STORMWATER TECHNICAL STANDARDS MANUAL CLARK COUNTY, INDIANA

November 2025

Chapter One

INTRODUCTION AND APPROVAL PROCEDURES

A. INTRODUCTION

This document, the Clark County Stormwater Technical Standards Manual, contains the necessary technical standards for administering the requirements of the Clark County Stormwater Management Ordinance (the "Ordinance"). This document is a companion document to the Ordinance and contains the necessary means and methods for achieving compliance with the Ordinance. This document is guidance to assist plan reviewers, developers, and designers. In case there are conflicts between the requirements contained in this document and the Ordinance, the requirements of the Ordinance shall prevail.

This document is applicable to those portions of Clark County, Indiana, which are, pursuant to the Ordinance, under the regulatory jurisdiction of the Clark County Drainage Board (the "CCDB"), which jurisdiction if hereafter referred to as Clark County.

This document contains formulas and methodologies for the review and design of both stormwater quantity and stormwater quality facilities. Chapters 2 through 6 contain stormwater conveyance and detention design calculations. Chapter 7 contains standards for erosion control and other pollution prevention measures for active construction sites. Chapters 8 through 9 contain standards and calculations methods required to properly size and design stormwater quality features that will treat runoff long-term following construction completion. This includes both Conventional and Low Impact Development (LID) approaches. One of the most recent, comprehensive resources for incorporating LID practices into site development design is "Low Impact Development Manual for Michigan: A Design Guide for Implementers and Reviewers" available online at www.semcog.org/LowImpactDevelopment.aspx. (the "LID Guide") and if such approach is used the design must be in accordance with the standards of the LID Guide and the requirements of the Indiana Department of Environmental Management permit (the "LID Approach"). Chapter 10 contains miscellaneous standards regarding lot grading and building pad elevations, acceptable outlet and the requirements associated with proposed dams or levees. A comprehensive glossary of terms is provided in Appendix A. Appendix B contains several useful and necessary standard forms. Best Management Practices (BMPs) for erosion control measures during the construction phase are contained in Appendix C, and supplemented by the Indiana Storm Water Quality Manual (ISWQM).

Developers, designers, and reviewers should also refer to companion documents the LID Guide and the *Stormwater BMP Operation and Maintenance Manual (BMP O&M Manual)*.

These documents contain non-structural and structural post-construction BMP Fact Sheets as well as Recommended Plant Lists, Recommended Materials, Soil Infiltration Testing Protocol, BMP Maintenance Checklists, and Maintenance Agreement for post-construction BMPs. These documents are referenced throughout Chapter 8.

B. DRAINAGE EASEMENT REQUIREMENTS

All new public or through drainage facilities shall be placed in Drainage Easements (DE's) and shall be designated on the record plat as DE's, or within a separate recorded easement document. There shall be no trees or shrubs planted in, nor any structures or fences erected in, nor any other obstruction allowed within any DE that would diminish the capacity of the DE, without appropriate approval from the CCDB. The following DE's shall be provided for the noted stormwater facilities:

1. Storm Sewers:

Depth of Storm Pipe from Finish Grade to Crown	Diameter of Storm Pipe	Minimum Easement Width
3 Feet or Less	24 Inches or Less	15 feet
Greater than 3 Feet	24 Inches or Less	20 feet
3 Feet or Less	Greater than 24 Inches	20 feet
Greater than 3 Feet	Greater than 24 Inches	20 feet

Easement width requirements may be modified by the CCDB based on individual site conditions.

2. A DE must encapsulate a 100 year flood event.

3. 100-year emergency overflow paths and emergency overflow routes associated with detention ponds shall be provided within a DE.

4. A minimum of 10 feet beyond the actual footprint (top of the bank) of stormwater detention facilities shall be designated as a DE. A minimum 15-foot wide DE shall also be required as access easement, unless the detention facility is immediately next to a public right-of-way.

5. If Clark County accepts the stormwater improvements into its system, the following statement shall become part of the Restrictive Covenants of every platted subdivision and shown on recorded plat: "*storm sewers and tile drains 12-inch or larger within designated drain easements are extensions of the Clark County stormwater drainage system and are the responsibility of Clark County. Drainage swales, detention and retention ponds, and post-construction stormwater quality measures shall be the responsibility of the* *owner or homeowner association. In the event the owner or the homeowner association fails to exercise its obligation, the CCDB may perform the required maintenance and shall have the right to assess each lot in the subdivision a proportionate amount of the associated costs. If necessary, a Notice of Lien shall be filed against the affected lots. The lien shall be enforced in the same manner as a mortgage lien under Indiana law and, therefore, shall include reimbursement of attorney's fees, title expenses, interest, and costs of collection."*

Chapter Two

METHODOLOGY FOR DETERMINATION OF RUNOFF RATES

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

A. Development Sites Less than or Equal to 5 Acres in Size, With a Contributing Drainage Area Less than or Equal to 25 Acres and No Depressional Storage

The Rational Method may be used. A computer model, such as TR-55 (NRCS), TR-20 (NRCS), HEC-HMS (COE), and HEC-1 (COE), that can generate hydrographs based on the NRCS TR-55 Time-of-Concentration (T_c) and Curve Number (CN) calculation methodologies may also be used along with a 24-hour duration NRCS Type 2 storm.

> **LID Exception:** If the LID Approach is pursued, the post-developed CN for the protected undisturbed or restored disturbed areas may be determined based on pre-development underlying soil layer.

In the Rational Method, the peak rate of runoff, Q, in cubic feet per second (cfs) is computed as:

$$Q = CIA$$

Where: C = Runoff coefficient, representing the characteristics of the drainage area and defined as the ratio of runoff to rainfall.

I = Average intensity of rainfall in inches per hour for a duration equal to the time of concentration (t_c) for a selected rainfall frequency.

A = Tributary drainage area in acres.

Values for the runoff coefficient "C" are provided in **Tables 2-1** and shows values for different types of surfaces 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.

Rainfall intensity shall be determined from the rainfall frequency data provided by **NOAA, National Weather Service**, "Precipitation-Frequency Atlas of the United States", NOAA Atlas 14, Volume 2, Version 3, rev 2006, or subsequent revisions, for central Clark County, Indiana.

In general, the T_c methodology to be used for all stormwater management projects within Clark County shall be as outlined in the U.S. Department of Agriculture (USDA) - NRCS TR-55 Manual. In urban or developed areas, the methodology to be used shall be the sum of the inlet time and flow time in the stormwater 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's Equation (see Chapter 4). 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.

TABLE 2-1

RUNOFF COEFFICIENTS BASED ON LAND USE, SOIL GROUP, SLOPE RANGE AND RETURN PERIOD

LAND USE		A			B			C			D		
		0-2	2-7	7+	2-0	2-7	7+	0-2	2-7	7+	0-2	2-7	7+
Urban/Surban													
Residential	%Imp												
1/8	65	.58	.59	.61[1]	.59	.61	.63	.60	.62	.64	.62	.63	.66
Acre Lots		.63	.65	.67[2]	.65	.66	.69	.66	.67	.70	.67	.69	.72
		.65	.67	.69[3]	.66	.68	.71	.68	.70	.73	.69	.71	.75
1/4	38	.37	.40	.43	.39	.42	.45	.41	.44	.48	.43	.46	.51
Acre Lots		.40	.43	.47	.43	.46	.50	.45	.48	.53	.48	.50	.56
		.42	.45	.49	.44	.48	.52	.47	.50	.56	.50	.53	.59
1/3	30	.30	.34	.37	.33	.36	.40	.35	.39	.44	.38	.41	.47
Acre Lots		.34	.37	.41	.36	.40	.45	.39	.42	.48	.42	.45	.51
		.35	.39	.43	.38	.42	.47	.41	.45	.51	.44	.47	.54
1/2	25	.27	.30	.34	.30	.33	.37	.32	.36	.41	.35	.38	.44
Acre Lots		.29	.33	.38	.32	.36	.41	.35	.38	.44	.38	.41	.48
		.31	.35	.39	.33	.38	.43	.37	.41	.48	.40	.44	.52
1	20	.23	.27	.31	.26	.29	.34	.28	.32	.38	.31	.35	.41
Acre Lots		.25	.29	.34	.28	.32	.38	.31	.35	.41	.35	.38	.45
		.26	.31	.36	.29	.34	.40	.33	.37	.45	.37	.41	.49
Apartments	75	.66	.67	.68	.67	.68	.69	.67	.69	.70	.68	.69	.71
		.72	.73	.75	.73	.74	.76	.74	.75	.77	.75	.76	.78
		.73	.75	.77	.75	.76	.78	.76	.77	.79	.77	.78	.80
Commercial,	85	.73	.74	.75	.74	.75	.75	.74	.75	.76	.75	.76	.77
Business		.80	.81	.82	.81	.82	.83	.81	.82	.83	.82	.83	.84
		.82	.83	.84	.83	.84	.85	.83	.84	.86	.84	.85	.86
Industrial	72	.63	.65	.66	.64	.65	.67	.65	.67	.68	.66	.67	.70
		.69	.71	.72	.70	.72	.74	.71	.73	.75	.73	.74	.76
		.71	.73	.74	.72	.74	.76	.73	.75	.77	.75	.76	.79
Roofs,	100	.85	.85	.85	.85	.85	.85	.85	.85	.85	.85	.85	.85
Driveways,		.93	.93	.93	.93	.93	.93	.93	.93	.93	.93	.93	.93
Streets, etc.		.95	.95	.95	.95	.95	.95	.95	.95	.95	.95	.95	.95
Open Spaces,	0	.07	.12	.17	.11	.15	.21	.14	.19	.26	.18	.22	.30
Lawns, Parks		.08	.13	.19	.12	.17	.24	.16	.20	.28	.20	.24	.33
Etc.		.09	.15	.21	.13	.19	.26	.18	.23	.32	.22	.27	.37

RUNOFF COEFFICIENTS BASED ON LAND USE, SOIL GROUP, SLOPE RANGE AND RETURN PERIOD

LAND USE	A			B			C			D		
	0-2	2-7	7+	2-0	2-7	7+	0-2	2-7	7+	0-2	2-7	7+
Agricultural												
Cultivated	.08	.13	.16	.11	.15	.21	.14	.19	.26	.18	.23	.31
	.11	.15	.19	.13	.18	.24	.17	.22	.30	.21	.26	.36
	.14	.18	.22	.16	.21	.28	.20	.25	.34	.24	.29	.41
Pasture	.12	.20	.30	.18	.28	.37	.24	.34	.44	.30	.40	.50
	.13	.22	.33	.20	.31	.41	.27	.38	.48	.33	.44	.55
	.15	.25	.37	.23	.34	.45	.30	.42	.52	.37	.50	.62
Meadow	.10	.16	.25	.14	.22	.30	.20	.28	.36	.24	.30	.40
	.12	.19	.27	.17	.25	.33	.23	.31	.40	.27	.35	.45
	.14	.22	.30	.20	.28	.37	.26	.35	.44	.30	.40	.50
Forest	.05	.08	.11	.08	.11	.14	.10	.13	.16	.12	.16	.20
	.06	.09	.12	.09	.12	.16	.11	.14	.18	.13	.18	.22
	.08	.11	.14	.10	.14	.18	.12	.16	.20	.15	.20	.25

1 Runoff coefficients for 10 year return period
2 Runoff coefficients for 25 year return period
3 Runoff coefficients for 100 year return period

Notes:

1. Where the imperviousness is significantly different from the assumed values, a weighted coefficient should be computed using the actual percent impervious.

2. Consideration should be given to whether the soil group has been changed due to soil compaction by heavy equipment or mixing of the surface and subsurface soils.

B. Development Sites Greater Than 5 Acres in Size or Contributing Drainage Area Greater than 25 Acres or With Significant Depressional Storage

The runoff rate for these development sites and contributing drainage areas shall be determined by a computer model that can generate hydrographs based on the NRCS TR-55 Time-of-Concentration (T_c) and Curve Number (CN) calculation methodologies.

> **LID Exception:** If the LID Approach is pursued, the post-developed CN for the protected undisturbed or restored disturbed areas may be determined based on pre-development underlying soil layer.

The 24-hour NRCS Type 2 Rainfall Distribution shall be utilized for runoff calculations. 24-hour Rainfall depth for various frequencies shall be taken from **NOAA, National Weather Service**, "Precipitation-Frequency Atlas of the United States", NOAA Atlas 14, Volume 2, Version 3, rev 2006, or subsequent revisions, for central Clark County, Indiana. The NRCS Type 2 distribution ordinates are found in **Table 2-6**. Examples of computer models that can generate such hydrographs include TR-55 (NRCS), TR-20 (NRCS), HEC-HMS (COE), and HEC-1 (COE). These programs may be downloaded free of charge from the associated agencies' web sites. Other models may be acceptable but the use of other models should be approved by the CCDB prior to their utilization.

TABLE 2-6

NRCS Type II Rainfall Distribution Ordinates					
Cumulative Storm Time (hr)	*Cumulative Percent of Storm Depth*	*Cumulative Storm Time (hr)*	*Cumulative Percent of Storm Depth*	*Cumulative Storm Time (hr)*	*Cumulative Percent of Storm Depth*
0.00	0	8.25	12.6	16.50	89.3
0.25	0.2	8.50	13.3	16.75	89.8
0.50	0.5	8.75	14	17.00	90.3
0.75	0.8	9.00	14.7	17.25	90.8
1.00	1.1	9.25	15.5	17.50	91.3
1.25	1.4	9.50	16.3	17.75	91.8
1.50	1.7	9.75	17.2	18.00	92.2
1.75	2	10.00	18.1	18.25	92.6
2.00	2.3	10.25	19.1	18.50	93
2.25	2.6	10.50	20.3	18.75	93.4
2.50	2.9	10.75	21.8	19.00	93.8
2.75	3.2	11.00	23.6	19.25	94.2
3.00	3.5	11.25	25.7	19.50	94.6
3.25	3.8	11.50	28.3	19.75	95
3.50	4.1	11.75	38.7	20.00	95.3
3.75	4.4	12.00	66.3	20.25	95.6
4.00	4.8	12.25	70.7	20.50	95.9
4.25	5.2	12.50	73.5	20.75	96.2
4.50	5.6	12.75	75.8	21.00	96.5
4.75	6	13.00	77.6	21.25	96.8
5.00	6.4	13.25	79.1	21.50	97.1
5.25	6.8	13.50	80.4	21.75	97.4
5.50	7.2	13.75	81.5	22.00	97.7
5.75	7.6	14.00	82.5	22.25	98
6.00	8	14.25	83.4	22.50	98.3
6.25	8.5	14.50	84.2	22.75	98.6
6.50	9	14.75	84.9	23.00	98.9
6.75	9.5	15.00	85.6	23.25	99.2
7.00	10	15.25	86.3	23.50	99.5
7.25	10.5	15.50	86.9	23.75	99.8
7.50	11	15.75	87.5	24.00	100
7.75	11.5	16.00	88.1		
8.00	12	16.25	88.7		

Source: National Resources Conservation Service (NRCS), "TR-20 Computer Program for Project Formulation Hydrology", page F9, May 1982.

NOTE: For use only when SCS Type II rainfall distribution is not a default option in the computer program.

C. Development Sites with Drainage Areas Greater than or Equal to One Square Mile

For the design of any major drainage system, as defined in **Appendix A**, the discharge must be obtained from, or be accepted by, the IDNR. Other portions of the site must use the discharge methodology in the applicable section of this Article.

Chapter Three

METHODOLOGY FOR DETERMINATION OF DETENTION STORAGE VOLUMES

The required volume of stormwater storage for all development sites shall be computed using a computer model that can generate hydrographs based on the NRCS TR-55 time of concentration and curve number calculation methodologies. Examples of computer models that can generate such hydrographs include TR-55 (NRCS), TR-20 (NRCS), HEC-HMS (COE), and HEC-1 (COE). Other models may be acceptable and should be reviewed and approved by the City prior to their utilization.

A. Post-Development Hydrologic Parameters

The Rational Method may be used. A computer model, such as TR-55 (NRCS), TR-20 (NRCS), HEC-HMS (COE), and HEC-1 (COE), that can generate hydrographs based on the NRCS TR-55 Time-of-Concentration (T_c) and Curve Number (CN) calculation methodologies may also be used along with a 24-hour duration NRCS Type 2 storm.

> **LID Exception:** If the LID Approach is pursued, the post-developed CN for the protected undisturbed or restored disturbed areas may be determined based on pre-development underlying soil layer.

B. Design Storm & Allowable Release Rates for Development Sites with On-site Detention Facilities

The 24-hour NRCS Type 2 Rainfall Distribution shall be utilized to determine the required storage volume. The allowable release rates shall be determined based on methodologies provided in Chapter 6 of this Technical Standards document.

Chapter Four

STORM SEWER DESIGN STANDARDS AND SPECIFICATIONS

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. Design Storm Frequencies

1. All storm sewers, inlets, catch basins, and street gutters shall accommodate (subject to the "allowable spread" provisions discussed later in this Section), at a minimum, peak runoff from a 10-year return frequency storm calculated based on methodology described in Chapter 2 and designed such that the 100 year hydraulic grade line does not exceed rim elevation of any structure. Additional discharges to storm sewer systems allowed in Section L below of this Section must be considered in all design calculations. For Rational Method analysis, the duration shall be equal to the time of concentration for the drainage area. In computer based analysis, the duration is as noted in the applicable methodology associated with the computer program.

2. Culvert capacities for conveyance under roadways shall be as follows:

Local	25-year Frequency Storm Discharge
Collector	50-year Frequency Storm Discharge
Arterial	100-year Frequency Storm Discharge

   The discharges should represent runoff from off-site areas under existing condition and on-site areas under post-developed conditions. Driveway culvert capacities shall be capacities required for the street classification to which the driveway connects. Greater culvert capacity shall be required to protect the finished floor elevation of buildings from the post-developed 100-year frequency storm when, in the opinion of the design engineer or the CCDB, the finished floor elevation is threatened. If the street or road provides the only access to or from any portion of any commercial or residential development, the crossing shall be designed for a minimum of 100-year frequency storm.

3. For portions of the system considered minor drainage systems, 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 lanes (such as a subdivision cul-de-sac) can have a water spread equal to one-half of their total width.

4. To ensure access to buildings and allow the use of the roadway by emergency vehicles during storms larger than the design storm, an overflow channel/swale between sag inlets and overflow paths or basin shall be provided at sag inlets so that the maximum depth of water that might be ponded in the street sag shall not exceed 7 inches measured from elevation of gutter. All water shall be contained in the right-of-way for a 100-year storm.

5. Facilities functioning as a major drainage system as defined in **Appendix A** must also meet IDNR design standards in addition to the standards of the CCDB. In case of discrepancy, the most restrictive requirements shall apply.

B. Manning's Equation

Determination of hydraulic capacity for storm sewers sized by the

Rational Method analysis must be done using Manning's Equation. where:

$$V = (1.486/n)(R^{2/3})(S^{1/2})$$

Then:

$$Q=(V)(A)$$

Where:

Q = capacity in cubic feet per second

V = mean velocity of flow in feet per second

A = cross sectional area in square feet

R = hydraulic radius in feet

S = slope of the energy grade line in feet per foot

n = Manning's "n" or roughness coefficient

The hydraulic radius, R, is defined as the cross sectional area of flow divided by the wetted flow surface or wetted perimeter. Allowable "n" values and maximum permissible velocities for storm sewer materials are listed in **Table 4-1**.

TABLE 4-1

Typical Values of Manning's "n"		
Material	*Manning's "n"*	*Maximum Velocities (feet/second)*
◆ **Closed Conduits**		
Concrete	0.013	10
Vitrified Clay	0.013	10
HDPE	0.012	10
PVC	0.011	10
◆ **Circular CMP, Annular Corrugations, 2 2/3 x ½ inch**		
Unpaved	0.024	7
25% Paved	0.021	7
50% Paved	0.018	7
100% Paved	0.013	7
Concrete Culverts	0.013	10
HDPE or PVC	0.012	10
◆ **Open Channels**		
Concrete, Trowel Finish	0.013	10
Concrete, Broom Finish	0.015	10
Gunite	0.018	10
Riprap Placed	0.030	10
Riprap Dumped	0.035	10
Gabion	0.028	10
New Earth **(1)**	0.025	4
Existing Earth **(2)**	0.030	4
Dense Growth of Weeds	0.040	4
Dense Weeds and Brush	0.040	4
Swale with Grass	0.035	4

Source of manning "n" values: HERPICC Stormwater Drainage Manual, July 1995.

(1) New earth (uniform, sodded, clay soil)
(2) Existing earth (fairly uniform, with some weeds).

C. Backwater Method for Pipe System Analysis

For hydraulic analysis of existing or proposed storm drains which possess submerged outfalls, a more sophisticated design/analysis methodology than Manning's equation will be required. The backwater analysis method provides a more accurate estimate of pipe flow by calculating individual head losses in pipe systems that are surcharged and/or have submerged outlets. These head losses are added to a known downstream water surface elevation to give a design water surface elevation for a given flow at the desired upstream location. Total head losses may be determined as follows:

Total head loss = frictional loss + manhole loss + velocity head loss + junction loss

Various computer modeling programs such as HYDRA, ILLUDRAIN, and STORMCAD are available for analysis of storm drains under these conditions. Computer models to be utilized, other than those listed, must be accepted by the CCDB prior to their use.

D. Minimum Size for Storm Sewers

The minimum diameter of all storm sewers shall be 12 inches. When the minimum 12-inch diameter pipe will not limit the rate of release to the required amount, the rate of release for detention storage shall be controlled by an orifice plate or other device, or reduced pipe size acceptable to the CCDB.

E. Pipe Cover, Grade, and Separation from Sanitary Sewers

Pipe grade shall be such that, in general, a minimum of 1.5 feet of cover is maintained over the top of the pipe. 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 between 2.0 and 15 feet per second, respectively, when the sewer is flowing full. Maximum permissible velocities for various storm sewer materials are listed in **Table 4-1**.

F. Alignment

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

G. Manholes/Inlets

All castings (Inlets and Manholes) must be identified with an appropriate "clean water" message. Manholes and/or inlets shall be installed to provide human access to continuous underground storm sewers for the purpose of inspection and maintenance. The casting access minimum inside diameter shall be no less than 22 inches or a rectangular opening of no less than 22 inches by 22 inches. Steps shall be provided in structures deeper than 4 feet, with the first step at the depth of 2 feet and the following steps spaced every 1 foot until the bottom is reached. When grade adjustments of manholes and inlets are required in the field to meet finish design or existing curb grade, adjustment rings with a maximum height of 12 inches may be used. Manholes shall be provided at the following locations:

1. Where two or more storm sewers converge.
2. Where pipe size or the pipe material changes.
3. Where a change in horizontal alignment occurs.
4. Where a change in pipe slope occurs.
5. At intervals in straight sections of sewer, not to exceed the maximum allowed. The maximum distance between storm sewer manholes shall be as shown in **Table 4-2**.

TABLE 4-2

Maximum Distance Between Manholes or Inlets	
Size of Pipe (Inches)	**Maximum Distance (Feet)**
12 through 42	400
48 and larger	600

When changing pipe size, match crowns of pipes, unless detailed modeling of hydraulic grade line shows that another arrangement would be as effective. Pipe slope should not be so steep that inlets surcharge, i.e., hydraulic grade line should remain below rim elevation for storm event discharges up to and including the 100-year storm event.

All connections to storm sewer structures shall be core-drilled and properly sealed. No direct connections or "blind taps" shall be made to storm pipes.

Manhole/inlet inside sizing shall be as shown in **Table 4-3**.

TABLE 4-3

Manhole/Inlet Inside Sizing		
Depth of Structure	**Minimum Diameter**	**Minimum Square Opening**
Less than 5 feet	36 inches	36" x 36"
5 feet or more	48 inches	48" x 48"

H. Inlet Sizing and Spacing

Inlets or drainage structures shall be utilized to collect surface water through grated openings and convey it to storm sewers, channels, or culverts. The inlet grate opening provided shall be adequate to pass the design 10-year flow with 50% of the sag inlet areas clogged. Inlets shall be provided so that surface water is not carried across or around any intersection nor for a distance greater than four-hundred (400) feet on local streets and three-hundred feet on collector streets. An overflow channel from sag inlets to the overflow channel or basin shall be provided at sag inlets. Inlet design and spacing may be done using the hydraulic equations by manufacturers or orifice/weir equations. Use of the U.S. Army Corps of Engineers HEC-12 computer program is also an acceptable method. Gutter spread on continuous grades may be determined using the Manning's equation. Further guidance regarding gutter spread calculation may be found in the latest edition of the Indiana LTAP Stormwater Drainage Manual, available from the Local Technical Assistance Program (LTAP). At the time of printing of this document, contact information for LTAP was:

Indiana LTAP
Purdue University
Toll-Free: (800) 428-7369 (Indiana only)
Phone: (765) 494-2164
Fax: (765) 496-1176
Email: inltap@ecn.purdue.edu
Website: www.purdue.edu/INLTAP

I. Installation and Workmanship

The point of commencement for laying a storm sewer pipe shall be the lowest point in the proposed sewer line. All pipes shall be laid, without break, upgrade from structure to structure. All storm sewer pipe outlets shall have poured in place toe-walls with anchor bolts. The specifications for the construction of storm sewers and sub-drains, including backfill requirements, shall not be less stringent than those set forth in the latest edition of the INDOT, "Standard Specifications".

J. Materials

Storm sewer manholes and inlets shall be constructed of cast in place concrete or pre-cast reinforced concrete. All subsurface drains, including swale underdrains, curb underdrains, etc. shall be smooth double-wall pipe. Material and construction shall conform to the latest edition of the Indiana Department of Transportation (INDOT) "Standard Specifications", Sections 702 and 720.

Pipe and fittings used in storm sewer construction shall be concrete pipe (AASHTO M170). Other pipe and fittings not specified herein or in Sections 907-908 of the latest edition of the INDOT “Standard Specifications” may be used only when specifically authorized by theCCDB. Pipe joints shall be flexible and watertight and shall conform to the requirements of Section 906, of the latest edition of the INDOT "Standard Specifications".

K. Special Hydraulic Structures

Special hydraulic structures required to control the flow of water in storm runoff drainage systems include junction chambers, drop manholes, 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. Certification of special structures by a certified Structural Engineer may also be required.

L. Drainage System Overflow Design

Overflow path/ponding areas throughout the development resulting from a 100-year storm event, calculated based on all contributing drainage areas, on-site and off-site, in their proposed or reasonably anticipated land use and with storm pipe system assumed completely plugged, shall be determined. The centerline of this 100-year overflow path shall be clearly shown as a distinctive line symbol on the plans, and a width such that the 100 year hydraulic grade line does not exceed rim elevation designated as permanent DE. A continuous flood route from the sag inlets to the final outfall shall be shown and the minimum 30-feet along the centerline contained within an easement or road right-of-way regardless of the 100-year storm event ponding elevation. There shall be no trees or shrubs planted, nor any structures or fences erected within the easement areas.

These areas are easements that are to be maintained by the property owners or be designated as common areas to be maintained by the homeowners' association. The Lowest Adjacent Grade (LAG) for all residential, commercial, or industrial buildings shall be set a minimum of 1 foot (rather than normal 2 feet, as the storm drains are assumed plugged as an additional safety factor) above the noted overflow path/ponding elevation.

All buildings shall have a minimum flood protection grade shown on the secondary plat. Minimum Flood Protection Grade of all structures fronting a pond or open ditch shall be no less than 2 feet (1 foot for the 100-year overflow path as the storm drains are assumed plugged as an additional safety factor) above any adjacent 100-year local or regional flood elevations, whichever is greater, for all windows, doors, attached garage entrances, unsealed pipe entrances, window well rim elevations, and any other structure member where floodwaters can enter a building.

The overflow path/ponding may be modeled as successive series of natural ponds and open channel segments. Ponds should be modeled similar to that discussed for modeling depressional areas in Chapter 6. Channels should be modeled according to modeling techniques discussed in Chapter 5. The calculations for determining the 100-year overflow path/ponding elevations may be based on hand calculation methods utilizing normal depth calculations and storage routing techniques or performed by computer models. Examples of computer models that either individually or in combination with other models can handle the required computations include TR-20, HEC-HMS, and HEC-1, combined with HEC-RAS. Other models may be acceptable but should be approved by the CCDB **prior** to theiruse.

Values in Table 4-4 may be used as an alternative to the above-noted detailed calculations for determining the required LAG or pad elevations of buildings near an overflow path.

TABLE 4-4

Minimum Building LAG/Pad Elevations With Respect to Overflow Path Invert Elevations		
Drainage Area (acres)	**Building LAG/Pad Elevation Above Overflow Path Invert (ft.)**	**Building LAG/Pad Elevation Above Overflow Path Invert, if Overflow Path is in the Street (ft.)**
Up to 5	2.50	1.50
6-10	3.00	1.50
11-15	3.25	1.75
16-20	3.50	1.75
21-30	4.00	2.00
30-50	4.25	2.00

If Table 4-4 is used, the designer shall indicate such on the plans and the CCDB reserves the right to require independent calculations to verify that the proposed building pads/building LAGs provide adequate freeboard above the anticipated overflow path/ponding elevations.

The LAG requirements for buildings adjacent to other flooding sources are discussed elsewhere in the Ordinance or in this Manual. In case there are more than one flooding sources applicable to a building site, the highest calculated LAG for the building shall govern the placement of the building on that site.

In the case of existing upstream detention, an allowance equivalent to the reduction in flow rate provided may be made for upstream detention only when: (1) such detention and release rate have previously been accepted by the CCDB or the official charged with the approval authority at the time of the acceptance, and (2) evidence of its construction and maintenance can be shown.

Chapter Five

OPEN CHANNEL DESIGN STANDARDS AND SPECIFICATIONS

All 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. Design Storm Frequencies

1. All channels and swales shall accommodate, as a minimum, peak runoff from a 24-hour, 10-year return frequency storm calculated based on methodology described in Chapter 2, provided, however, that the 100 year flow spread must be within the DE. For Rational Method analysis, the storm duration shall be equal to the time of concentration for the drainage area. In computer-based analysis, the duration is as noted in the applicable methodology associated with the computer program.

2. Channel facilities functioning as a major drainage system, as defined in **Appendix A**, must also meet IDNR design standards in addition to the standards of the CCDB. In case of discrepancy, the most restrictive requirements shall apply.

3. Regardless of minimum design frequencies stated above, the performance of all parts of drainage system shall be checked for the 100-year flow conditions to insure that all buildings are properly located outside the 100-year flood boundary and that flow paths are confined to designated areas with sufficient easement.

B. Manning's Equation

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

$$A = Q/V$$

A = Waterway area of channel in square feet

Q = Discharge in cubic feet per second (cfs)

V = Steady-State channel velocity, as defined by Manning's Equation (See Chapter 4)

C. Backwater Method for Drainage System Analysis

The determination of 100-year water surface elevation along channels and swales shall be based on accepted methodology and computer programs designed for this purpose. Computer programs HEC-RAS, HEC-2, and ICPR are preferred programs for conducting such backwater analysis. The use of other computer models must be approved in advance by the CCDB.

D. Channel Cross-Section and Grade

1. The required channel cross-section and grade are determined by the design capacity, the material in which the channel is to be constructed, and the requirements for maintenance. A minimum depth may be required to provide adequate outlets for subsurface drains, tributary ditches, or streams. The channel grade shall be such that the velocity in the channel is high enough to prevent siltation but low enough to prevent erosion. Velocities less than 2 feet per second are not acceptable, as siltation will take place and ultimately reduce the channel cross-section area. The maximum permissible velocities shall not exceed the designed channel lining. In addition to existing runoff, the channel design should incorporate increased runoff due to the proposed development.

2. Where depth of design flow is slightly below critical depth, channels shall have freeboard adequate to cope with the effect of hydraulic jumps.

3 Along the streets and roads, the bottom of the ditch should be low enough to install adequately sized driveway culverts without creating "speed bumps". The driveway culvert inverts shall be designed to adequately consider upstream and downstream culvert elevations.

E. Side Slopes

1. Earthen channel and swale side slopes shall be no steeper than 3 horizontal to 1 vertical (3:1).

2. Where channels will be lined with riprap, concrete, or other acceptable lining method, side slopes shall be no steeper than 2 horizontal to 1 vertical (2:1) with adequate provisions made for weep holes, if necessary.

3. Side slopes steeper than 2 horizontal to 1 vertical (2:1) may be used for lined channels provided that the side lining is designed and constructed as a structural retaining wall with provisions for live and dead load surcharge.

4. When the design discharge produces a depth of greater than three (3) feet in the channel, appropriate safety precautions shall be added to the design criteria based on reasonably anticipated safety needs.

F. Channel Stability

1. Characteristics of a stable channel are:

   a] It neither promotes sedimentation nor degrades the channel bottom and sides.

   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, 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 new and aged condition and the velocity shall be based on the 100 year frequency storm using an "n" value for various channel linings as shown in **Tables 4-1**.

G. Drainage Swales

Minimum longitudinal swale slopes are 0.5%. Minimum swale width shall be 6 feet. All flow shall be confined to the specific easements associated with each rear and side lot swale that are part of the minor drainage system. If the swale longitudinal slope is less than 1%, a paved concrete swale as approved by the CCDB shall be required.

H. Deposition of Spoil

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

1. Minimize overbank wash.

2. Provide for the free flow of water between the channel and floodplain boundary unless the valley routing and water surface profiles 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 accepted by the IDNR, IDEM, and COE, if applicable.

I. Materials

Materials acceptable for use as channel lining are:

1. Grass
2. Revetment Riprap
3. Concrete
4. Hand Laid Riprap
5. Precast Cement Concrete Riprap
6. Gabions
7. Straw or Coconut Mattings (only until grass is established)

Other lining materials must be approved in writing by the CCDB. Materials shall comply with the latest edition of the INDOT, "Standard Specifications".

J. Drainage System Overflow Design

See Chapter 4, Section L.