requirements.

Manning's equation is required, except in cases where backwater conditions are significant. All calculations must be submitted for review.

Channels and ditches should be capable of conveying the 10-year storm flow within their banks. Through drainage systems (culverts, storm sewers, etc.) shall generally be designed to collect and transport the post-development rate of runoff for the 10-year design storm. In all cases, the 100-year discharge elevation shall be checked to ensure that adjacent structures do not suffer flood damage.

All through systems constructed must be capable of passing the 100-year design flow within the drainage easement.

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.

### 4.1.1 Manning Equation:

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

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

Q = Flow Rate (cfs)

R = Hydraulic Radius (ft)

S = Slope of the Energy Grade Line (ft/ft)

n = Manning's Roughness Coefficient

A - Cross-sectional area (ft<sup>2</sup>)

The hydraulic radius, R, is defined as the cross sectional area of flow divided by the wetted flow surface or wetted perimeter.

### 4.1.2 Channel Cross Section and Grade:

The design capacity, the material in which the channel is to be constructed, and the requirements for maintenance determine the required channel cross-section and grade. 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 1.5 feet per second should be avoided because siltation will take place and ultimately reduce the channel cross—section.

#### **4.1.3 Side Slopes**

Earthen channel side slopes shall be no steeper than 3 to 1. Flatter slopes may be required to prevent erosion and for ease of maintenance. Where concrete lined channels are required, side slopes shall be no steeper than 1 ½ to 1 with adequate provisions made for weep holes or subsurface drainage. Side slopes steeper than 1 ½ to 1 may be used for lined channels provided that the side lining is designed and constructed as a retaining wall with provisions for live and dead load surcharge.

#### **4.1.4 Channel Stability:**

All channels constructed shall have the following characteristics:

1. It neither aggrades nor 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.
5. Gullies do not form or enlarge due to the entry of uncontrolled surface flow to the channel.

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. In no case is it necessary to check channel stability for discharges greater than that from a 100-year return period storm.

## 5. DETENTION BASINS

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Detention basins shall be designed in accordance with the following criteria:

Detention basins are typically designed to remain empty during dry weather and to backup or detain excessive runoff generated during a storm.

Fencing must be provided if deemed necessary by the North Vernon Utility Service Board (USB). The USB must approve design and locations.

### 5.1.1 Basin Volume Design

1. A minimum basin volume shall be the difference in runoff volume discharged from the project area to the basin site between the pre-development and post-development 100-year storm. In cases where the volume requirement governs, the design calculations must not only show that the required volume has been created, but that the basin functions to detain the volume difference.
2. In many areas of the City the increased runoff volumes can be as critical, if not more critical, than the rate of discharge. The USB will address this issue on a site-specific basis. All development submittals will be evaluated for the impacts of increased runoff and volume control. Satisfying the volume requirement may be met onsite, at approved off-site locations, or by purchase of volume in a Flood Compensation Bank if one is available in the watershed.
3. Maximum basin side slopes shall be 3:1, unless paved.
4. Low flow channels shall be grass if the channel grade is greater than 1.0%.
5. Basin design must include maintenance accessibility and responsibility.
6. The Professional Engineer shall address provisions for anti-seep collars, extended detention basins, wet ponds, soil bioengineering, baffles, outlet protection and length to width ratios.
7. Detention basins must be completely within a recorded permanent Detention Basin Easement.

Basin discharge shall be designed with the following criteria:

1. Discharge control structures shall be multi-stage and capable of limiting 2, 10, and 100-year post-development discharges to the respective pre-development peak discharge rates or downstream system capacity and shall be constructed of concrete or approved alternate.
2. The emergency spillway shall be sized to accommodate a flow equal to the design overflow of the 100-year storm post-development discharge without overtopping the dam. Erosion protection must be provided for the spillway and receiving stream.

3. The dam elevation shall not be less than one foot above the 100-year storm storage and overflow elevation.
4. Appropriate downstream channel protection must be installed.
5. Storage, discharge, and routing calculations for the 2-, 10-, and 100-year discharges must be submitted for review.
6. Spillways shall be protected from erosion and shall employ energy dissipation, if necessary.
7. Detention basins shall be fully discharged within 36 hours after the storm event unless specifically approved by the USB.
8. The detention basin shall be the first item of construction prior to any other earth moving or land disturbing activities and must be designed to function as a sediment basin through the construction period. The basin design must be checked for capacity due to additional runoff generated by disturbed site conditions.

#### 5.1.2 Parking Lot Storage

Paved parking lots may be designed to provide temporary detention storage of storm water directly from the parking area, but are not appropriate for storing large volumes. Ponding should, in general, be confined to those positions of the parking lots farthest from the area served. Ponding areas must not conflict with handicapped parking and access routes. Such ponding areas should be exposed to sunlight in winter months to minimize icing. Storage depth must be limited so as not to conflict with parking lot use. Any detention facility utilizing a parking lot must take resurfacing and other parking lot maintenance activities into consideration during design.

#### 5.1.3 Facility Maintenance Responsibility

Maintenance of drainage facilities during construction must be the responsibility of the land developer. Maintenance responsibilities must be documented by appropriate restrictive covenants to property deeds prior to final drainage plan approval. The permanent pool of a wet bottom basin is the responsibility of the developer or homeowners' association. Routine maintenance must, at a minimum, assure that the drainage facility performs the functions for which it was designed and constructed. **All drainage facilities must be privately owned and funded.** The detention basin must be mowed a minimum of once a year and be kept free of trees and shrubs.

## 6. SINKHOLES

### 6.1.1 General

The use of sinkholes as storm water management is not permitted, unless there are no other alternatives.

The City of North Vernon does not encourage the use of natural sinkholes as outlets for drainage from developed areas and will avoid requests for modifications to sinkhole entrances. The proposed use of sinkholes as outlets for development must be approved by the North Vernon Utility Service Board (USB).

For circumstances that have no other means for drainage, the following criteria shall be implemented:

### 6.1.2 Design

Specific design requirements for the use of sinkholes, when permitted, include but are not limited to:

1. The sinkhole shall have the volume to store a 100-year, 24-hour NRCS storm with a no outlet condition.
2. Storm water discharge into a sinkhole shall not be increased over its preexisting rate according to standards as established by the USB. Depressions containing sinkholes shall not be utilized for storm water detention unless no other alternatives exist.
3. Photographic evidence should be submitted to the USB showing the current condition of the sinkhole feature. If recent subsidence is evident, the sinkhole shall not be used for storm water drainage unless the feature has been evaluated by a Geotechnical Engineer, and he/she has determined that the feature can be treated so that significant future subsidence is not likely.
4. To confirm the suitability for an existing feature to accept a given runoff volume, the feature must be pump tested using at least 80% of the 100-year design storm for an 8-hour duration. The condition of the sinkhole before and after the pump test should be documented by a licensed Professional Engineer registered in the State of Indiana. Any evidence of significant subsidence that occurs during or after the test will be taken as unsuitability of the feature to accept runoff. To confirm that runoff into the sinkhole feature will not affect adversely adjacent properties, fluorescent dye should be injected into the sinkhole during the pump testing. A Geotechnical Engineer, registered in the State of Indiana, should be retained to make observations of the fate of the dye in the surrounding area.
5. Protective measures for the sinkhole inlet must be applied prior to the start of construction activities. Surface water runoff from stripped areas should be directed away from the sinkhole until the areas have been developed or ground cover has been installed and has become established.
6. An alternate means of surface water disposal must be provided in the event that the sinkhole ceases to accept runoff or significant subsidence occurs in the feature.

7. Storm water runoff from paved areas or structures shall not directly enter a sinkhole. Drainage plans shall be designed to route runoff through vegetative filters or other filtration measures before it enters a sinkhole. Such filters or filtration methods must be reviewed by the USB.
8. A Geotechnical Engineer, licensed in the State of Indiana, must supervise the design and installation of sinkhole treatment measures. The engineer shall also observe installation of treatment measures and shall document that treatment measures comply with approved plans. The engineer shall be responsible for documenting significant subsidence or other changes in the existing sinkhole feature during treatment that may affect the effectiveness or practicality of the approved treatment method.
9. Any instances of significant subsidence must be fully documented and a Geotechnical Engineer, licensed in the State of Indiana, must supervise design of treatment measures, must inspect treatment installation, and must document construction of repairs prior to bond release.



## 7. FINAL DRAINAGE PLANS

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Final drainage plans shall be submitted to the North Vernon Utility Service Board (USB). Before final subdivision plat approval or before construction for all other developments, the final construction plans shall provide or be accompanied by calculations, maps and/or other descriptive material including:

### 7.1.1 Cover Sheet

Location map with the site outlined.

1. Location map with the site outlined.
2. Title block: title of development, name and address of developer, name and address of Professional Engineer or Professional Land Surveyor, date of preparation, revision dates.
3. Index of sheets.
4. Engineer's or Land Surveyor's seals and signatures.
5. Construction notes.

### 7.1.2 Composite Drainage Plan

1. Topography: minimum scale 1" = 100' with existing contours at two-foot intervals, NGVD datum. Contours to extend a minimum of 50 feet beyond property lines.
2. Proposed development: street rights-of-way, street names, street centerline stationing, lot lines, lot numbers, property boundary, existing drainage structures, proposed drainage structures (labeled by number or other designation) and easements with widths shown.
3. Hydrologic data: designate drainage areas (in acres) to individual inlets, and off-site drainage areas (acres), which generate through drainage.
4. Pipe chart: pipe number, drainage area, coefficient of runoff (c), time of concentration, intensity, discharge (Q), size, length, slope, capacity, velocity.
5. 100-year FEMA and local regulatory floodplain and conveyance zone, if applicable, with flood elevations noted.
6. Identification of outlet system.

### 7.1.3 Plan and Profile (Road) Sheets

Plan View

1. Catch basins: line and station number (structure number), grate type and elevation, invert elevation(s).
2. Pipes: length, size, type, slope, pipe number of designation.
3. Headwalls: type, invert elevation.
4. Ditches and swales: number or designation, type, stations.
5. Easements: type, size, existing with deed book and page numbers, proposed.
6. Utilities: existing and proposed (including sanitary sewers).
7. Other drainage structures to be labeled accordingly.

#### 7.1.4 Profile View

1. Storm lines and structures to be shown on road profiles.
2. Utility and sanitary sewer crossings.

#### 7.1.5 Storm Drainage Profiles (pipes, ditches, box culverts)

1. Catch basins: station or number, type, grate type and elevation, invert elevation(s).
2. Pipes: length, size, type, class, grade, line number, headwater elevations for the 100-year storm (determined from inlet and outlet control analysis).
3. Ditches:
  - a. Type
  - b. Grade
  - c. Flow line elevation at grade changes
  - d. Design depth
  - e. Manning's "n"
  - f. Slope
  - g. 10-year velocities
  - h. 100-year velocities
  - i. 100-year discharge depths
4. Headwalls: type and invert elevation.
5. Existing and proposed ground surfaces.

#### 7.1.6 Examples

Refer to Examples #1 -3 in **Appendix A** for additional information.

## 8. SUBMITTALS AND FEES

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Plans shall be submitted twenty (20) working days prior to the scheduled North Vernon Utility Service Board (USB) meeting. In addition to the plans, the design professional shall submit the following:

1. Drainage Plan Review Application.
2. Drainage Plan Review Checklist.
3. Detention Analysis Checklist.

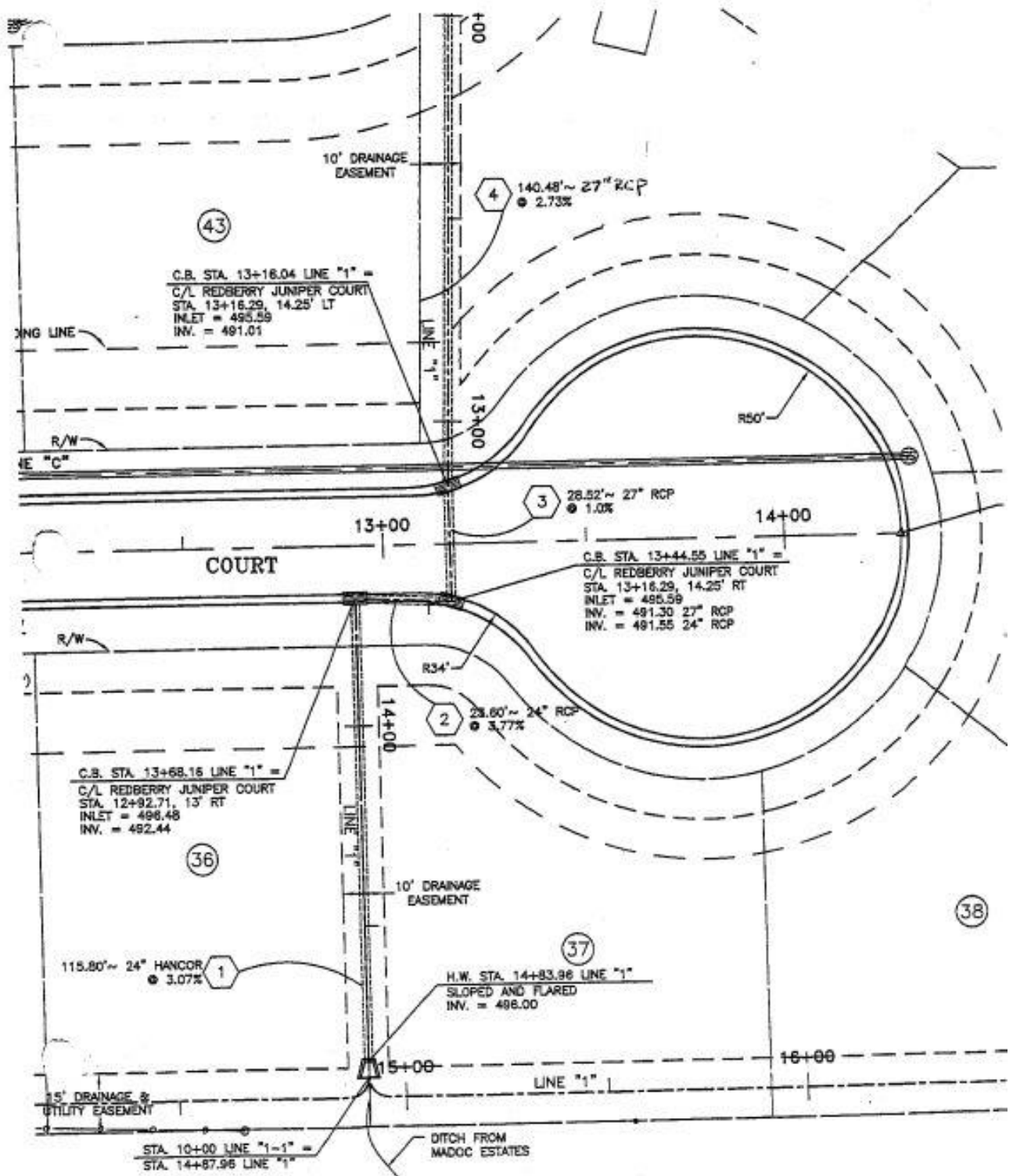
# APPENDIX A: EXAMPLES

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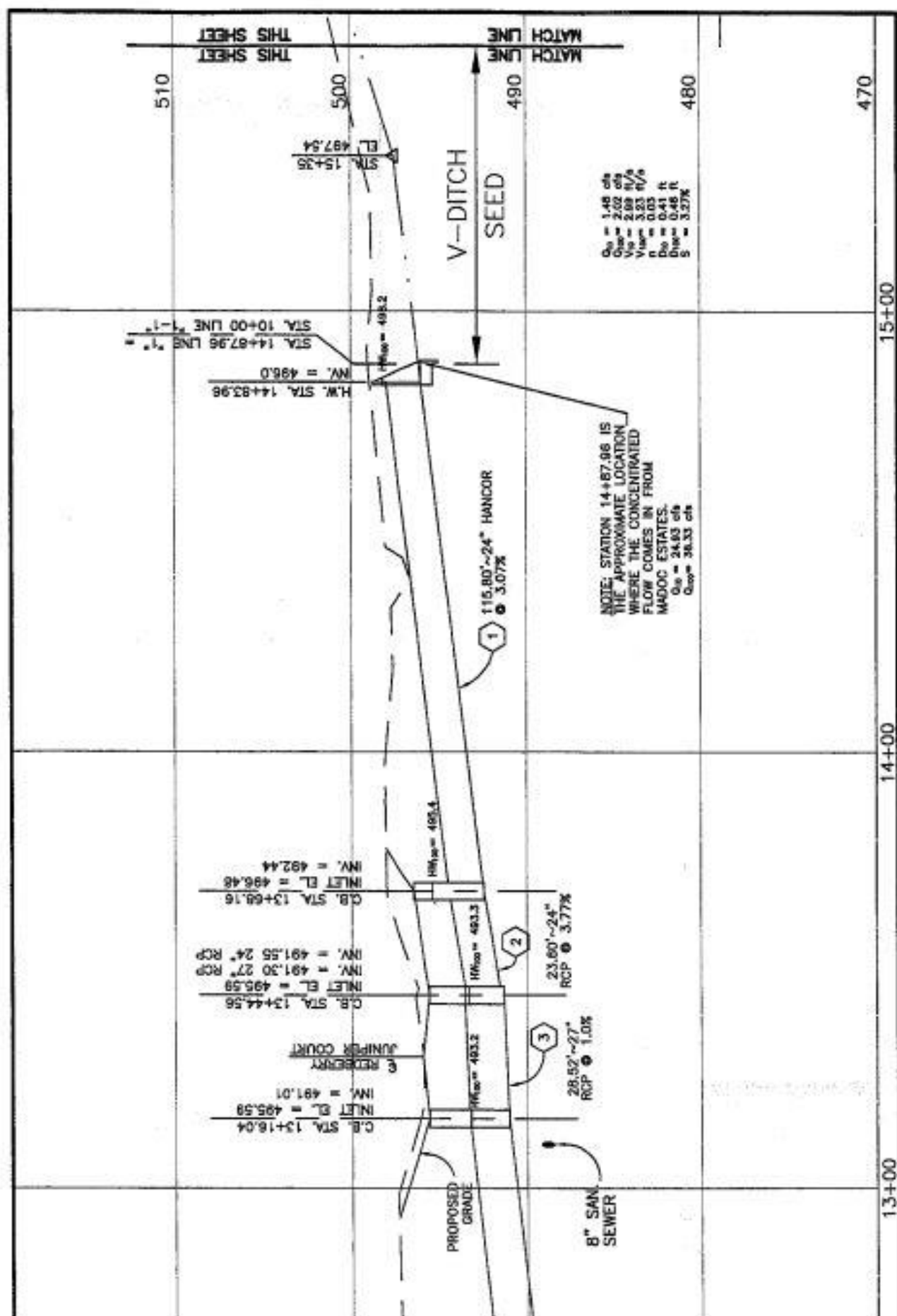




## EXAMPLE #2



# EXAMPLE #3



## APPENDIX B: APPLICATION AND CHECKLISTS

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City of North Vernon  
725 N. Greensburg Street  
North Vernon, IN 47265

## DRAINAGE PLAN REVIEW APPLICATION

### SECTION 1: PROJECT INFORMATION

*To be completed by the applicant*

Project Name: \_\_\_\_\_

Project Address: \_\_\_\_\_

### SECTION 2: CONTACT INFORMATION

Property Owner: \_\_\_\_\_ Contact Person: \_\_\_\_\_  
Address: \_\_\_\_\_  
City: \_\_\_\_\_ State: \_\_\_\_\_ Zip: \_\_\_\_\_ Phone: \_\_\_\_\_

Developer: \_\_\_\_\_ Contact Person: \_\_\_\_\_  
Address: \_\_\_\_\_  
City: \_\_\_\_\_ State: \_\_\_\_\_ Zip: \_\_\_\_\_ Phone: \_\_\_\_\_

Design Firm: \_\_\_\_\_ Contact Person: \_\_\_\_\_  
Address: \_\_\_\_\_  
City: \_\_\_\_\_ State: \_\_\_\_\_ Zip: \_\_\_\_\_ Phone: \_\_\_\_\_

I, \_\_\_\_\_ being the Design Professional (Professional Engineer and/or Professional Land Surveyor  
of \_\_\_\_\_ (name of developmen) shall submit Final Record Drawings including a digital file  
AutoCAD format) within 3 months after the completion of the installation of the drainage infrastructure

Signature: \_\_\_\_\_

Contractor\*: \_\_\_\_\_ Contact Person: \_\_\_\_\_  
Address: \_\_\_\_\_  
City: \_\_\_\_\_ State: \_\_\_\_\_ Zip: \_\_\_\_\_ Phone: \_\_\_\_\_

*\*If the contractor is unknown, leave blank*

#### Utility Board

Date of Meeting \_\_\_\_\_ Approved: \_\_\_\_\_ Denied: \_\_\_\_\_

Signature of Chairperson: \_\_\_\_\_



City of North Vernon  
725 N. Greensburg Street  
North Vernon, IN 47265

## DRAINAGE PLAN REVIEW CHECKLIST

Project Name: \_\_\_\_\_

Developer \_\_\_\_\_

Address \_\_\_\_\_

Date \_\_\_\_\_

*The purpose of this checklist is to expedite and facilitate the review process. This checklist gives the minimum requirements needed for review. All items should be checked or marked N/A. The omission of required items may be cause for rejection of the submittal without review.*

### REQUIRED ITEMS TO BE SHOWN ON THE PLANS

\_\_\_\_\_ Plan Review Application

\_\_\_\_\_ Location Map

\_\_\_\_\_ Registered Professional Stamp and Signature

\_\_\_\_\_ Property Boundaries

\_\_\_\_\_ Offsite Drainage Areas

\_\_\_\_\_ Pipe, Length, Size, Slope, Type, and Number

\_\_\_\_\_ Existing and Proposed Utilities

\_\_\_\_\_ Existing and Proposed Impervious Areas

\_\_\_\_\_ Existing and Proposed Drainage Structures

\_\_\_\_\_ Existing and Proposed Easements

\_\_\_\_\_ Existing and Proposed Structures

\_\_\_\_\_ Erosion and Sediment Controls

\_\_\_\_\_ Standard Underground Utility Notes

\_\_\_\_\_ Existing Sanitary Sewers

\_\_\_\_\_ Proposed Sanitary Sewers Location and Elevation

\_\_\_\_\_ Pipe Chart (refer to example)

\_\_\_\_\_ Total Project Acreage and Number of Lots

\_\_\_\_\_ Existing and Proposed Topography and Countours, including area 25' outside of property

\_\_\_\_\_ Adequate information / details pertaining to storage basin and drainage structures

\_\_\_\_\_ Owner Name / Address

\_\_\_\_\_ Street Name and R/W

\_\_\_\_\_ Adjacent Property Owners

\_\_\_\_\_ Inlet Drainage Areas

\_\_\_\_\_ Inlet Grate / Inlet Elevation

\_\_\_\_\_ Drainage Flow Arrows

\_\_\_\_\_ Pipe Profiles for Through Drainage

\_\_\_\_\_ Channel Profiles for Through Drainage

\_\_\_\_\_ Headwater at Culvert Pipes (100-yr)

\_\_\_\_\_ 100-Year Floodplain Limits

\_\_\_\_\_ North Arrow

\_\_\_\_\_ Scale

\_\_\_\_\_ Legend

\_\_\_\_\_ Plan Date

\_\_\_\_\_ Revision Date

\_\_\_\_\_ Inlet Type

\_\_\_\_\_ Headwall Type

**The Design Professional that stamped and submitted plans must sign the checklist.**

\_\_\_\_\_  
Signature

\_\_\_\_\_  
Date



City of North Vernon  
725 N. Greensburg Street  
North Vernon, IN 47265

## DETENTION ANALYSIS CHECKLIST

Project Name: \_\_\_\_\_

Date \_\_\_\_\_

*The purpose of this checklist is to expedite and facilitate the review process. This checklist gives the minimum requirements needed for review. All items should be checked or marked N/A. The omission of required items may be cause for rejection of the submittal without review.*

\_\_\_\_\_ Table of Contents

\_\_\_\_\_ Explanation of Analysis with Assumptions

\_\_\_\_\_ Analysis of Downstream Capacity Limitations

\_\_\_\_\_ Composite Drainage Area Map(s) - Pre-Development

\_\_\_\_\_ Composite Drainage Area Map(s) - Post-Development

\_\_\_\_\_ Time of Concentration (Tc) Supporting Calculations: Pre-development

\_\_\_\_\_ Time of Concentration (Tc) Supporting Calculations: Post-development

\_\_\_\_\_ Runoff Coefficient or Curve Number Calculations & Map: Pre-development

\_\_\_\_\_ Runoff Coefficient or Curve Number Calculations & Map: Post-development

\_\_\_\_\_ Calculations of 100-year Peak Flow Pre-Development Runoff

\_\_\_\_\_ Calculations of 100-year Peak Flow Post-Development Runoff

\_\_\_\_\_ Calculations of 2, 10 and 100-year By-passing or Unmitigated: Post Development

\_\_\_\_\_ Basin Volume Data (Elevation/Storage)

\_\_\_\_\_ Basin Grading Plan

\_\_\_\_\_ Basin Outlet Structure Data and Construction Details

\_\_\_\_\_ Basin Overflow Component (Positive Through Drainage Outlet)

\_\_\_\_\_ Additional 100-year Analysis Check of Overflow Function (Upstream Developed Condition)

\_\_\_\_\_ Basin Routing Data (Stage, Storage, Peak Elevation, Peak Inflow and Outflow)

\_\_\_\_\_ Combined Hydrographs (2, 10 and 100-year peak flows) Routed and Unmitigated

\_\_\_\_\_ Velocity Dissipation Calculation (Property Line Point Discharge)

\_\_\_\_\_ Complete Summary of Drainage Analysis

*I, the undersigned, acknowledge by signature that these documents meet or exceed the design standards of the Drainage Ordinance of the City of North Vernon and that they were prepared under my supervision. I also acknowledge that to the best of my knowledge and belief, the products resulting from these documents will function as intended.*

\_\_\_\_\_  
Design Professional's Signature

\_\_\_\_\_  
Date