CITY OF LAFAYETTE
STORMWATER TECHNICAL STANDARDS MANUAL

ADOPTED DECEMBER, 2011

TABLE OF CONTENTS

Chapter	*Title*
1	INTRODUCTION
2	METHODOLOGY FOR DETERMINATION OF RUNOFF RATES
3	METHODOLOGY FOR DETERMINATION OF DETENTION STORAGE VOLUMES
4	STORM SEWER DESIGN STANDARDS AND SPECIFICATIONS
5	OPEN CHANNEL DESIGN STANDARDS AND SPECIFICATIONS
6	STORMWATER DETENTION DESIGN STANDARDS
7	EROSION CONTROL PRACTICES AND CONSTRUCTION PHASE BMPS
8	POST-CONSTRUCTION STORMWATER QUALITY BMPS
9	METHODOLOGY FOR DETERMINATION OF REQUIRED SIZING OF BMPS
10	MISCELLANEOUS REQUIREMENTS

APPENDIX A: ABBREVIATIONS AND DEFINITIONS
APPENDIX B: STANDARD FORMS
APPENDIX C: CONSTRUCTION BMP FACT SHEETS
APPENDIX D: POST-CONSTRUCTION BMP MANUAL (BOUND SEPARATELY)

Chapter One

INTRODUCTION

This document, the City of Lafayette Stormwater Technical Standards Manual, prepared by Christopher B. Burke Engineering, Ltd. for the City of Lafayette, contains the necessary technical standards for administering the requirements of 327 IAC 15-13 and the City of Lafayette Stormwater Code. This document should be considered as a companion document to the Code. Whereas the Code contains the majority of the regulatory authority and general requirements of comprehensive stormwater management, this document contains the necessary means and methods for achieving compliance with the Code. It is not intended as a regulatory document, but rather guidance to assist plan reviewers, developers, and designers. In case there are conflicts between the requirements contained in this document and the Code, the requirements of the Code should prevail.

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 calculations and requirements. Chapter 7 contains information on erosion control requirements and other pollution prevention measures for active construction sites. Chapters 8 and 9 cover calculations 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. 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. It is the intent of the City of Lafayette that material presented in Appendix C will be revised or eliminated once the Indiana Storm Water Quality Manual (ISWQM) is updated to include details regarding the BMPs currently included in Appendix C. Appendix D contains 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 a Maintenance Agreement for post-construction BMPs.

The site designer is encouraged to review the LID discussion in Chapter 8 prior to the site design to take advantage of runoff reduction recognitions provided towards water quantity calculations if LID practices are utilized as part of the site design.

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 50 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 and curve number calculation methodologies may also be used with the duration storm that produces the highest peak runoff rate. Note that for the purpose of determining the post-developed conditions curve numbers, due to significant disturbance to the upper soil layers during the construction activities, the initially determined hydrologic soil group for disturbed areas should be changed to the next less infiltrating capacity category (i.e., A to B, B to C, and C to D).

> **LID Exception:** If Low Impact Development (LID) approach is pursued in satisfying the requirements noted in Chapter 8 (Post-Construction Water Quality BMPs), the post-developed CN for the protected undisturbed or restored disturbed areas meeting the requirements described in Chapter 8 and BMP fact sheets 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 **2-2**, which show 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. **Table 2-3** provides runoff coefficients and inlet times for different land use classifications.

Rainfall intensity shall be determined from the rainfall frequency data shown in **Table 2-4**.

In general, the time of concentration (t_c) methodology to be used for all stormwater management projects within City of Lafayette 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
Urban Runoff Coefficients

Type of Surface	*Runoff Coefficient "C"*
Hard Surfaces	
Asphalt	0.82
Concrete	0.85
Roof	0.85
Gravel/Stone	0.50
Lawns (Sandy)	
Flat (0-2% Slope)	0.07
Rolling (2-7% Slope)	0.12
Steep (Greater than 7% Slope)	0.17
Lawns (Clay)	
Flat (0-2% Slope)	0.16
Rolling (2-7% Slope)	0.21
Steep (Greater than 7% Slope)	0.30

Source: LTAP Stormwater Drainage Manual, July 1995.

The coefficients of this tabulation are applicable to storms of 1 to 10 year frequencies. Coefficients for less frequent, higher intensity storms shall be modified as follows*:

Return Period (yrs.)	Multiply (C) by
25	1.10
50	1.20
100	1.25

* The upper limit for runoff is 1.0.

TABLE 2-2
Rural Runoff Coefficients

Type of Surface	*Runoff Coefficient "C"*
Woodland (Sandy)	
Flat (0-5% Slope)	0.10
Rolling (5-10% Slope)	0.25
Steep (Greater than 10% Slope)	0.30
Woodland (Clay)	
Flat (0-5% Slope)	0.30
Rolling (5-10% Slope)	0.35
Steep (Greater than 10% Slope)	0.50
Pasture (Sandy)	
Flat (0-5% Slope)	0.10
Rolling (5-10% Slope)	0.16
Steep (Greater than 10% Slope)	0.22
Pasture (Clay)	
Flat (0-5% Slope)	0.30
Rolling (5-10% Slope)	0.36
Steep (Greater than 10% Slope)	0.42
Cultivated (Sandy)	
Flat (0-5% Slope)	0.30
Rolling (5-10% Slope)	0.40
Steep (Greater than 10% Slope)	0.52
Cultivated (Clay)	
Flat (0-5% Slope)	0.50
Rolling (5-10% Slope)	0.60
Steep (Greater than 10% Slope)	0.72

Source: LTAP Stormwater Drainage Manual, July 1995.

The coefficients of this tabulation are applicable to storms of 1 to 10 year frequencies. Coefficients for less frequent, higher intensity storms shall be modified as follows*:

Return Period (yrs.)	Multiply (C) by
25	1.10
50	1.20
100	1.25

* The upper limit for runoff is 1.0.

TABLE 2-3
Runoff Coefficients "C" by Land Use and Typical Inlet Times

Land Use	*Runoff Coefficients*			*Inlet Times (Minutes)* [4]
	Flat [1]	**Rolling** [2]	**Steep** [3]	
Commercial *(CBD)*	0.75	0.83	0.91	5
Commercial *(Neighborhood)*	0.54	0.60	0.66	5-10
Industrial	0.63	0.70	0.77	
Garden Apartments	0.54	0.60	0.66	
Churches	0.54	0.60	0.66	
Schools	0.31	0.35	0.39	10-15
Semi Detached Residential	0.45	0.50	0.55	
Detached Residential	0.40	0.45	0.50	
Quarter Acre Lots	0.36	0.40	0.44	
Half Acre Lots	0.31	0.35	0.39	
Parkland	0.18	0.20	0.22	To be Computed

Source: LTAP Stormwater Drainage Manual, July 1995.

[1] Flat terrain involves slopes of 0-2%.
[2] Rolling terrain involves slopes of 2-7%.
[3] Steep terrain involves slopes greater than 7%.
[4] Interpolation, extrapolation and adjustment for local conditions shall be based on engineering experience and judgment.

The coefficients of this tabulation are applicable to storms of 1 to 10 year frequencies. Coefficients for less frequent, higher intensity storms shall be modified as follows*:

Return Period (yrs.)	Multiply (C) by
25	1.10
50	1.20
100	1.25

* The upper limit for runoff is 1.0.

B. Development Sites Greater Than 5 Acres in Size or Contributing Drainage Area Greater than 50 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 and curve number calculation methodologies and the Huff Third Quartile (50%) Rainfall Distribution. Note that for the purpose of determining the post-developed conditions curve numbers, due to significant disturbance to the upper soil layers during the construction activities, the initially determined hydrologic soil group for disturbed areas should be changed to the next less infiltrating capacity category (i.e., A to B, B to C, and C to D).

LID Exception: If Low Impact Development (LID) approach is pursued in satisfying the requirements noted in Chapter 8 (Post-Construction Water Quality BMPs), the post-developed CN for the protected undisturbed or restored disturbed areas meeting the requirements described in Chapter 8 and BMP fact sheets may be determined based on pre-development underlying soil layer.

A critical duration analysis should be performed to determine which rainfall duration would produce the highest peak runoff rate. Rainfall depth for various frequencies and durations shall be taken from **Table 2-5**. The Huff Third Quartile (50%) distribution ordinates are found in **Table 2-6**. Examples of computer models that can generate such hydrographs include TR-20 (NRCS), HEC-HMS (COE), and HEC-1 (COE). Other models may be acceptable and should be approved by the City of Lafayette prior to their utilization. Examples of other computer models that have been previously approved by the City of Lafayette include PondPack, AdICPR, and XP-SWMM.

TABLE 2-4
Rainfall Intensities for Various Return Periods and Storm Durations *(Inches/Hour)*

Duration	***Return Period (Years)***						
	1	**2**	**5**	**10**	**25**	**50**	**100**
5 Min.	4.76	5.65	6.72	7.6	8.7	9.6	10.45
10 Min.	3.7	4.42	5.22	5.86	6.65	7.27	7.87
15 Min.	3.02	3.6	4.27	4.81	5.48	6	6.52
30 Min.	2	2.41	2.92	3.34	3.87	4.29	4.71
1 Hr.	1.22	1.48	1.83	2.12	2.51	2.83	3.15
2 Hrs.	0.71	0.86	1.07	1.25	1.5	1.7	1.91
3 Hrs.	0.51	0.61	0.77	0.9	1.08	1.24	1.4
6 Hrs.	0.3	0.36	0.45	0.53	0.64	0.73	0.83
12 Hrs.	0.17	0.21	0.26	0.3	0.36	0.41	0.46
24 Hrs.	0.1	0.12	0.15	0.17	0.2	0.23	0.25

Source: NOAA, National Weather Service, "Precipitation-Frequency Atlas of the United States", NOAA Atlas14, Volume 2, Version 2, 2004, for Lafayette, Indiana. (Values for intermediate durations can be logarithmically interpolated.)

TABLE 2-5
Rainfall Depths for Various Return Periods and Storm Durations *(Inches)*

Duration	***Return Period (Years)***						
	1	**2**	**5**	**10**	**25**	**50**	**100**
5 Min.	0.4	0.47	0.56	0.63	0.72	0.8	0.87
10 Min.	0.62	0.74	0.87	0.98	1.11	1.21	1.31
15 Min.	0.76	0.9	1.07	1.2	1.37	1.5	1.63
30 Min.	1	1.2	1.46	1.67	1.93	2.15	2.35
1 Hr.	1.22	1.48	1.83	2.12	2.51	2.83	3.15
2 Hrs.	1.42	1.71	2.15	2.51	3	3.4	3.83
3 Hrs.	1.53	1.84	2.31	2.7	3.25	3.71	4.2
6 Hrs.	1.8	2.17	2.72	3.18	3.83	4.38	4.96
12 Hrs.	2.1	2.53	3.14	3.65	4.37	4.96	5.58
24 Hrs.	2.38	2.86	3.53	4.07	4.81	5.41	6.02

Source: NOAA, National Weather Service, "Precipitation-Frequency Atlas of the United States", NOAA Atlas 14, Volume 2, Version 2, 2004, for Lafayette, Indiana.

TABLE 2-6
Huff Third Quartile (50%) Rainfall Distribution Ordinates

Cumulative Percent of Storm Time	***Cumulative Percent of Storm Depth***
0	0
5	3
10	6
15	9
20	12
25	15
30	19
35	23
40	27
45	32
50	38
55	45
60	57
65	70
70	79
75	85
80	89
85	92
90	95
95	97
100	100

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 approved 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

A. Development Sites Less than or Equal to 5 Acres in Size, With a Contributing Drainage Area Less than or Equal to 50 Acres and No Depressional Storage

The required volume of stormwater storage may be calculated using the Rational Method and based on the runoff from 10-year and 100-year return period storm**s**. A computer model, such as TR-20 (NRCS), HEC-HMS (COE), and HEC-1 (COE), that can generate hydrographs based on the NRCS TR-55 time of concentration and curve number calculation methodologies may also be used along with the duration storm that produces the highest peak storage volume and pond elevation. Note that for the purpose of determining the post-developed conditions curve numbers, due to significant disturbance to the upper soil layers during the construction activities, the initially determined hydrologic soil group for disturbed areas should be changed to the next less infiltrating capacity category (i.e., A to B, B to C, and C to D).

> **LID Exception:** If Low Impact Development (LID) approach is pursued in satisfying the requirements noted in Chapter 8 (Post-Construction Water Quality BMPs), the post-developed CN for the protected undisturbed or restored disturbed areas meeting the requirements described in Chapter 8 and BMP fact sheets may be determined based on pre-development underlying soil layer.

The following 9-step procedure, based on the Rational Method, may be used to determine the required volume of storage.

1. Determine the parcel area in acres "A" tributary to each outlet.
2. Compute 100-year frequency allowable release rate (Q_u) to each outlet based on methodologies provided in Chapter 6 of these technical standards
3. Determine composite runoff coefficient "C_d" based on developed conditions and a 100-year return period. As noted on Tables 2-1 through 2-3, the composite runoff coefficient for the 100-year return period should be multiplied by 1.25.
4. Determine 100-year return rainfall intensity "I_d" for various storm durations "t_d" up through 24 hours for the developed area using **Table 2-4**.
5. Determine developed inflow rates "Q_d" for various storm durations "t_d", measured in hours.

$$Q_d = (C_d)(I_d)(A_d)$$

6. Compute a storage rate "$S(t_d)$" for various storm durations "t_d" up through 24 hours for the developed area.

$$S(t_d) = (Q_d) - (Q_u)$$

7. Compute required storage volume "S_R" in acre-feet for each storm duration "t_d". This assumes a triangular hydrograph of duration ($2t_d$) hours with a peak flow of $S(t_d)$ at t_d hours.

$$S_R = S(t_d)\left(\frac{t_d}{12}\right)$$

8. Select largest storage volume computed in Step **7** for any storm duration "t_d" for detention basin design.

9. Repeat Steps 2 – 8 of this process for the post-developed 10-year storm.

B. Development Sites Greater Than 5 Acres in Size or Contributing Drainage Area Greater than 50 Acres or With Significant Depressional Storage

All runoff detention storage calculations for these development sites shall be prepared using a computer model that can generate hydrographs based on the NRCS TR-55 time of concentration and curve number calculation methodologies. Note that for the purpose of determining the post-developed conditions curve numbers, due to significant disturbance to the upper soil layers during the construction activities, the initially determined hydrologic soil group for disturbed areas should be changed to the next less infiltrating capacity category (i.e., A to B, B to C, and C to D).

> **LID Exception:** If Low Impact Development (LID) approach is pursued in satisfying the requirements noted in Chapter 8 (Post-Construction Water Quality BMPs), the post-developed CN for the protected undisturbed or restored disturbed areas meeting the requirements described in Chapter 8 and BMP fact sheets may be determined based on pre-development underlying soil layer.

The Huff Third Quartile (50%) Rainfall Distribution shall be utilized to determine the required storage volume. A critical duration analysis should be performed to determine which rainfall duration would produce the highest storage volume and pond elevation. The allowable release rates shall be determined based on methodologies provided in Chapter 6 of these technical standards. Examples of computer models that can generate such hydrographs include TR-20 (NRCS), HEC-HMS (COE), and HEC-1

(COE). Other models may be acceptable and should be approved by the City of Lafayette prior to their utilization. Examples of other computer models that have been previously approved by the City of Lafayette include PondPack, AdICPR, and XP-SWMM.

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. Proposed storm sewer systems must be sized and designed to convey at least the 10-year frequency on-site stormwater runoff, as well as the anticipated 10-year frequency tributary off-site stormwater runoff based on the future developed condition (using Table 6-1 of the Technical Standards). An analysis of the emergency routing of stormwater runoff through the subject development must be provided to confirm that the development will not obstruct the free flow of floodwaters from the tributary off-site property in its current condition and after development. In addition, the Drainage System Overflow Design must be completed in accordance with Section M of this chapter to ensure the safe routing of flood waters through the subject development with the tributary off-site property in its current condition and after development.

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), as a minimum, peak runoff from a 10-year return frequency storm. 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. Culverts shall be capable of accommodating peak runoff from the 50-year frequency storm of critical duration when crossing under a road which is part of the INDOT Rural Functional Classification System or is classified as interstate highway, divided primary arterial, arterial, and/or collectors by the City of Lafayette Thoroughfare Plan or provides the only access to and from any portion of any commercial or residential developments. 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 City of Lafayette, the finished floor elevation is threatened.

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 from sag inlets to the overflow channel or basin shall be provided at sag inlets so that the maximum depth of water that might be ponded in the street sag shall not exceed 7 inches.

5. Facilities functioning as a major drainage system as defined in **Appendix A** must also meet IDNR design standards.

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**.

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 City of Lafayette.

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: LTAP Stormwater Drainage Manual, July 1995.

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

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, subject to approval of the City of Lafayette.

E. Pipe Cover and Grade

Sewer grade shall be such that, in general, a minimum of 1.5 feet of cover is maintained over the top of the pipe. If the pipe is to be placed under pavement, then the minimum pipe cover shall be 2.0 feet from top of pavement to top of 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 2.5 and 10 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

Manholes and/or inlets shall be installed to provide human access to continuous underground storm sewers for the purpose of inspection and maintenance. The manhole/inlet access shall be no less than the jurisdictional entity standards. 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

Size of Pipe (Inches)	Maximum Distance (Feet)
12 through 42	400
48 and larger	600

In addition to the above requirements, a minimum drop of 0.1 foot through manholes and inlet structures should be provided. 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).

6. 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
3-5 feet	36 inches	36" x 36"
5 or more feet	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. An overload 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, or by using **Figure 4-1**. Further guidance regarding gutter spread calculation may be found in the latest edition of HERPICC 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

Bedding and backfill materials around storm sewer pipes, sub-drains, and the associated structures will be installed per City of Lafayette standards. Dips/sags on

newly installed storm systems will not be allowed. Variations from these standards must be justified and receive written approval from the City of Lafayette.

J. Materials

Storm sewer manholes and inlets shall be constructed of cast in place concrete or precast reinforced concrete. Material and construction shall conform to the latest edition of the Indiana Department of Transportation (INDOT) "Standard Specifications", Sections 702 and 720.

Pipe and fittings used in storm sewer construction shall be extra-strength clay pipe (ASTM C-12), ductile iron pipe (AWWA C-151), poly vinyl chloride pipe (AASHTO M252), polyethylene pipe (AASHTO M252 or AASHTO M294), or 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 the City of Lafayette. 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. Connections to Storm Sewer System

To allow any connections to the storm sewer system, provisions for the connections shall be shown in the drainage calculations for the system. Specific language shall be provided in the protective covenants, on the record plat, or with the parcel deed of record, noting the ability or inability of the system to accommodate any permitted connections, for example, sump pumps and footing drains.

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

2. **Footing drains and perimeter drains** shall be connected to manholes or curb inlets, where possible, or to designated storm sewers or discharged into designated storm drainage channels/swales.

3. All **roof downspouts**, roof drains, or roof drainage piping shall discharge onto the ground or be connected to the storm drainage system. No downspouts or roof drains shall be connected to the sanitary sewers.

4. **Garage and basement floor drains** shall not be connected to the storm sewers.

5. **Swimming pool drains** shall not be connected to the storm sewers unless the water is dechlorinated, as defined in Appendix A, prior to being connected to the storm sewer.

In addition, none of the above mentioned devices shall be connected to any street underdrains, unless specifically authorized by the City of Lafayette.

M. Drainage System Overflow Design

Overflow paths throughout the development resulting from a 100-year storm event, shall be determined, clearly shown on the plans, and contained in permanent drainage easements with a minimum width of 10 feet along the centerline of the flow path. A continuous flood route from the sag inlets to the final outfall shall be shown and the minimum 10 feet along the centerline contained within an easement or road right-of-way. No fences or landscaping can be constructed within the easement areas.

The minimum adjacent grade of the portion of any residential, commercial, or industrial building (the ground elevation next to the building after construction is completed that sits adjacent to the overflow path or may be subject to flooding by the overflow path) shall be a minimum of 1 foot above the estimated 100-year elevation of the overflow path. **Table 4-**4 provides minimum adjacent grades for buildings adjacent to overflow paths and minimum requirements for easement widths along overflow paths as a function of drainage area tributary to the overflow path. This table is based on 1 foot of freeboard above the water surface elevation in the overflow path and the expected width of the overflow path, using a grassed triangular channel section with 3:1 sideslopes, and the difference in runoff between a 10-year frequency and 100-year frequency storm for a runoff coefficient of 0.45 and a time of concentration of 20 minutes.

In lieu of **Table 4-4**, the designer can calculate the anticipated depth of flow in the overflow system and the overflow path easement widths independently. The designer shall then submit to the City of Lafayette the overflow path depth calculations with any other necessary information to verify that the minimum adjacent grades provide approximately 1 foot of freeboard above the anticipated overflow water surface elevation and that the proposed easement widths are sufficient If the overflow path

easement widths are calculated independently, the minimum easement width shall be 10 feet. 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 approved by the City of Lafayette official charged with the approval authority at the time of the approval, and (2) evidence of its construction and maintenance can be shown.

The overflow path may be modeled as a 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 100-year overflow path elevations may be based on hand calculation methods that utilize normal depth calculations and storage routing techniques or determined using 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, which may be combined with HEC-RAS. Other models may be acceptable but should be approved by the City of Lafayette prior to their utilization.

If the designer utilizes **Table 4-4**, the City of Lafayette reserves the right to require independent calculations to verify that the minimum adjacent grades provide adequate freeboard above the anticipated overflow water surface elevations and to verify that sufficient overflow path easement widths are being provided. The emergency routing easement width downstream of a detention pond should be determined independently based on the proposed grading along the flow path and the discharge used in the sizing of the detention pond emergency spillway.

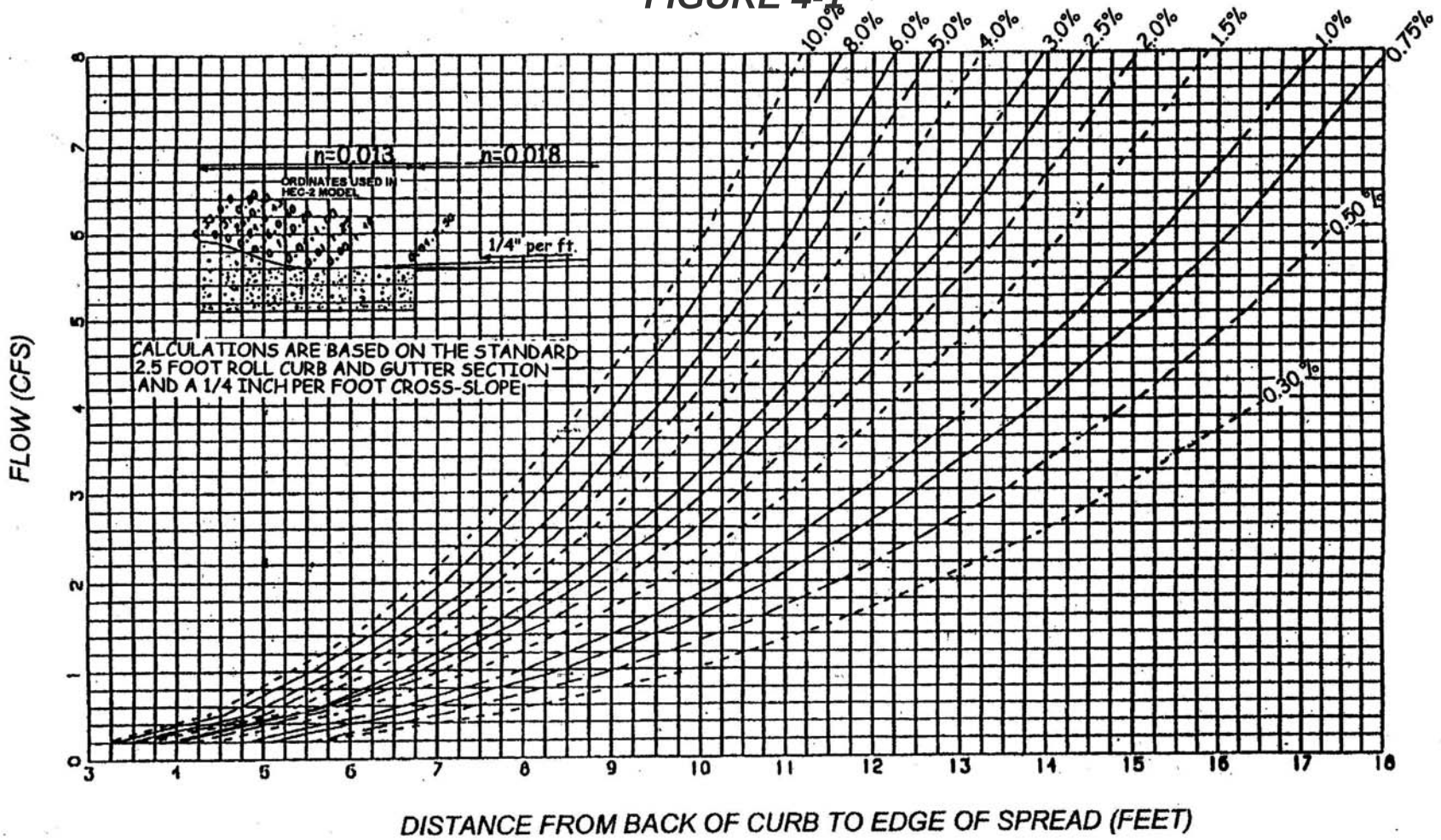
TABLE 4-4
Minimum Adjacent Grades and Easement Widths Along Overflow Paths as a Function of Drainage Area Tributary to the Overflow Path

Drainage Area (acres)	Minimum Building Adjacent Grade Above Overflow Path Invert (ft.)	Minimum Building Adjacent Grade Above Overflow Path Invert, if Overflow Path is in the Street (ft.)	Minimum Emergency Overflow Path Easement Width (ft.)
Up to 3	2.0	1.25	15
3-8	2.25	1.25	15
9-25	2.5	1.5	20
26-55	3.0	1.5	25
56-100	3.5	1.75	30
Over 100	To be calculated independently	To be calculated independently	To be calculated independently

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.

STREET AND GUTTER CAPACITIES

FIGURE 4-1



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. Proposed open channels must be sized and designed to convey at least the 10-year frequency on-site stormwater runoff, as well as the anticipated 10-year frequency tributary off-site stormwater runoff based on the future developed condition (using Table 6-1 of the Technical Standards). An analysis of the emergency routing of stormwater runoff through the subject development must be provided to confirm that the development will not obstruct the free flow of floodwaters from the tributary off-site property in its current condition and after development. In addition, the Drainage System Overflow Design must be completed in accordance with Section M of Chapter 4 to ensure the safe routing of flood waters through the subject development with the tributary off-site property in its current condition and after development.

A. Design Storm Frequencies

1. All channels and swales shall accommodate, as a minimum, peak runoff from a 10-year return frequency storm. 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. Channels with a carrying capacity of more than 30 cfs at bank-full stage shall be capable of accommodating peak runoff for a 24-hour, 50-year return frequency storm within the drainage easement.

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

4. Residential rear and side lot swales shall not convey more than 4 cfs during the 10-year event. Unless designed as a post-construction stormwater quality BMP, the maximum length of rear and side lot swales before reaching any inlet shall not exceed 400 feet.

5. Regardless of minimum <u>design</u> frequencies stated above, the performance of all parts of drainage system shall be <u>checked</u> 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,

$$A = Q/V$$

where: 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 City of Lafayette.

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 in vegetated-lined channels are shown in **Table 5-1.** 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.

4. Flow of a channel into a closed system is prohibited, unless runoff rate and head loss computations demonstrate the closed conduit to be capable of carrying the 100-year channel flow for developed conditions, either entirely or in combination with a defined overflow channel, with no reduction of velocity

TABLE 5-1: Maximum Permissible Velocities in Vegetation-Lined Channels [1]

Cover	*Channel Slope Range (Percent)* [3]	*Permissible Velocity* [2]	
		Erosion Resistant Soils (ft. per sec.) [4]	*Easily Eroded Soils (ft. per sec.)* [4]
Bermuda Grass	0-5 5-10 Over 10	8 7 6	6 5 4
Bahia Buffalo Grass Kentucky Bluegrass Smooth Brome Blue Grama	0-5 5-10 Over 10	7 6 5	5 4 3
Grass Mixture Reed Canary Grass	0-5 [3] 5-10	5 4	4 3
Lespedeza Sericea Weeping Lovegrass Yellow Bluestem Redtop Alfalfa Red Fescue	0-5[4] 5-10	3.4	2.5
Common Lespedeza [5] Sudangrass [5]	0-5[6]	3.5	2.5

[1] From Soil Conservation Service, SCS-TP-61, "Handbook of Channel Design for Soil and Water Conservation".

[2] Use velocities exceeding 5 feet per second only where good channel ground covers and proper maintenance can be obtained.

[3] Do not use on slopes steeper than 10 percent except for vegetated side slopes in combination with a stone, concrete, or highly resistant vegetative center section.

[4] Do not use on slopes steeper than 5 percent except for vegetated side slopes in combination with a stone, concrete, or highly resistant vegetative center section.

[5] Annuals - use on mild slopes or as temporary protection until permanent covers are established.

[6] Use on slopes steeper than 5 percent is not recommended.

E. Side Slopes

1. Earthen channel and swale side slopes shall be no steeper than 3 horizontal to 1 vertical (3:1). Flatter slopes may be required to prevent erosion and for ease of maintenance.

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.

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 an aged condition and the velocity shall be based on the design flow or the bankfull flow, whichever is greater, using an "n" value for various channel linings as shown in **Tables 4-1 and 5-1**. In no case is it necessary to check channel stability for discharges greater than that from a 100-year frequency storm.

3. Channel stability shall be checked for conditions immediately after construction. For this stability analysis, the velocity shall be calculated for the expected flow from a 10-year frequency storm on the watershed, or the bankfull flow, whichever is smaller, and the "n" value for the newly constructed channels in fine-grained soils and sands may be determined in accordance with the "National Engineering Handbook 5, Supplement B, Soil Conservation Service" and shall not exceed 0.025. This reference may be obtained by contacting the National Technical Information Service in Springfield, Virginia. The allowable velocity in the newly

constructed channel may be increased by a maximum of 20 percent to reflect the effects of vegetation to be established under the following conditions:

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

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

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

G. Drainage of Swales

Minimum swale slopes are 0.5%. 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. Unless designed to act as a stormwater BMP, vegetated swales with a slope between 0.5% to 0.75% shall include paved gutters, and vegetated swales with a slope between 0.75% to less than 1.0% shall be drained with a tile system. Further guidance regarding this subject may be found in the latest edition of the Indiana Drainage Handbook.

H. Appurtenant Structures

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

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

I. 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 approved by the IDNR or COE, if applicable.

J. 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 City of Lafayette. Materials shall comply with the latest edition of the INDOT, "Standard Specifications".

K. Drainage System Overflow Design

See Chapter 4, Section M.

Chapter Six

STORMWATER DETENTION DESIGN STANDARDS FOR PEAK FLOW CONTROL

Basins shall be constructed to temporarily detain the stormwater runoff that exceeds the maximum peak release rate authorized by the Stormwater Code. The required volume of storage provided in these basins, together with such storage as may be authorized in other on-site facilities, shall be sufficient to control excess runoff from the 10-year or 100-year storm as explained below in Section "B. Also, basins shall be constructed to provide adequate capacity to allow for sediment accumulation resulting from development and to permit the pond to function for reasonable periods between cleanings.

In addition to the requirement for peak flow control through detention, the Stormwater Code and Technical Standards require the developer to address Channel Protection and Water Quality Control requirements discussed in Chapter 8. The proper way to accommodate the water quality, channel protection, and peak flow rate control of a site is to first consider addressing the water quality and channel protection volume requirements through conventional or LID approaches (as described in Chapter 8) and then add in the required detention storage for peak flow rate control to the overall site design. Meeting the channel protection/water quality volume requirements, either using Conventional or LID Approaches, often includes providing extended detention storage features that are usually combined with the detention storage needed for peak runoff rate control of the site into one facility.

Such a combined facility should accommodate the correct channel protection volume, water quality volume, peak detention such that the allowable release rates are met, and the appropriate drain times. The following is the suggested calculation sequence for designing a detention pond with combined extended detention and peak flow control detention functions.

[Note: Developments with disturbed areas that are 10 acres or less and/or discharge directly into a stream without providing detention do not require Channel Protection Volume (CPv) measures.]

1. Calculate the required extended detention storage volume as needed to address the on-site Channel Protection Volume (CPv) through the methodology provided in Chapters 8 and 9 (Depending on the approach utilized, there may be no need for providing an extended detention storage).

2. Determine the control elevation/invert for the drain serving the proposed extended detention storage (ensuring a positive drain to the site outlet). This will

be the elevation of the bottom of the proposed extended detention storage and top of the permanent pool if a wet bottom pond is being provided for.

3. Design a storage space to accommodate the extended detention storage volume determined in Step 1, assuming 0.0 cfs going through the drain that will serve this extended detention storage volume. The top of this storage space will be the bottom of the peak flow rate control detention storage and the invert of the main outlet of this peak flow rate control detention storage.

4. Design the main outlet of the peak flow rate control detention storage, sized to carry the allowable on-site 10-year and 100-year release rates, with its control elevation/invert at the top of the extended detention storage space. For storage space calculation purposes, use the actual orifice size calculated to accommodate the release rates regardless of whether the orifice size is smaller or larger than the minimum orifice size allowed under the Ordinance or Technical Standards.

5. Design the peak flow rate control detention storage space by routing the on-site 10-year and 100-year inflow hydrographs through the pond, assuming the pond is empty to the control elevation of the extended detention storage drain as determined in Step 2, but still assuming 0.0 cfs can get out of the extended detention storage drain as the pond fills up. The resulting maximum water surface elevation is where the invert of the emergency overflow weir (sized for 1.25 times the peak inflow rate) is located. The pond size and control elevation/invert elevations are final at this stage.

6. Determine the size of the extended detention storage drain and design the drain system in a manner to meet the extended detention minimum and maximum emptying time requirements discussed in Chapter 8, using both on-site and, if applicable, off-site runoff. Due to typically required clog-free design and maintenance of the extended detention storage drain structures, the minimum orifice size requirements do not apply to these drain structures.

7. To make sure that the addition of the release through the drain will not cause the allowable release rate to be exceeded, reroute the on-site and off-site 10-year and 100-year inflow hydrographs through the pond, this time allowing water to also leave through the extended detention storage drain as the pond fills up. If the total peak outflow discharge exceeds the allowable release rate, reduce the size of the main outlet orifice accordingly (but do not go back to redesign the storage space). The resulting maximum water surface elevation is the 100-year pool elevation.

8. If the calculated orifice size of the main peak flow rate control storage outlet is less than the minimum orifice size allowed in the Ordinance or these Technical Standards, designate the minimum orifice size on the construction plans, but do not go back and recalculate/redesign the storage spaces.

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

A. Acceptable Detention Facilities

The increased stormwater runoff resulting from a proposed development should be detained on-site by the provisions of appropriate above- or below-ground wet bottom or dry bottom detention facilities, parking lots, or other acceptable techniques. Measures that retard the rate of overland flow and the velocity in runoff channels shall also be used to partially control runoff rates.

B. Allowable Release Rates

1. General Release Rates

Control devices shall limit the discharges to a rate such that the post-developed release rates from the site are no greater than the general release rates provided in Table 6-1. The general release rates may be set at a lower value by the City of Lafayette for certain watersheds if more detailed data becomes available as a result of comprehensive watershed studies conducted and/or formally approved and adopted by the City of Lafayette. The applicant shall confirm the applicable release rates with the City of Lafayette prior to initiating the design calculations to determine whether a basin-specific rate has been established for the watershed.

For sites where the pre-developed area has more than one (1) outlet, the release rates should be computed based on the pre-developed discharge to each outlet point.

2. Site-Specific Release Rates for Sites with Depressional Storage

For sites where depressional storage exists, the general release rates provided above may have to be further reduced. If depressional storage exists at the site, site-specific release rates must be calculated according to methodology described in Chapter 2, accounting for the depressional storage by modeling it as a pond whose outlet is a weir at an elevation that stormwater can currently overflow the depressional storage area. Post-developed release rates for sites with depressional storage shall be the 2-year pre-developed peak runoff rate for the post-developed 10-year storm and the 10-year pre-developed peak runoff rate for the post-developed 100-year storm. In no case shall the calculated site-specific release rates be larger than the general rates provided above.

Note that by definition, depressional storage does not have a direct gravity outlet, but if in agricultural production, it is more than likely drained by a tile and should be modeled as “empty” at the beginning of a storm. The function of any existing depressional storage should be modeled using an event hydrograph model to

determine the volume of storage that exists and its effect on the existing site release rate. To prepare such a model, certain information must be obtained, including delineating the tributary drainage area, the stage-storage relationship and discharge-rating curve, and identifying the capacity and elevation of the outlet(s).

The tributary area should be delineated on the best available topographic data. After determining the tributary area, a hydrologic analysis of the watershed should be performed, including, but not limited to: a calculation of the appropriate composite runoff curve number and time of concentration. Stage-storage data for the depressional area should be obtained from the site topography. The outlet should be clearly marked and any calculations performed to create a stage-discharge rating curve must be included with the stormwater submittal.

Also, note that for determining the post-developed peak runoff rates, the depressional storage must be assumed to be filled unless the City of Lafayette can be assured that the noted storage will be preserved in perpetuity.

3. Management of Off-site Runoff

Runoff from all upstream tributary areas (off-site land areas) may be bypassed around the detention/retention facility without attenuation**.** Such runoff may also be routed through the detention/retention facilities provided that a separate outlet system or channel is incorporated for the safe passage of such flows, i.e., not through the primary outlet of a detention facility. Unless the pond is being designed as a regional detention facility and therefore all off-site runoff to the pond detained, the primary outlet structure shall be sized and the invert elevation of the emergency overflow weir determined according to the on-site runoff only. To accomplish this, the 100-year on-site runoff must be determined by temporarily ignoring the off-site runoff and routing it through the pond and through the primary outlet pipe. The resulting pond elevation would be the invert elevation of the emergency overflow weir. Once the size and location of the primary outlet structure as well as the invert elevation of the emergency overflow weir is determined by considering on-site runoff, the 100-year pond elevation is determined by routing the entire inflow, on-site and off-site, through the pond. Note that the total peak flow released from the outlet system shall not be larger than the total of the allowable release rate and the off-site flow being bypassed through the pond for the 100-year event. A separate emergency overflow spillway would then need to be placed at the 100-year pond elevation and the top of the dam elevation selected with a minimum freeboard of 1 foot. It should be noted that the efficiency of the detention/retention facility in controlling the on-site runoff may be severely affected if the off-site area is considerably larger than the on-site area. As a general guidance, on-line detention may not be effective in controlling on-site runoff where the ratio of off-site area to on-site area is larger than 5:1. Additional detention (above and beyond that required for on-site area) may be required by the City of Lafayette when the ratio of off-site area to on-site area is larger than 5:1.

4. Downstream Restrictions

In the event the downstream receiving channel or storm sewer system is inadequate to accommodate the post-developed release rate provided above, then the allowable release rate shall be reduced to that rate permitted by the capacity of the receiving downstream channel or storm sewer system. Additional detention, as determined by the City of Lafayette, shall be required to store that portion of the runoff exceeding the capacity of the receiving sewers or waterways.

If the proposed development makes up only a portion of the undeveloped watershed upstream of the limiting restriction, the allowable release rate for the development shall be in direct proportion to the ratio of its drainage area to the drainage area of the entire watershed upstream of the restriction.

In accordance with Section 8.08.670 of the Stormwater Code, the allowable release rates may be further reduced by the City of Lafayette if on-site or off-site conditions warrant the reduction.

As an alternative to reduction of release rates, the City of Lafayette may allow the applicant to pursue alleviating downstream restrictions. The applicant would be responsible for obtaining all permits and consents required and for incurring all expenses involved in such undertaking.

TABLE 6-1
General Release Rates (cfs/acre) Based on
Pre-Developed Condition Curve Number at Each Outlet Point

Curve Number	10-Year	100-Year
≤ 65	0.07	0.23
66 – 69	0.13	0.33
70 – 73	0.20	0.43
74 – 77	0.27	0.53
78 – 81	0.34	0.63
82 – 85	0.44	0.75
≥ 86	0.55	0.87

5. Documentation of Results

The results of the allowable release rate determinations as well as the modeling simulation results must be summarized in a table that shall be included in the Stormwater Drainage Technical Report. The table must include, for each eventual site outlet, the pre-developed acreage tributary to each eventual site outlet, the unit discharge allowable release rate used, the resulting allowable

release rate in cfs for the post-developed 10-year and 100-year events, as well as pre- and post-developed flow rates for the 2-,10- and 100-year events. The worksheet provided as Table 6-2 should be filled for each final site outlet.

TABLE 6-2

SITE OUTLET #	ITEM	PRE-DEVELOPMENT					POST-DEVELOPMENT				
		D.A. (ac)	Depress. Storage? (yes/no)	2-Yr.	10-Yr.	100-Yr.	D.A. (ac)	Depress. Storage? (yes/no)	2-Yr.	10-Yr.	100-Yr.
1	General Allowable Release Rate (cfs/acre)										
	Basin-Specific Unit Discharge Allowable Release Rate, if any (cfs/acre)										
	Unit Discharge Allowable Release Rate Based on D/S Restrictions, if any (cfs/acre)										
	Adopted Unit Discharge Allowable Release Rate (cfs/acre)										
	Contributing Area of Development Site (ac) and Allowable Release Rate (cfs)										
	Total Contributing DA (ac) and Modeling Results (cfs)										

C. General Detention Basin Design Requirements

1. The detention facility shall be designed in such a manner that a minimum of 90% of the maximum volume of water stored and subsequently released at the design release rate shall not result in a storage duration in excess of 48 hours

from the start of the storm unless additional storms occur within the period. In other words, the design shall ensure that a minimum 90% of the original detention capacity is restored within 48 hours from the start of the design 100-year storm.

2. The 100-year elevation of stormwater detention facilities shall be separated by not less than 25 feet from any building or structure to be occupied. The Lowest Adjacent Grade (including walkout basement floor elevation) for all residential**,** commercial, or industrial buildings shall be set a minimum of 2 feet above the 100-year pond elevation**,** or 2 feet above the emergency overflow weir elevation, whichever is higher. The decision by the owner to include a basement for any residential, commercial, or industrial building shall be dictated by site soil conditions, the water table, and other related on-site considerations.

3. No detention facility or other water storage area, permanent or temporary, shall be constructed under or within twenty (20) feet of any pole or high voltage electric line. Likewise, poles or high voltage electric lines shall not be placed within twenty (20) feet of any detention facility or other water storage area.

4. All stormwater detention facilities shall be separated from any road right-of-way by no less than 50 feet, measured from the top of bank or the 100-year pool if no defined top of bank is present. Use of guard rails**,** berms, or other devices is encouraged and may be considered in lieu of the above-noted setbacks to minimize the chances of vehicles sliding into the pond.

5. Slopes no steeper than 3 horizontal to 1 vertical (3:1) for safety, erosion control, stability, and ease of maintenance shall be permitted.

6. Safety screens having a maximum opening of four (4) inches shall be provided for any pipe or opening 18” in diameter, or larger, to prevent children or large animals from crawling into the structures.

7. Use of fences around all detention ponds is strongly encouraged to assure safety.

   Unless specifically required by the City of Lafayette, the decision to use fencing around detention ponds is left to the owner or the developer. Recommendations contained within this document do not relieve the applicant and owner/developer from the responsibility of taking all necessary steps to ensure public safety with regards to such facilities.

8. Outlet control structures shall be designed to operate as simply as possible and shall require little or no maintenance and/or attention for proper operation. For maintenance purposes, pond outlets shall be a minimum of 0.5 foot above the normal water level of the receiving water bodies. They shall limit discharges into existing or planned downstream channels or conduits so as not to exceed

the predetermined maximum authorized peak flow rate. For above ground facilities, if an outlet control structure includes an orifice to restrict the flow rate, such orifice shall be no less than 4 inches in diameter, even if the 4-inch diameter orifice results in a discharge that exceeds the predetermined maximum authorized peak flow release rates. However, the sizing of the pond still should be based on the more restrictive maximum allowable release rate. Storm sewer pipes that act as outlet control structures from detention ponds shall be reinforced concrete pipe.

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

   Emergency overflow facilities shall be designed to convey, without overtopping the detention facility banks, one and one-quarter (1.25) times the peak inflow discharge resulting from the 100-year design storm event runoff from the entire contributing watershed draining to the detention facility, assuming post-development condition on-site and existing condition off-site. The length of the weir is to be determined using the weir equation, with the overflow weir control elevation at the pond's 100-year elevation (pond is assumed full to the overflow weir control elevation), discharge equal to 1.25 times the peak 100-year inflow, and the maximum head being the difference between the weir control elevation and the top of the bank.

   The emergency overflow routing from the emergency overflow facility to an adequate receiving system must be positive (by gravity) and shown on the construction plans and on the plat. It must be sized to accommodate the design flow of the pond's emergency overflow weir. Thirty (30) feet along the centerline of this emergency overflow route shall be designated as permanent drainage easement. No fences or landscaping can be constructed within the easement areas. The Lowest Adjacent Grade of all residential, commercial, or industrial buildings along this emergency overflow route shall be set a minimum of 2 feet above the flood elevation along the route, calculated based on the pond's emergency overflow weir design discharge.

10. Grass or other suitable vegetative cover shall be provided along the banks of the detention storage basin. Vegetative cover around detention facilities should be maintained as appropriate.

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

12. For wet-bottom facilities; A dedicated permanent stormwater easement extending 20 feet from the 100-year frequency ponding limits will surround the

facility. The drainage easement shall be accessible from a public right-of-way and shall be dedicated and granted to the persons or entities authorized to maintain the facility. In no case shall the easement be dedicated to the Tippecanoe County Drainage Board. The individual lot owner shall be responsible for maintaining that part of the facility easement which exists on his or her property. No trees, playground equipment, fencing, mini-barns, swimming pools, landscaping appurtenances, or other potential obstructions may be placed within the facility easement. Written evidence in the form of covenants that run with and become a charge against the land providing for the perpetual maintenance of the stormwater easement shall be submitted to the Tippecanoe County Drainage Board, which said covenant shall be recorded with the County Recorder. The permanent water level, facility outlet, and facility emergency spillway will be placed within a common area under the responsibility of a lot owner's association for the subdivision in which the facility is located.

For dry-bottom facilities; The 100-year frequency ponding limits, facility outlet, and facility emergency spillway will be placed within a common area under the responsibility of a lot owner's association for the subdivision in which the facility is located.

D. Additional Requirements for Wet-Bottom Facility Design

Where part of a detention facility will contain a permanent pool of water, all the items required for detention storage shall apply. Also, a controlled positive outlet will be required to maintain the design water level in the wet bottom facility and provide required detention storage above the design water level. However, the following additional conditions shall apply (For visual clarification, refer to **Figures 6-1** and **6-2)**:

1. Facilities designed with permanent pools or containing permanent lakes shall have a water area of at least one-half (0.5) acre with a minimum depth of eight (8) feet over the majority of pond area. If fish are to be used to keep the pond clean, a minimum depth of approximately ten (10) feet shall be maintained over at least 25 percent of the pond area. Construction trash or debris shall not be placed within the permanent pool.

2. Prior to final acceptance, danger signs warning of deep water, possible flood conditions during storm periods, or other dangers per the City of Lafayette standards, shall be installed at an interval of 400 feet around the perimeter of wet-bottom facilities without a security fence. Rescue equipment stations shall be posted at the same locations as the warning signs. Maintenance of the warning signs and rescue equipment stations shall be the responsibility of the owner or the homeowners association.

3. For wet-bottom facilities with a security fence, a maintenance ledge six (6) feet in width is required and shall be installed approximately 12 inches above the permanent water level. A safety ledge six (6) feet in width is also required, and shall be installed approximately 18 inches below the permanent water level. The slope between the two ledges shall be stable and protected from erosion with hard armoring or bioengineered techniques.

   For wet-bottom facilities without a security fence, a safety ledge ten (10) feet in width is required and shall be installed on a slope no steeper than 5 horizontal to 1 vertical (5:1), with the outer edge of the safety ledge no deeper than 18 inches below the permanent water level. The ground surface shall be no steeper than 3:1 from the top of slope to the safety ledge, and from the safety ledge to the bottom of the facility.

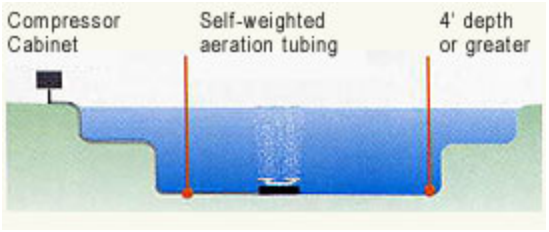
4. A safety ramp exit from the lake shall be required in all cases and shall have a minimum width of twenty (20) feet and exit slope of 6 horizontal to 1 vertical (6:1). The ramp shall be constructed of suitable material to prevent structural instability due to vehicle impacts and/or wave action.

5. The planting of vegetated barriers, from the top of bank to the waters edge around the perimeter of wet-bottom detention facilities without a security fence, is highly recommended. These barriers serve as potential obstacles to persons who may consider entering the water. The seed mixes used to plant the barrier should be able to survive in long dry periods as well as potential long wet periods. The vegetation should be planted in a manner so as not to hide or disguise the ponds edge. Maintenance of the vegetated barrier shall be the responsibility of the owner or the homeowners association.

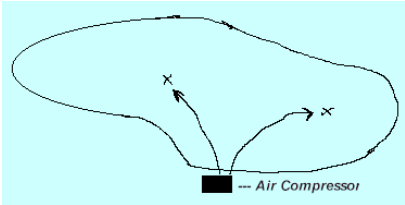
6. Parks, playgrounds, and athletic fields shall be separated from all stormwater detention facilities by no less than 100 feet, measured from the 100-year pool of the pond. Trails and sidewalks shall be separated from all stormwater detention facilities by no less than 25 feet, measured from the 100-year pool of the pond.

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

8. Methods to prevent pond stagnation, including but not limited to surface or sub-surface aeration or destratification facilities that can, at the minimum, achieve one complete pond volume turnover per day should be considered. Figure below shows a typical diffuser aeration system that consists of a quiet air compressor at the shore, aeration tubing, and one or more sets of diffuser head(s).



Irregularly shaped ponds should be treated as two or three separate ponds. Likewise, larger ponds will also need multiple aeration units.



Design calculations to substantiate the effectiveness of proposed aeration facilities shall be submitted with final engineering plans. Design calculations should, at a minimum, indicate that the device and or series of devices are providing a minimum volume turnover of once per 24 hours over the majority of the pond volume (i.e. pump radius of influence calculations, etc.). Agreements for the perpetual operation and maintenance of aeration facilities shall be prepared to the satisfaction of the City of Lafayette.

If the detention pond is also proposed to be used as a post-construction stormwater BMP, alternative means of aeration (such as diffuser aeration systems) shall be used that would not result in re-suspension of sediment particles and would not prevent the efficient settling of sediment particles

E. Additional Requirements for Dry-Bottom Facility Design

In addition to general design requirements, detention facilities that will not contain a permanent pool of water shall comply with the following requirements:

1. Provisions shall be incorporated into facilities for complete interior drainage of dry bottom facilities, including the provisions of natural grades to outlet structures, longitudinal and transverse grades to perimeter drainage facility, paved gutters, or the installation of subsurface drains.

2. For residential developments, the maximum planned depth of stormwater stored shall not exceed four (4) feet.

3. In excavated detention facilities, a minimum side slope of 3:1 shall be provided for stability. In the case of valley storage, natural slopes may be considered to be stable.

F. Parking Lot Storage

Paved parking lots may be designed to provide temporary detention storage of stormwater on all or a portion of their surfaces. Outlets for parking lot storage of stormwater will be designed so as to empty the stored waters slowly. Depths of storage shall be limited to a maximum depth of seven (7) inches so as to prevent damage to parked vehicles and so that access to parked vehicles is not impaired. Ponding should in general, be confined to those positions of the parking lots farthest from the area served. Before such detention method is allowed, a perpetual maintenance agreement must be executed by the owner or the developer and filed with the City of Lafayette. In addition, the 100-year inundation boundary should be determined and clearly shown on the construction plans.

G. Detention Facilities in Floodplains

Placement of detention ponds within the 100-year floodplain is not appropriate. In rare cases when the City of Lafayette may allow detention storage within a 100-year floodplain, only the net increase in storage volume above that which naturally existed on the floodplain shall be credited to the development. Wet-bottom detention storage facilities located within the 100-year floodplain may eliminate the floodplain storage that existed on the detention pond site. Therefore, compensatory floodplain storage may needs to be provided elsewhere for the floodplain storage lost as a result of the wet-bottom detention pond. A detention storage facility located within the 100-year floodplain and utilizing a backflow prevention device will eliminate the floodplain storage that existed on the detention pond site, and will also require compensatory floodplain storage. The detention analysis for a detention pond in the floodplain must consider appropriate tailwater impacts and the effect of any backflow prevention device.

H. Joint Development of Control Systems

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

I. Diffused Outlets

When the allowable runoff is released in an area that is susceptible to flooding or erosion, the developer may be required to construct appropriate storm drains through such area to avert increased flood hazard caused by the concentration of allowable runoff at one point instead of the natural overland distribution. The requirement of diffused outlet drains shall be at the discretion of the City of Lafayette.

J. IDNR Requirements

All designs for basins to be constructed in the floodway of a stream with a drainage area of one square mile or more must also satisfy IDNR permit requirements.

K. Allowance for Sedimentation

Detention basins shall be designed with an additional six (6) percent of available capacity to allow for sediment accumulation resulting from development and to permit the pond to function for reasonable periods between cleanings. Basins should be designed to collect sediment and debris in specific locations so that removal costs are kept to a minimum. For wet-bottom ponds, the sediment allowance may be provided below the permanent pool elevation. No construction trash or debris shall be allowed to be placed within the permanent pool. If the pond is used as a sediment control measure during active construction, the performance sureties will not be released until sediment has been cleaned out of the pond and elevations and grades have been reestablished as noted in the approved plans.

FIGURE 6-1
Wet –Bottom Detention Facility – With Fence

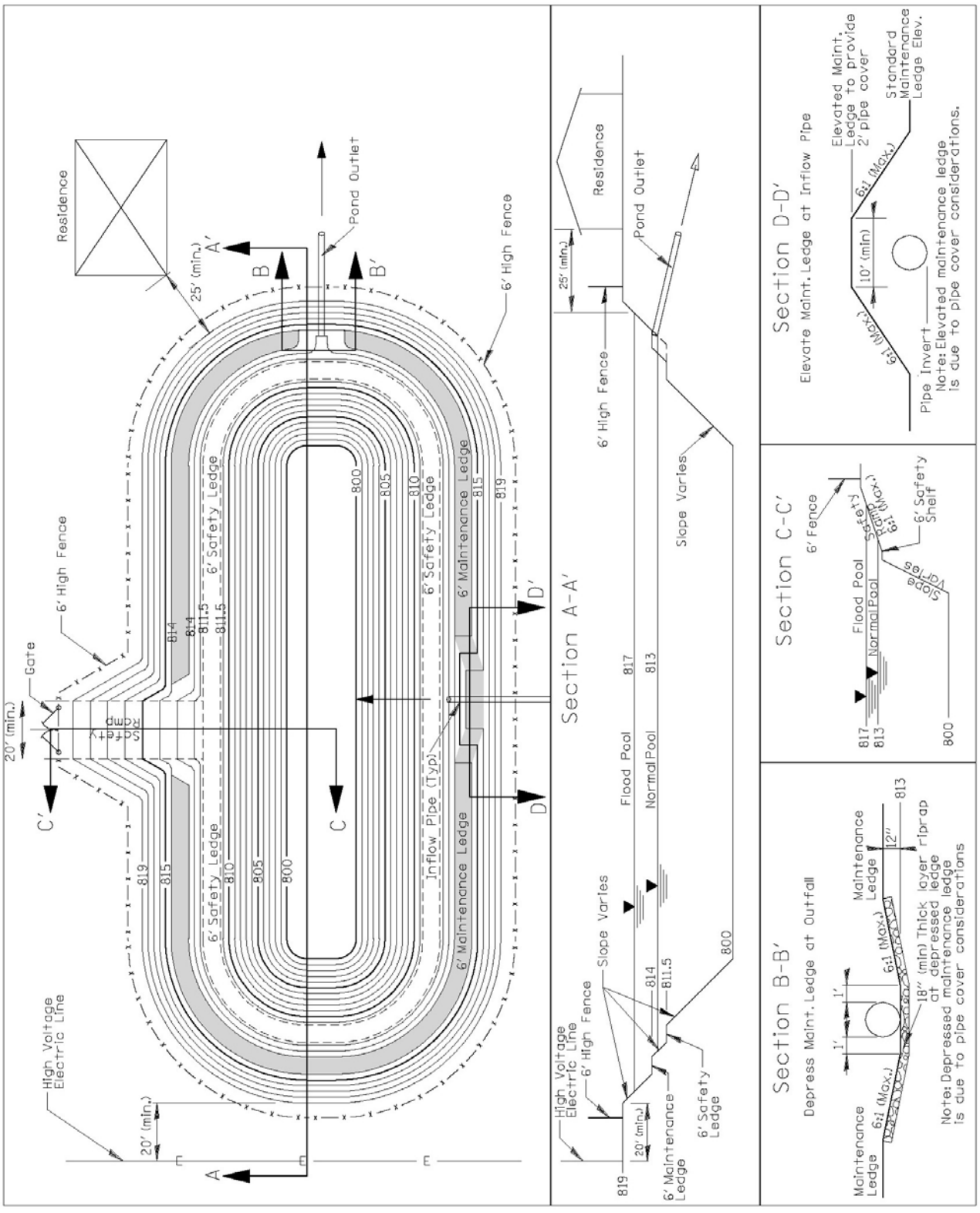
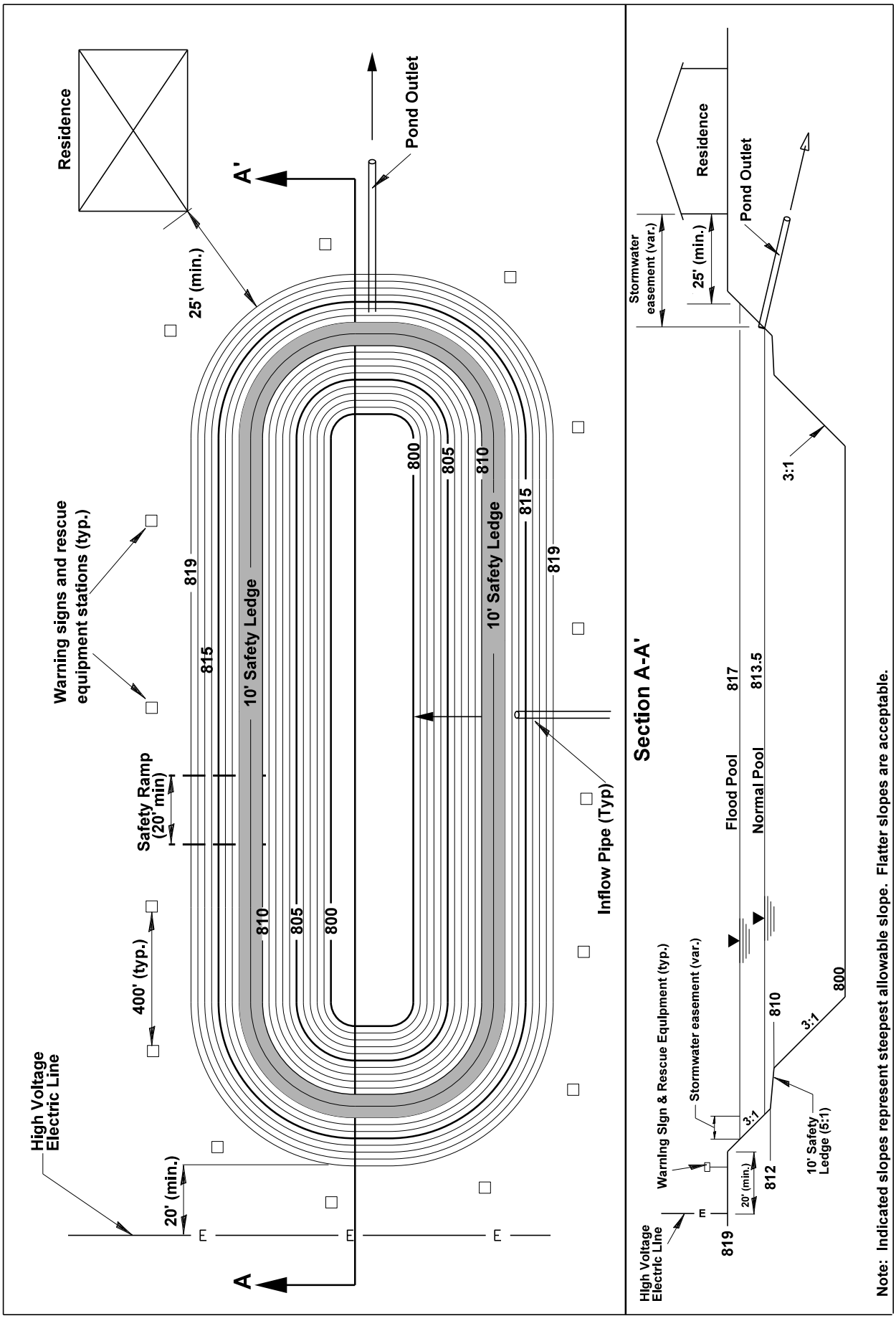


FIGURE 6-2
Wet Bottom Detention Facility without Fence



Chapter Seven

EROSION CONTROL PRACTICES AND CONSTRUCTION PHASE BMPs

The requirements contained in this chapter are intended to prevent stormwater pollution resulting from soil erosion and sedimentation or from mishandling of solid and hazardous waste. Practices and measures included herein should assure that no foreign substance, (e.g. sediment, construction debris, chemicals) be transported from a site and allowed to enter any drainageway, whether intentionally or accidentally, by machinery, wind, rain, runoff, or other means.

A. POLLUTANTS OF CONCERN DURING CONSTRUCTION

The major pollutant of concern during construction is sediment. Natural erosion processes are accelerated at a project site by the construction process for a number of reasons, including the loss of surface vegetation and compaction damage to the soil structure itself, resulting in reduced infiltration and increased surface runoff. Clearing and grading operations also expose subsoils which are often poorly suited to re-establish vegetation, leading to longer term erosion problems.

Problems associated with construction site erosion include: transport of pollutants attached to transported sediment; increased turbidity (reduced light) in receiving waters; recreational use impairment. The deposited sediment may pose direct toxicity to wildlife, or smother existing spawning areas and habitat. This siltation also reduces the capacity of waterways, resulting in increased flood hazards to the public.

Other pollutants of concern during the construction process are hazardous wastes or hydrocarbons associated with the construction equipment or processes. Examples include concrete washoff, paints, solvents, and hydrocarbons from refueling operations. Poor control and handling of toxic construction materials pose an acute (short-term) or chronic (long-term) risk of death to both aquatic life, wildlife, and the general public.

B. EROSION AND SEDIMENT CONTROL REQUIREMENTS

The following principles should govern erosion and sediment control practices on all sites:

1. Sediment-laden water flowing from the site shall be detained by erosion control measures appropriate to minimize sedimentation.

2. Water shall not be discharged in a manner that causes erosion at or downstream of the point of discharge.

3. All access to building sites that cross a natural watercourse, drainage easement, or swale/channel shall have a culvert of appropriate size.

4. Wastes or unused building materials, including but not limited to garbage, debris, cleaning wastes, wastewater, toxic materials, and hazardous substances, shall not be carried by runoff from a site. All wastes shall be disposed of in a proper manner. No construction trash or debris shall be allowed to be placed within the permanent pool of the detention/retention ponds. If the pond is used as a sediment control measure during active construction, the performance sureties will not be released until sediment has been cleaned out of the pond and elevations and grades have been reestablished as noted in the approved plans.

5. Sediment being tracked from a site onto public or private roadways shall be minimized. This can be accomplished initially by a temporary gravel construction entrance, in addition to a well-planned layout of roads, access drives, and parking areas.

6. Public or private roadways shall be kept cleared of accumulated sediment. Bulk clearing of sediment shall not include flushing the area with water.

7. All storm drain inlets shall be protected against sedimentation with barriers meeting accepted criteria, standards and specifications.

8. Runoff passing through a site from adjacent areas shall be controlled by diverting it around disturbed areas, where practical. Diverted runoff shall be conveyed in a manner that will not erode the channel and receiving areas. Alternatively, the existing channel may be left undisturbed or improved to prevent erosion or sedimentation from occurring.

9. Drainageways and swales shall be designed and adequately protected so that their final gradients and resultant velocities will not cause channel or outlet scouring.

10. All disturbed ground left inactive for fifteen (15) or more days shall be stabilized by seeding, sodding, mulching, covering, or by other equivalent erosion control measures.

11. Appropriate sediment control practices shall be installed prior to any land disturbance and thereafter whenever necessary.

12. During the period of construction activity at a site, erosion control measures necessary to meet the requirements of this Ordinance shall be maintained by the applicant.

C. COMMON CONTROL PRACTICES

All erosion control and stormwater pollution prevention measures required to comply with this Ordinance shall meet the design criteria, standards, and specifications similar to or the same as those outlined in the "Indiana Drainage Handbook" and the "Indiana Storm Water Quality Manual (ISWQM)," or other comparable and reputable references. Table 7-1 lists some of the more common and effective practices for preventing stormwater pollution from construction sites. Details of each practice can be found in the Indiana Drainage Handbook, the ISWQM, or in Appendix C. These practices should be used to protect ***every*** potential pollution pathway to stormwater conveyances.

Table 7-1
Common Stormwater Pollution Control Practices for Construction Sites

Practice No.	BMP Description	Applicability	Fact Sheet
1	Site Ass**e**ssment	All sites	ISWQM (Ch.2)
2	Development Of A Construction Sequence Schedule	All sites	ISWQM (Ch. 5)
3	Tree Preservation and Protection	Nearly all sites	ISWQM
4	Temporary Construction Ingress/Egress Pad	All sites	ISWQM
5	Wheel Wash	All sites	CN - 101
6	Silt Fence	Small drainage areas	ISWQM
7	Surface Roughening	Sites with slopes that are to be stabilized with vegetation	ISWQM
8	Temporary Seeding	Areas of bare soil where additional work is not scheduled to be performed for a minimum of 15 days	ISWQM
9	Mulching	Temporary surface stabilization	ISWQM
10	Erosion Control Blanket (Surface)	Temporary surface stabilization, anchor for mulch	ISWQM
11	Temporary Diversion	Up-slope and down-slope sides of construction site, above disturbed slopes within site	ISWQM
12	Rock Check Dam	2 acres maximum contributing drainage area	ISWQM
13	Temporary Slope Drain	Sites with cut or fill slopes	ISWQM
14	Straw Bale Dam	Small drainage areas	ISWQM
15	Geotextile Fabric Drop Inlet Protection	1 acre maximum contributing drainage area	ISWQM
16	Insert (Basket) Curb Inlet Protection	1 acre maximum contributing drainage area	ISWQM
17	Stone Bag Curb Inlet Protection	1 acre maximum contributing drainage area	ISWQM
18	Temporary Sediment Trap	5 acre maximum contributing drainage area	ISWQM
19	Temporary Dry Sediment Basin	30 acre maximum contributing drainage area	ISWQM
20	Dewatering Structures	Sites requiring dewatering	CN-102
21	Dust Control	All sites	ISWQM
22	Spill Prevention and Control	All sites	CN - 103

23	Solid Waste Management	All sites	CN - 104
24	Hazardous Waste Management	All sites	CN - 105

* See ISWQM Chapter 7 (2007 or latest version), unless otherwise noted. (http://www.in.gov/idem/stormwater/)

D. INDIVIDUAL LOT CONTROLS

Although individual lots within a larger development may not appear to contribute as much sediment as the overall development, the cumulative effect of lot development is of concern. From the time construction on an individual lot begins, until the individual lot is stabilized, the builder must take steps to:

- protect adjacent properties from sedimentation,
- prevent mud/sediment from depositing on the street,
- protect drainageways from erosion and sedimentation, and
- prevent sediment laden water from entering storm sewer inlets.

This can be accomplished using numerous erosion and sediment control measures. A standard erosion control plan for individual lots is provided in Appendix B. The standard plan includes perimeter silt fence, stabilized construction entrance, curb inlet protection, drop inlet protection, stockpile containment, stabilized drainage swales, downspout extensions, temporary seeding and mulching, and permanent vegetation. Every relevant measure should be installed at each individual lot site.

Construction sequence on individual lots should be as follows:

1. Clearly delineate areas of trees, shrubs, and vegetation that are to be undisturbed. To prevent root damage, the areas delineated for tree protection should be at least the same diameter as the crown.
2. Install perimeter silt fence at construction limits. Position the fence to intercept runoff prior to entering drainage swales.
3. Avoid disturbing drainage swales if vegetation is established. If drainage swales are bare, install erosion control blankets or sod to immediately stabilize.
4. Install drop inlet protection for all inlets on the property.
5. Install curb inlet protection, on both sides of the road, for all inlets along property frontage and the along the frontage of adjacent lots.
6. Install gravel construction entrance that extends from the street to the building pad.
7. Perform primary grading operations.
8. Contain erosion from any soil stockpiles created on-site with silt fence around the base.
9. Establish temporary seeding and straw mulch on disturbed areas.
10. Construct the home and install utilities.
11. Install downspout extenders once the roof and gutters have been constructed. Extenders should outlet to a stabilized area.

12. Re-seed any areas disturbed by construction and utilities installation with temporary seed mix within 3 days of completion of disturbance.
13. Grade the site to final elevations.
14. Install permanent seeding or sod.

All erosion and sediment control measures must be properly maintained throughout construction. Temporary and permanent seeding should be watered as needed until established. For further information on individual lot erosion and sediment control, please see the "Individual Lot Erosion and Sediment Control Certification" form in Appendix B, the IDNR, Division of Soil Conservation's pamphlet titled "Erosion and Sediment control for Individual Building Sites," or the City of Lafayette standard drawings.

Chapter Eight

POST-CONSTRUCTION WATER QUALITY BMPs

A. INTRODUCTION

It is recognized that developed areas, as compared to undeveloped areas, generally have increased imperviousness, decreased infiltration rates, increased runoff rates, and increased concentrations of pollutants such as fertilizers, herbicides, greases, oil, salts and other pollutants. As new development and re-development continues within the corporate boundaries of the City of Lafayette, measures must be taken to intercept and remove pollutants from stormwater runoff prior to reaching regional creeks, streams, and rivers. Through the use of appropriate Best Management Practices (BMPs), harmful amounts of sediment, nutrients, and contaminants will be removed from stormwater.

The City of Lafayette has adopted a policy that the control of stormwater runoff quality will be based on the management of Total Suspended Solids (TSS). This requirement is being adopted as the basis of the Tippecanoe County stormwater quality management program for all areas of jurisdiction. The following table provides the post-construction stormwater quality best management practice requirements for development sites within the City of Lafayette:

Table 8-1
Post-Construction Stormwater Quality Best Management Practice Requirements

Disturbed Area	Post-Construction BMP Requirement
0 to less than ½ acre	No BMP
At least ½ acre to less than 3 acres	At least 1 BMP to provide 80% TSS removal[A]
At least 3 acres	At least 1 BMP to provide 80% TSS removal OR 2 BMPs[B,C]

Note:

A. Since pollutant loadings generally increase with an increase in developed area, at least one BMP is required to provide 80% TSS removal from sites with a disturbed area of at least ½ acre to less than 3 acres.
B. A combination of at least two BMPs is encourage, but not required, for sites with a disturbed area of at least 3 acres. The first BMP will act as a pretreatment measure to reduce TSS concentrations within the downstream, or secondary, BMP. A dual BMP provision provides a failsafe benefit should

adverse conditions result in undue clogging or other potential BMP impairment. Only one of the required BMPs can be a proprietary Water Quality Device.

C. Those sites with a disturbed area in excess of 3 acres need only provide one BMP to provide 80% TSS removal and do not need to provide channel protection volume (described in Section A, below) when any of the following apply:
    a. Stormwater runoff from the subject site is tributary to an existing regional detention facility designed by the jurisdictional entity
    b. Stormwater runoff from the subject site is tributary to existing stormwater drainage infrastructure constructed as part of the larger overall development, previously approved by the jurisdictional entity, and designed to receive stormwater runoff from the developed subject site
    c. Stormwater runoff from the subject site is tributary to an existing detention pond constructed as part of a different development previously approved by the jurisdictional entity, provided that:
        i. Stormwater runoff from the subject site is tributary to the existing detention facility in the pre-developed condition
        ii. The existing detention pond was designed to receive stormwater runoff from the developed subject site

It is also recognized that another major source of pollution in many Indiana streams, including those within the corporate boundaries of the City of Lafayette, is the streambank erosion associated with urbanizing watersheds. Stream channels develop their shape in response to the volume and rate of runoff that they receive from their contributing watersheds. Research has shown that in hydrologically stable watersheds, the stream flow responsible for most of the shaping of the channel (called the bankfull flow) occurs between every one to two years. When land is developed, the volume and rate of runoff from that land increases for these comparatively small flooding events that are not normally addressed by detention practices and the stream channel will adapt by changing its shape. As the stream channel works to reach a new stable shape, excess erosion occurs. As new development and re-development continues within the corporate boundaries of the City of Lafayette, measures must be taken to minimize the impact of such development or re-development on streambank erosion. Through the use of appropriate Best Management Practices (BMPs), the volume and rate of runoff for channel-forming flows will be reduced in an attempt to minimize increased streambank erosion in the receiving streams and channels.

Channel protection is typically achieved by matching the post-construction runoff volume and rate to the pre-settlement condition (the condition prior to any historical land conversion by man) for all runoff events up to the bankfull flow. The bankfull flow in most Indiana streams correlate with 1.5- to 2-year flood event flow. However, due to difficulties in determining the pre-settlement conditions, the net control of runoff resulting from a 1-year, 24-hour storm in proposed conditions (rather than the alternative method

of determining increase in 2-year, 24-hour storm over pre-settlement conditions) is established as the City of Lafayette standard for channel protection.

Requirements of the Stormwater Code and this Technical Standards Manual with regard to channel protection and water quality protection can be satisfied through a variety of methods broadly categorized under two general approaches:

1. Conventional Approach
2. Low Impact Development (LID) Approach

This chapter of the manual establishes minimum standards for the selection and design of post-construction water quality and channel protection BMPs. The information provided in this chapter establishes performance criteria for stormwater quality management and procedures to be followed when preparing a BMP plan for compliance. Post-construction BMPs must be sized to treat the channel protection volume (CPv), water quality volume (WQv), and for flow-through BMPs, the water quality discharge rate (Qwq). For the conventional approach, the methodology for calculating the CPv, WQv, and Qwq values is provided in Chapter 9. For the LID approach, alternative methods of calculating these values are provided in Section C of this chapter.
[Note: Developments discharging directly into a stream without providing detention do not require Channel Protection Volume (CPv) measures. Developments discharging directly to a regional detention facility will be evaluated on a case-by-case basis.]

B. CONVENTIONAL APPROACH PROCEDURES

The following procedures shall be followed according to the conventional approach:

Step 1: Provide BMPs to address Channel Protection Volume

In a conventional approach, the receiving channel is protected through extended detention of the 1-year, 24-hour storm event for the entire site (disturbed and undisturbed) tributary to each outlet. The methodology for calculating the Channel Protection Volume (CPv) is according to that discussed in Chapter 9 of this Standards Manual. Both wet and dry extended detention may be used so long as only 10% of the maximum stored volume is left in the basin after 36 hours from maximum storage time and no more than 40% of the maximum stored volume is released within the first 12 hours. To ensure adequate detention volume is available within the facility over time, the facility should be designed for long-term sediment accumulation (a minimum of 50 years). If long-term sediment accumulation cannot be adequately provided for in the pond, or if the pond is intended to provide sediment control during the construction phase of the project, forebays near inlets can be included to help manage sediment accumulation. Forebays do not require a hard maintenance surface and shall not be visibly disconnected from the pond by rip rap or other berm structures.

Since by design 90% of the original volume will be available within 48 hours of the start of each storm event (assumed to be about 36 hours from when the Channel Protection pool is full), the volume in the pond associated with the channel protection (CPv) may be assumed empty for the purpose of peak flow detention analysis discussed in Chapter 6. In addition, the volume provided for channel protection would also satisfy the water quality volume (WQv) requirement for one (1) post-construction water quality BMP provided that the facility meets the design criteria in the fact sheet.

Step 2: Provide BMPS to address Water Quality Management

A channel protection volume BMP can also be used as a post-construction stormwater quality BMP if it meets the design criteria in Appendix D. City of Lafayette has designated a number of pre-approved BMP methods (listed in Tables 8-2 through 8-7 and 8-9) to be combined in various ways to achieve the stormwater quality performance criteria noted in Section A of this chapter. BMP methods address the runoff generated from not more than the first inch of rainfall for the entire site (disturbed and undisturbed) tributary to each outlet. These BMP measures are listed along with their anticipated average pollutant removal rates in **Table 8-2**. Applicants desiring to use a different removal rate for these BMPs must follow the requirements for Innovative BMPs. Details regarding the applicability and design of these pre-approved BMPs, including the effectiveness of these BMPs in removing TSS, are contained within fact sheets presented in Appendix D.

Innovative BMPs, including but not limited to, BMPs not previously accepted by the City of Lafayette must be certified by a Professional Engineer or Professional Land Surveyor licensed in the state of Indiana and approved through the City of Lafayette. ASTM standard methods must be followed when verifying performance of new measures. New BMPs, in all possible combinations, must meet the performance criteria noted in Section A of this chapter, including the capture and removal of floatables. All innovative BMPs must have a low to medium maintenance requirement to be considered by the City of Lafayette. Testing to establish the pollutant removal rate must be conducted by an independent testing facility, not the BMP manufacturer. The accepted design flow rate for a Water Quality Device shall be the flow value at which the claimed removal rate for each pollutant is equaled or exceeded based on the unit's efficiency curve (flow rate versus removal rate graph).

TABLE 8-2
Pre-approved Post-Construction BMPs

BMP[A]	Typical % TSS Removal Efficiency[B]	Maintenance Easement Requirements
Bioretention	90[C]	25 feet wide along the perimeter
Constructed Wetland	67[C]	25 feet wide along the outer perimeter of forebay & 30 feet wide along centerline of outlet
Underground Detention	70	20 feet wide strip from access easement to tank's access shaft & 30 feet wide along centerline of inlet and outlet
Extended Detention/Dry Pond	72	25 feet wide along the outer perimeter of forebay & 30 feet wide along centerline of outlet
Infiltration Basin	87	25 feet wide along the perimeter
Infiltration Trench	90[C]	25 feet wide along the perimeter
Constructed (Sand) Filter	70[C]	25 feet wide along the perimeter
Water Quality Device	NA[D]	20 feet wide strip from access easement to chamber's access shaft
Vegetated Filter Strip	78[C]	25 feet wide along the length on the pavement side
Vegetated Swale	81[C]	25 feet wide along the top of bank on one side
Wet Ponds/Retention Basin	80	25 feet wide along the outer perimeter of forebay & 30 feet wide along centerline of outlet

Notes:

A. Detailed specifications for these BMPs are provided in the fact sheets contained in Appendix D.
B. Removal rates shown are based on typical results. Unless otherwise shown, data extracted by CBBEL from various data sources. These rates are also dependent on proper installation and maintenance. The ultimate responsibility for determining whether additional measures must be taken to meet the Ordinance requirements for site-specific conditions rests with the applicant.
C. Based on IDEM Stormwater Quality Manual, 2007.
D. The removal rate for this category varies widely between various models and manufacturers. Independent testing must be provided, rather than the manufacturer's testing data. In lieu of Independent testing data, the latest pre-approved proprietary BMPs list from the city of Indianapolis will be used. These BMPs must be configured as offline units. The accepted design flow rate for a Water Quality Device shall be the flow value at which the claimed removal rate for each pollutant is equaled or exceeded based on the unit's efficiency curve (flow rate versus removal rate graph).

C. LOW IMPACT DEVELOPMENT (LID) APPROACH PROCEDURES

Low impact development (LID) stormwater management design approaches are fundamentally different from conventional design approaches and challenge traditional thinking regarding development standards, watershed protection, and public participation. LID combines fundamental hydrologic concepts with many of today's common stormwater strategies, practices and techniques to reshape development patterns in a way that maintains natural watershed hydrologic functions. When the City of Lafayette has a stormwater user fee system based on imperviousness, the utilization of LID concepts also often results in a smaller stormwater user fee for non-residential lots. The five principles of LID are:

a) Conservation of existing natural and topographic features;
b) Minimization of land clearing and impervious surfaces;
c) Maintain or lengthen the pre-developed time of concentration;
d) Installation of integrated structural best management practices; and
e) Use of pollution prevention measures and practices.

Several methods for achieving the above requirements and principals are outlined below. In addition to methods described in this Standards Manual, several readily available references provide details on incorporating LID practices into site development. 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 noted resource was used extensively for the development of the LID section in this Standards Manual.

The following steps shall be followed for the LID approach:

Step 1: <u>Minimize Disturbed Areas and Protect Sensitive Areas</u>

- Map sensitive areas such as waterbodies, floodplains, and natural flow paths. Identify existing structures and infrastructure. Identify hydrologic soil types on the maps. Show elevations and identify critical slopes of 15 percent to 25 percent and above 25 percent. Show areas of known contamination. Also show existing structures and infrastructure.
- Determine the total area of impervious surface existing prior to development.
- Note the seasonal high groundwater level.
- Designate sensitive areas that are proposed to be protected as part of the proposed layout.
- Lay out the proposed development, minimizing disturbance and avoiding the sensitive areas.
- The non-structural BMPs listed in **Table 8-3** are designed to properly protect sensitive areas so they maintain their pre-development state and runoff characteristics. Fact sheets for these BMPs are provided in **Appendix D**.

Table 8-3
Pre-approved BMPs with Treatment Area Reduction Recognitions for LID Approach

BMP[A]	Runoff Reduction Recognition[B]
Protect Sensitive Areas	Area (acres complying with the requirements of this BMP) can be subtracted from site development area for Channel Protection Volume and Water Quality Volume/Rate calculations.
Protect Riparian Buffers	Area (acres complying with the requirements of this BMP) can be subtracted from site development area for Channel Protection Volume and Water Quality Volume/Rate calculations.
Minimize Total Disturbed Area	Area (acres complying with the requirements of this BMP) can be subtracted from site development area for Channel Protection Volume and Water Quality Volume/Rate calculations.
Reduce Impervious Surfaces	Area (acres complying with the requirements of this BMP) can be subtracted from site development area for Channel Protection Volume and Water Quality Volume/Rate calculations.
Protect Natural Flow Pathways	Area (acres complying with the requirements of this BMP) can be subtracted from site development area for Channel Protection Volume and Water Quality Volume/Rate calculations.
Cluster-Type Development	Area (undisturbed acres complying with the requirements of this BMP) can be subtracted from site development area for Channel Protection Volume and Water Quality Volume/Rate calculations.

Notes:

A. In using and recognizing the runoff reduction of these BMPs, applicants must meet the review criteria located within the discussion of each BMP provided in Appendix D.
B. If the LID track is pursued, reduced CNs (associated with pre-developed underlying soil types instead of the normal requirement of assigning the post-development CN according to the next lower infiltration soil group) for areas protected by these BMPs may be used for determining the post-developed runoff rates and volumes for larger events (up to and including the 100-year event). See **Table 8-9**.

- As shown in Table 8-3, when using the LID Approach, any area that is set aside and protected as described in those BMPs may be subtracted from site development area for purposes of determining Channel Protection Volume calculations and water quality volume/rate calculations.
- In addition, for determining the 10-year and 100-year runoff and peak discharges, the CN associated with the original, pre-development soil groups (instead of the normal requirement of assigning the post-development CN according to the next lower infiltration soil group) may be used for these areas (see **Table 8-9**).

- The runoff reduction recognition only works with designs based on the Curve Number or CN method of analysis utilizing non-composite CN determination methods.

Step 2: <u>Restore Disturbed Areas</u>

- For the LID Approach, runoff reduction recognitions are used in the design process to emphasize the use of BMPs that, when applied, restore/alter the disturbed area in a way that reduces the volume of runoff from that area.
- Runoff reduction recognition is provided for the five BMPs listed in **Table 8-4** because they enhance the response of a piece of land to a storm event rather than treat the runoff that is generated. These BMPs are encouraged because they are relatively easy to implement over structural controls, require little if any maintenance, and the land they are applied to remains open to other uses.
- Runoff reduction recognition is applied by reducing the default CN value so that the amount of runoff generated from an event is reduced.
- The runoff reduction recognition only works with designs based on the Curve Number or CN method of analysis utilizing non-composite CN determination methods.
- Fact sheets for these BMPs are provided in Appendix D.

Table 8-4
Pre-approved BMPs with Runoff Reduction Recognitions for Restoring Disturbed Areas as Part of LID Approach

BMP[A]	Runoff Reduction Recognition[B]
Minimize Soil Compaction	Area (acres complying with the requirements of this BMP) can be assigned a CN based on the Pre-developed soil group conditions instead of the normal requirement of assigning the post-development CN according to the next lower infiltration soil group.
Protection of Existing Trees within disturbed areas (part of Protect Sensitive Areas)	Trees protected under the requirements of this BMP can be assigned a CN based on the Pre-developed soil group conditions at a rate of 800 square feet per tree instead of the normal requirement of assigning Post-developed CN according to the next lower infiltration soil group for the acres covered by the tree area.
Soil Amendment and Restoration	Area (acres complying with the requirements of this BMP) can be assigned a CN based on the Pre-developed soil group conditions instead of the normal requirement of assigning the post-development CN according to the next lower infiltration soil group.
Native Revegetation	Proposed trees and shrubs over and above the requirements of the landscaping ordinance to be planted under the requirements of this BMP can be assigned a CN based on the Pre-developed soil group conditions at a rate of 200 square feet per tree and 25 square feet per shrub instead of the normal requirement of assigning Post-developed CN according to the next lower infiltration soil group for the acres covered by the existing land use area.
Riparian Buffer Restoration	Proposed trees and shrubs to be planted under the requirements of this BMP can be assigned a CN based on the Pre-developed soil group conditions at a rate of 200 square feet per tree and 25 square feet per shrub instead of the normal requirement of assigning Post-developed CN according to the next lower infiltration soil group for the acres covered by the existing land use area.

Notes:

A. In using and recognizing the runoff reduction of these BMPs, applicants must meet the review criteria located within the discussion of each BMP provided in Appendix D.
B. If the LID track is pursued, reduced CNs (associated with pre-developed underlying soil types instead of the normal requirement of assigning the post-development CN according to the next lower infiltration soil group) for areas covered by these BMPs may be used for determining the post-developed runoff rates and volumes for larger events (up to and including the 100-year event). See **Table 8-9**.

Step 3: <u>Minimize Imperviousness</u>

- The BMPs listed in **Table 8-5** are designed to reduce the volume of runoff from hard surfaces such as roads, sidewalks, parking areas, roofs, etc. For the LID approach, runoff reduction recognition is used to encourage these practices and recognize their runoff reduction impacts. Fact sheets for these BMPs are provided in Appendix D.

Table 8-5
Pre-approved BMPs with Runoff Reduction Recognitions for Reducing Imperviousness as Part of LID Approach

BMP[A]	Runoff Reduction Recognition[B]
Porous Pavement	Area covered by Porous Pavement with a minimum of 8 inch washed aggregate base may be assigned a weighted CN value of 87 (instead of CN of 98 normally used for impervious surfaces) for the purpose of Channel Protection Volume calculations. Use a weighted CN of 74 for the purpose of Water Quality Volume calculations, if needed. Note: If this BMP is specifically designed to provide permanent volume reduction through infiltration or through providing detention storage within the aggregate void, the volume reduction recognition discussed in Step 5 should be pursued instead of the CN reduction recognition.
Vegetated Roof	Vegetated roofs are designed to reduce runoff volumes. However, the volume reduction is highly dependent on the media and planting used, with the calculation methods very complex at times. In lieu of calculating the volume reduction benefits, the roof area with vegetated roof with a minimum media depth of 4 inches and a void ratio of 0.3 (as described in the fact sheet) may be assigned a weighted CN of 87 (instead of CN of 98 normally used for impervious surfaces) for the purpose of Channel Protection Volume calculations. Use a weighted CN of 74 for the purpose of Water Quality Volume calculations, if needed.

Notes:

A. In using and recognizing the runoff reduction of these BMPs, applicants must meet the review criteria located within the discussion of each BMP provided in Appendix D.
B. If the LID track is pursued, reduced CNs for areas covered by these BMPs may be used for determining the post-developed runoff rates and volumes for larger events (up to and including the 100-year event). See **Table 8-9** for weighted CN values used for such larger events.

- Although imperviousness reduction BMPs are encouraged throughout any new development or re-development, the runoff reduction recognition may only be considered where the following conditions are met:
    - The BMP must be in the common areas and covered by an easement or other agreement that assigns responsibility for its maintenance.
    - The BMP must be covered by a maintenance plan and agreement with assurances for the long-term availability of maintenance funds (such as funds held in a permanent escrow account) provided to the City of Lafayette in a form acceptable to the City of Lafayette

Step 4: <u>Calculate the amount of volume control needed for channel protection</u>

- Determine the 1-year 24-hour rainfall from Table 2-5.
- Delineate sub-basins in a manner that, at a minimum and to the extent possible, the pervious and impervious surfaces are in different sub-basins.
- Determine the disturbed drainage area for each sub-basin by subtracting the protected area determined in Step 1 from total contributing drainage area.
- Assign CN to each cover type and land use, assigning "credited CN" for areas treated in Steps 2 and 3 instead of normal post-development CN that is determined based on the proposed land use and the next less infiltrating underlying soil group, when applicable. Published pre-determined weighted CN values shall <u>not</u> be utilized for LID approach. This applies regardless of whether manual methods or computer modeling techniques are used.
- Determine the total post-development 1-year, 24-hour runoff volume for the entire site's disturbed areas through the use of acceptable computer models or manually as specified below. This is the net Channel Protection volume needing to be <u>permanently</u> removed by appropriate structural BMPs.
    - Computer Model: Use acceptable computer models (listed in Chapter 2) to determine the total runoff volume for the site, utilizing 1-year, 24 hour rainfall depth with Soil Conservation Service (SCS) type 2 storm distribution, drainage area, and CN determined above, according to the Soil Conservation Service (SCS) CN loss method along with SCS unitless hydrograph methodology.
    - Manual Calculation: If calculating manually, use the following formula:
        - Runoff Volume (ft3) for each cover type = Qv x 1/12 x A
          Where
          A = disturbed area of the particular cover type (ft^2)
          Qv = Runoff Depth (in) = $(P - 0.2S)^2/(P + 0.8S)$
          P = 1-Year, 24 Hr Rainfall (in)
          S = 1000/CN – 10
        - Sum the individual volumes to obtain the total post-development runoff volume for area to be managed.

Step 5: <u>Provide Distributed Volume Reduction/Infiltration Practices</u>

- **Table 8-6** includes a list of the structural BMPs from potential BMPs that provide volume removal. Select and design structural BMPs that provide

volume control to meet, when combined, the total net channel protection volume determined in Step 4. Fact sheets for these and other relevant post-construction structural BMPs are provided in Appendix D.

Table 8-6
Pre-approved Structural BMPs with Permanent Volume Reduction Recognitions for Channel Protection as Part of LID Approach

BMP[A]	Channel Protection Volume Runoff Reduction Recognition[B]
Infiltration Practices (Infiltration Basin, Subsurface Infiltration Bed, Infiltration Trench, and Dry Well)	Volume reduction is achieved by surface storage volume (if included in the design), subsurface volume (if included in the design), and infiltration volume as described in the fact sheet. If an underdrain has to be used due to soil conditions, no volume reduction is granted for the "infiltration volume" portion.
Bioretention	Volume reduction is achieved by surface storage volume, soil storage volume, and infiltration bed volume as described in the fact sheet.
Vegetated Swale	Volume reduction is achieved by surface storage volume (if included in the design through inclusion of check dams) and active infiltration volume during the storm (when infiltration is expressly designed for as a purpose) as described in the fact sheet.

Notes:

A. In using and recognizing the runoff reduction of these BMPs, applicants must meet the review criteria located within the discussion of each BMP provided in Appendix D.
B. If the LID track is pursued, the volume reduction provided by these BMPs may be recognized towards determining the post-developed runoff rates and volumes for larger events (up to and including the 100-year event). See **Table 8-9** for extent of runoff reduction recognition allowed for such larger events.

- The volume reduction BMPs may not be successfully implemented in every situation. See "Applicability and Limitation" discussions in each Fact Sheet. In order to qualify for credit, the BMPs must meet all the following:
  - Be in the common areas and covered by an easement or other agreement that assigns responsibility for its maintenance.
  - Be covered by a maintenance plan and agreement with assurances for the long-term availability of maintenance funds (such as funds held in a permanent escrow account) provided to the City of Lafayette in a form acceptable to the City of Lafayette.
  - Be constructed on undisturbed A or well-drained B soils (B/D soils do not qualify) or amended soil with underdrains, as needed. If underdrains are used, the bottom elevations of the underdrains should be above the seasonal high water table. Soil infiltration testing protocol, provided in Appendix D, must be followed to determine if

infiltration BMPs are suitable at a site and to obtain the required data (such as soil conditions and depth of seasonal high water table) for infiltration design.
    - Be constructed in an area where the depth of seasonal high water table and any bedrock is more than a minimum of 2 feet (4 feet is desirable) from ground elevation.
    - Be constructed in a manner that any infiltration practices are adequately separated from basement foundations (50 feet up gradient, 10 feet down gradient), on-site septic systems/drainfields (100 feet), wells (50 feet), and other building elements that could be affected by infiltration systems.
    - Be constructed outside of any 1-year (Zone 1) or 5-year (Zone 2) time of travel areas to public water supply wells, as defined by a modeled wellfield delineation performed in compliance with 327 IAC 8-4.1. When such delineation is not available, said practice must be at least 3,000 feet from the nearest public water supply well (unless applicant can demonstrate that the proposed practice will have no impacts on the water quality of the water supply well).
    - Final construction should be completed after the contributing drainage area has been stabilized.
    - Must contain erosion-protection features at the inflow to prevent scouring.
    - Must contain a maintenance area near the inlet to collect large debris. Examples include small concrete aprons, catch basin inserts, or similar durable maintenance point.
- When the LID Approach is being pursued in all other aspects of the design but site limitations would not allow permanent volume reduction practices, channel protection volume shall, at a minimum, be accommodated through distributed storage solutions noted in Table 8-6 that also include underdrains as described in the appropriate Fact Sheets so that at a minimum they can act as both extended detention and filtration practices.
- **Calculation Methods for Recognizing Impacts of Distributed Storage on Overall Site's Peak Flow Detention Requirements:** When all the stated conditions above are met for volume-reduction distributed storage practices noted in Table 8-6, total volume provided for channel protection within distributed storage units (not to exceed the required channel protection volume calculated in Step 4) may be applied towards the site's overall detention requirements for peak (10-year and 100-year) flow control (see **Table 8-9**). Several methods are available to account for the noted runoff reduction recognition. A few common methods are listed below (other methods not noted below may also be used as appropriate):
    - Method 1: Assume that the provided Channel Protection Volume in the distributed storage units (not to exceed the required channel protection volume calculated in Step 4) will be stored below the detention pond's normal pool (below the lowest outlet). To simulate this condition, all the volumes in the elevation-storage table are increased by the

provided Channel Protection Volume, an additional table entry is made as the first row with an artificial lower elevation and with zero for storage, and the reservoir's starting elevation is set at the noted artificial elevation.

- Method 2: Utilize the "Divert" option of the hydrologic model used to compute the inflow to the pond to simulate the diversion (abstraction) of the provided Channel Protection Volume (not to exceed the required channel protection volume calculated in Step 4) from the detention pond inflow before the remaining flood hydrograph is routed through the detention system. To accomplish this, the model should have capability to simulate diversion with a volume cap option.
- Method 3: Explicitly model the distributed storage features as a network of storage and conveyance units through the use of computer programs that can correctly model interconnected storage.

Step 6: <u>Provide Additional (As-needed) Extended Detention Practices</u>

- When the LID Approach is being pursued in all other aspects of the design but site limitations would not allow adequate distributed volume reduction practices noted in Step 5 (with or without underdrains), then a constructed wetland or a wet-bottom extended detention facility along with incorporation of an appropriate wetland fringe should be utilized as listed in **Table 8-6**. If designed properly, such a facility can be incorporated into a multi-purpose facility to control channel protection volume, water quality volume, and 100-year peak flow rate. Note that since by design conditions of a wet-bottom extended detention facility, 90% of the original volume will be available within 48 hours of each storm event (i.e., a maximum of 36 hours from when the channel protection pool is full), the volume in the pond associated with the channel protection may be assumed empty for the purpose of peak flow detention analysis discussed in Chapter 6 of these Standards (see **Table 8-9**).

Table 8-7
Pre-approved BMPs with Additional, As-needed Extended Detention Runoff Reduction Recognitions for Channel Protection as Part of LID Approach

BMP[A]	Runoff Reduction Recognition[B]
Constructed Wetland	The volume of the supplementary extended detention, in lieu of permanent volume reduction, is applied towards meeting Channel Protection Volume requirements so long as only 10% of the maximum stored volume is left in the basin after 36 hours from maximum storage time and no more than 40% from the maximum stored volume is released within the first 12 hours.
Extended Detention Wet/Dry Pond	The volume of the supplementary extended detention, in lieu of permanent volume reduction, is applied towards meeting Channel Protection Volume requirements so long as only 10% of the maximum stored volume is left in the basin after 36 hours from maximum storage time and no more than 40% from the maximum stored volume is released within the first 12 hours.

Notes:

A. In using and recognizing the runoff reduction of these BMPs, applicants must meet the review criteria located within the discussion of each BMP provided in Appendix D.
B. If the LID track is pursued, the volume reduction provided by these BMPs may be applied towards determining the post-developed runoff rates and volumes for larger events (up to and including the 100-year event). See **Table 8-9** for extent of volume reduction allowed for such larger events.

Step 7: <u>If needed – determine water quality volume and select appropriate BMPs</u>

- A channel protection volume BMP can also be used as a post-construction stormwater quality BMP if it meets the design criteria in Appendix D. City of Lafayette has designated a number of pre-approved BMP methods to be combined in various ways to achieve the stormwater quality performance criteria noted in Section A of this chapter. BMP methods address the runoff generated from not more than the first inch of rainfall for the entire site (disturbed and undisturbed) tributary to each outlet. These BMP measures are listed along with their anticipated average pollutant removal rates in **Table 8-2**. Applicants desiring to use a different removal rate for these BMPs must follow the requirements for Innovative BMPs. Details regarding the applicability and design of these pre-approved BMPs, including the effectiveness of these BMPs in removing TSS, are contained within fact sheets presented in Appendix D.
- The methodology to determine the design water quality volume or rate for the LID approach is the same as that described for the Channel Protection Volume Calculation described in Step 4, except the rainfall depth for water quality will be 1 inch instead of the 1-year, 24-hour rainfall depth used for

calculating the Channel Protection Volume. A few considerations specific to water quality volume/rate calculations are as follows:

- Time of concentration in the case of LID design is the time it takes a drop of water to move from the furthest point in the disturbed area to its discharge from the disturbed area.
- If calculating manually, use the following formula:
  - Runoff Volume (ft^3) = Qv x 1/12 x A
    Where
    A = disturbed area of the particular cover type (ft^2)
    Qv = Runoff Depth (in) = $(P – 0.2S)^2/(P + 0.8S)$
    P = 1 inch
    S = 1000/CN – 10
  - Peak Runoff Rate (ft^3/sec) = qu x A x Qv x1/43,560
    Where
    A = disturbed area of the particular cover type (ft^2)
    Qv = Runoff Depth (in) calculated in previous step
    q_u = Unit Peak Discharge (cfs/mi^2/in), determined from TR-55 Exhibit 4-II
  - Sum the individual volumes and peak runoff rates to obtain the total design post-development water quality runoff volume and rate.

Step 8: <u>Complete the LID Approach Utilization Summary Form</u>

- As the final step of the LID Approach, a summary of non-structural and structural BMPs utilized, as part of the LID Approach, in the site design of a particular development site is provided in **Table 8-9** and submitted as part of the permit request package.
- The presence of Table 8-9 in the submittal package and the information contained in the form would alert the plan reviewer that the LID Approach is being used to meet the post-construction stormwater quality requirements of the site and that the overall site design as well as peak discharge and detention calculations should be reviewed with the impacts of LID Approach in mind.

Table 8-8
LID Approach Summary Worksheet

Project Information	
Project Name	Developer
Project Address	Developer's Address
Engineer	Developer's Telephone

This worksheet is a tool to allow both the regulatory agency and the Developer to reference various LID measures implemented within the development in order to meet the development's Post Construction Stormwater Management requirements.

Site Specific Information

Total Site Area: _____sf
Proposed Earth Disturbance Area: _____sf
Existing Impervious Area: _____sf

LID Measure Category	Potential BMPs	Total Surface Area (sf) of LID Measure	Plan Pg # of LID Measure	Pg # of Calculations for LID Measure
Minimize Disturbed Areas	Protect Sensitive Areas			
	Protect Riparian Buffers			
	Protect Natural Flow Pathways			
	Minimize Total Disturbed Area			
	Reduce Impervious Surfaces			
	Cluster-Type Development			
Restore Disturbed Areas	Minimize Soil Compaction			
	Protect Trees in Disturbed Areas			
	Soil Amendment and/or Restoration			
	Native Revegetation			
	Riparian Buffer Restoration			
Minimize Imperviousness	Porous Pavement			
	Vegetated Roof			
Provide Distributed Retention/Infiltration Practices	Infiltration Practices*			
	Bio-retention			
	Vegetated Swale			
Total Surface Area of LID Measures (sf)				

Proposed Final Impervious Surface Area _____ sf

Percent of Total Site Area Covered by LID _____%

Note: Not all LID measures are necessary or appropriate for every site. It is imperative that proper site assessments and due diligence is completed by the Developer and/or Engineer prior to design.

*: Infiltration Practices include: Infiltration Basins, Subsurface Infiltration Beds or Trenches, and Dry Wells

Summary of Runoff Reduction Recognitions for Water Quality Volume, Channel Protection, and Peak Flow Control Detention Volume for LID approach

As discussed throughout this Section, to encourage LID approach for stormwater management, runoff reduction recognitions towards all three major stormwater management requirements, i.e., Water Quality, Channel Protection, and Peak Runoff Detention, are associated with various BMPS as noted through the above seven step process. These runoff reduction recognitions are summarized in **Table 8-9.**

Table 8-9
Summary of Runoff Reduction Recognitions for Pre-Approved BMPS Used in the LID Approach

Implementation Order	DESCRIPTION	POTENTIAL BMPS	REDUCTION RECOGNITION FOR POST-CONSTRUCTION WATER QUALITY CALCULATIONS		REDUCTION RECOGNITION FOR WATER QUANTITY (DETENTION AND STORM DRAIN) CALCULATIONS
			WATER QUALITY VOLUME	CHANNEL PROTECTION VOLUME	
1	Minimize Disturbed Areas	• Protect Sensitive Areas • Protect Riparian Buffers • Minimize Total Disturbed Area • Protect Natural Flow Pathways • Reduce Impervious Surfaces • Cluster-Type Development	Full recognition through allowing to use "disturbed surface area" only for all calculations	Full recognition through allowing to use "disturbed surface area" only for all calculations	Full recognition through allowing CN for the undisturbed, protected area to be calculated based on pre-developed underlying soil types
2	Restore Disturbed Areas	• Minimize Soil Compaction • Protection of Existing Trees within disturbed areas (part of Minimize Total Disturbed Area) • Soil Amendment and Restoration • Native Revegetation • Riparian Buffer Restoration	Full recognition through allowing CN for the restored/protected area to be calculated based on pre-developed underlying soil types	Full recognition through allowing CN for the restored/protected area to be calculated based on pre-developed underlying soil types	Full recognition through allowing CN for the restored/protected area to be calculated based on pre-developed underlying soil types
3	Minimize Imperviousness	• Porous Pavement	Full recognition of perviousness through allowing CN for the application area to be calculated based on a pre-set value (74 instead of 98) AND full recognition of the stored volume (if provided for in the design) and WQ treatment, if designed as a true infiltration practice (no underdrain/ or extended 24-48 hrs release)	Partial (weighted) recognition of perviousness through allowing CN for the application area to be calculated based on a pre-set value (87 instead of 98) AND full recognition of the stored volume (if provided for in the design), if designed as a true infiltration practice (no underdrain/ or extended 24-48 hrs release)	Partial (weighted) recognition of perviousness through allowing CN for the application area to be calculated based on pre-set values (89 for 10-year and 90 for 100-year calculations instead of using 98) and full recognition of the stored volume (if provided for in the design), on a case by case basis, treated as an underground detention
		• Vegetated Roof	Full recognition of perviousness through allowing CN for the application area to be calculated based on a pre-set value (74 instead of 98) AND full recognition of the stored volume (if provided for in the design) and/or WQ treatment if designed for	Partial (weighted) recognition of perviousness through allowing CN for the application area to be calculated based on a pre-set value (87 instead of 98)	Partial (weighted) recognition of perviousness through allowing CN for the application area to be calculated based on a pre-set value 89 for 10-year and 90 for 100-year calculations instead of using 98)
4	Provide Distributed Volume Reduction/Infiltration Practices (or Filtration Practices, if underdrains have to be provided) in Common Areas	• Infiltration Practices (Infiltration Basin, Subsurface Infiltration Bed, Infiltration Trench, and Dry Well) • Bioretention • Vegetated Swale	Full recognition of perviousness through allowing CN for the application area to be calculated based on cover type and underlying soil AND full recognition of the retained volume (if provided for in the design) and/or WQ treatment if designed for	Full recognition of retained volume if designed as true infiltration practice (on appropriate soil and no underdrain/ or extended 24-48 hrs release)	Limited recognition of retained volume (up to the Channel Protection Volume) if designed as true infiltration practice (on appropriate soil and no underdrain/ or extended 24-48 hrs release)
5	Provide, As-needed, Additional Extended Detention Practices in Common Areas	• Constructed Wetland • Extended Detention Wet/Dry Pond	full recognition of the stored volume (with extended 24-48 hrs release) and/or WQ treatment if designed for	Full Recognition of stored volume (with extended 24-48 hrs release)	Full Recognition of stored volume (with extended 24-48 hrs release)
6	Provide, As needed, Additional Water Quality BMPs	• Pre-approved BMPs noted in Table 8-1 for conventional method	Full recognition of WQ treatment	N/A	N/A

D. SPECIAL PROVISIONS FOR "HOT SPOT" LAND USES

For all those projects involving land uses considered to be high pollutant producers or "hot spots" (see **Table 8-10** e.g., vehicle service and maintenance facilities, vehicle salvage yards and recycling facilities, vehicle and equipment cleaning facilities, fleet storage areas for buses, trucks, etc., industrial/commercial or any hazardous waste storage areas or areas that generate such wastes, industrial sites, restaurants and convenience stores, any activity involving chemical mixing or loading/unloading, outdoor liquid container storage, public works storage areas, commercial container nurseries, and some high traffic retail uses characterized by frequent vehicle turnover), additional water quality requirements may be imposed by the City of Lafayette in addition to those included in water quality criteria in order to remove potential pollutant loadings from entering either groundwater or surface water systems. These pre-treatment requirements are included in **Tables 8-10 and 8-11**.

Table 8-10
Pre-Treatment options for Stormwater Hot Spots

Stormwater Hot Spots	Minimum Pre-Treatment Options
Vehicle Maintenance and Repair Facilities	A, E, F, G
Vehicle Fueling Stations	A, D, G
Drive-through Restaurants, Pharmacies, Convenience Stores	B, C, D, I, K
Outdoor Chemical Mixing or Handling	G, H
Outdoor Storage of Liquids	G
Commercial Nursery Operations	I, J, L
Other Uses or Activities Designated by Appropriate Authority	As Required

Table 8-11
Minimum Pre-Treatment Options

Minimum Pre-Treatment Options	
A	Oil/Water Separators / Hydrodynamic Separators
B	Sediment Traps/Catch Basin Sumps
C	Trash/Debris Collectors in Catch Basins
D	Water Quality Inserts for Inlets
E	Use of Drip Pans and/or Dry Sweep Material under Vehicles/Equipment
F	Use of Absorbent Devices to Reduce Liquid Releases
G	Spill Prevention and Response Program
H	Diversion of Stormwater away from Potential Contamination Areas
I	Vegetated Swales/Filter Strips
J	Constructed Wetlands
K	Stormwater Filters (Sand, Peat, Compost, etc.)
L	Stormwater Collection and Reuse (especially for irrigation)
M	BMPs that are a part of a Stormwater Pollution Prevention Plan (SWPPP) under a NPDES Permit

E. CONSTRUCTION SEQUENCING CONSIDERATIONS

BMPs noted in this chapter refer to post-construction BMPs, which continue to treat stormwater after construction has been completed and the site has been stabilized. Installing certain BMPs, such as bioretention areas and sand filters, prior to stabilization can cause failure of the measure due to clogging from sediment. If such BMPs are installed prior to site stabilization, they should be protected by traditional erosion control measures.

In those instances, the construction sequence must require that the pond is cleaned out with pertinent elevations and storage and treatment capacities reestablished as noted in the accepted stormwater management plan.

REFERENCES

Southeast Michigan Council of Governments (SEMCOG), Low Impact Development Manual for Michigan: A Design Guide for Implementers and Reviewers, Detroit, Michigan, 2008.

Chapter Nine

METHODOLOGY FOR DETERMINATION OF REQUIRED SIZING OF BMPs

A. INTRODUCTION

This Chapter describes the acceptable methods for calculating Channel Protection Volume, Water Quality Volume, and Flow-Through BMP Flow Rate associated with Conventional Stormwater Management Approach (acceptable methods associated with the LID Stormwater Management Approach are discussed in Chapter 8). Channel Protection is achieved through retention or extended detention of runoff volume for 1-year, 24-hour storm event. Structural Water Quality treatment is achieved by treating the first inch of rainfall, either through retention/detention BMPs or by Flow-through BMPs. Detention/Retention BMPs impound (pond) the runoff to be treated, while flow-through BMPs treat the runoff through some form of filtration process.

B. RETENTION/DETENTION BMP SIZING

1. Channel Protection Volume

Channel Protection Detention/Retention BMPs must be designed to store the channel protection volume. The channel protection volume, CPv, is the storage needed to retain or detain the runoff to the receiving stream from the 1-year, 24-hour rainfall. The methodology for calculating the Channel Protection Volume (CPv) for each of site's final outlets using computer models or manual calculation is as follows:

- Computer Model: Use acceptable computer models (listed in Chapter 2) to determine the total runoff volume for the site contributing to each site's outlet, utilizing 1-year, 24 hour rainfall depth with Soil Conservation Service (SCS) type 2 storm distribution, drainage area, and the composite CN calculated for the site, according to the Soil Conservation Service (SCS) CN loss method along with SCS unitless hydrograph methodology.

- Manual Calculation: If calculating manually, use the following formula:

$$CPv\ (ft3) = Qv \times 1/12 \times A$$

Where

A = total post-construction site area contributory to each outlet (ft^2)
Qv = Runoff Depth (in) = $(P - 0.2S)^2/(P + 0.8S)$
P = 1-Year, 24 Hr Rainfall (in)
S = 1000/CN – 10

2. Water Quality Volume

Water Quality Detention BMPs must be designed to store the water quality volume for treatment. The water quality volume, WQv, is the storage needed to capture and treat the runoff from the first one inch of rainfall. The water quality volume is equivalent to one inch of rainfall multiplied by the volumetric runoff coefficient (Rv) multiplied by the site area.

A calculation methodology similar to that described for the channel protection volume may be utilized, except that the rainfall depth (P) will be equal to 1, instead of the 1-year, 24-hour depth.

Alternatively, a simpler methodology may be used for calculation of WQv as follows:

$$WQv = \frac{(P)\ (Rv)\ (A)}{12}$$

where:
WQv = water quality volume for each site's outlet (acre-feet)
P = 1 inch
Rv = volumetric runoff coefficient
A = area in acres

The volumetric runoff coefficient is a measure of imperviousness for the contributing area, and is calculated as:

$$Rv = 0.05 + 0.009(I)$$

Where:
I is the percent impervious cover

For example, a proposed commercial site will be designed to drain to three different outlets, with the following drainage areas and impervious percentages:

Subarea ID	On-site Contributing Area (acres)	Impervious Area %	Off-Site Contributing Area (acres)
A	7.5	80	0.0
B	4.3	75	0.0
C	6.0	77	0.0

Calculating the volumetric runoff coefficient for subareas A, B and C yields:

Rv (subarea A) = 0.05+0.009(80) = 0.77
Rv (subarea B) = 0.05+0.009(75) = 0.73
Rv (subarea C) = 0.05+0.009(77) = 0.74

The water quality volumes for these three areas are then calculated as:

WQv (subarea A) = (1")(Rv)(A)/12=0.77(7.5)/12 = 0.48 acre-feet
WQv (subarea B) = 0.73(4.3)/12 = 0.26 acre-feet
WQv (subarea C) = 0.74(6.0)/12 = 0.37 acre-feet

Note that this example assumed no off-site sources of discharge through the water quality BMPs. If there were significant sources of off-site runoff (sometimes called runon for upstream areas draining to the site), the designer would have the option of bypassing off-site runoff around the on-site systems, or the detention BMP should be sized to treat the water quality volume for the entire contributing area, including off-site sources.

C. FLOW-THROUGH TYPE BMP SIZING

Flow-through BMPs are designed to treat runoff at a peak design flow rate through the system. Examples of flow through BMPs include catch basin inserts, sand filters, and grassed channels. Another flow through BMP which is gaining popularity is a dynamic separator. Dynamic separators are proprietary, and usually include an oil-water separation component.

The following procedure should be used to estimate peak discharges for flow through BMPs (adapted from Maryland, 2000). It relies on the volume of runoff computed using the Small Storm Hydrology Method (Pitt, 1994) and utilizes the NRCS, TR-55 Method.

Using the WQv methodology, a corresponding Curve Number (CNwq) is computed utilizing the following equation:

$$CNwq = \left[\frac{1000}{10 + 5P + 10Qa - 10\sqrt{Qa^2 + 1.25QaP}}\right]$$

where:

CNwq =	curve number for water quality storm event
P =	1" (rainfall for water quality storm event)
Qa =	runoff volume, in inches = 1"×Rv = Rv (inches)
Rv =	volumetric runoff coefficient (see previous section)

Due to the complexity of the above equation, the water quality curve number is represented as a function of percent imperviousness in **Figure 9-1**.

The water quality curve number, CNwq, is then used in conjunction with the standard calculated time-of-concentration, tc, and drainage area as the basis input for TR-55 calculations. Using the SCS Type II distribution for 1 inch of rainfall in 24-hours, the water quality treatment rate, Qwq, can then be calculated.

REFERENCES

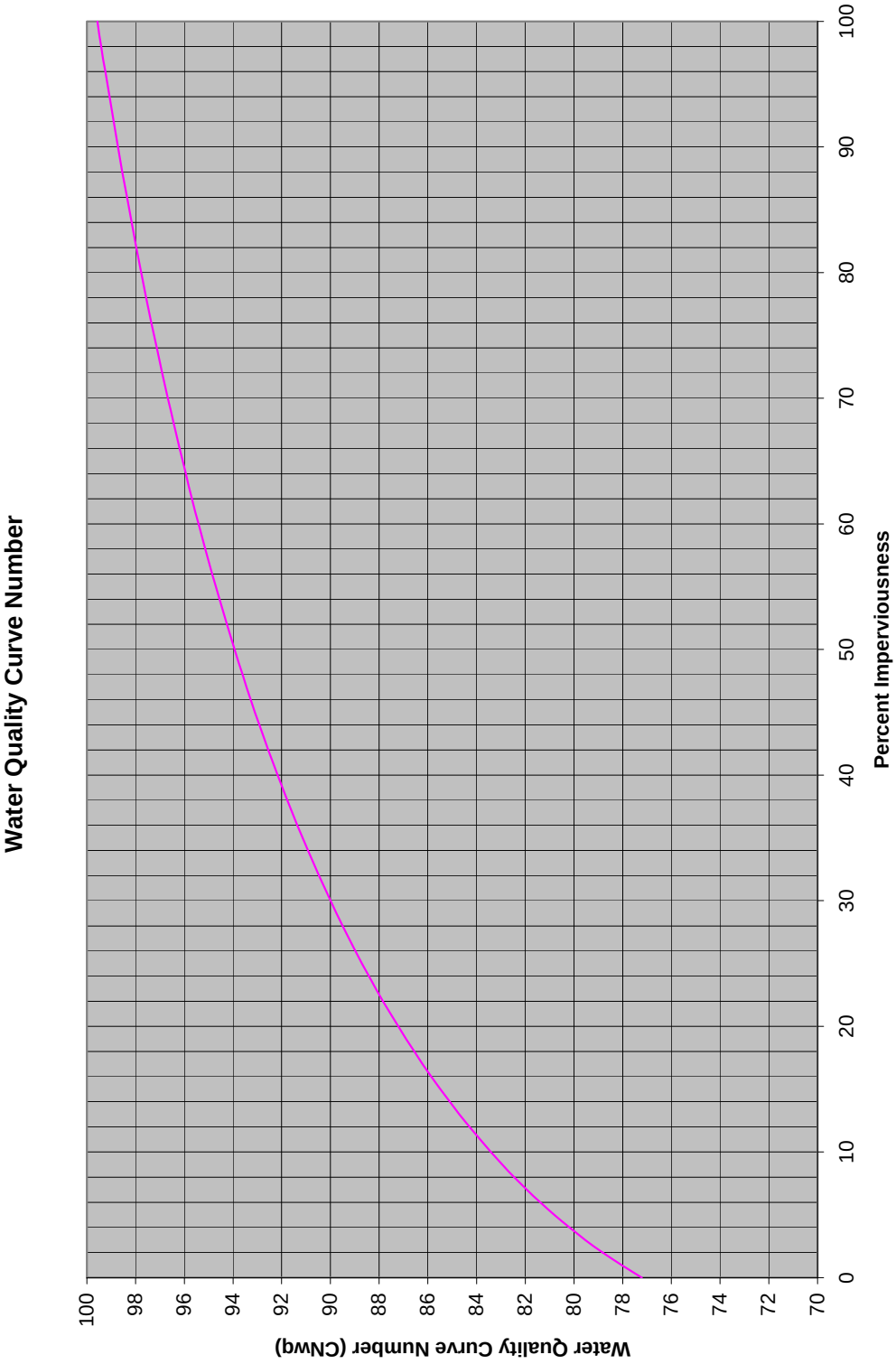
1. Maryland Stormwater Design Manual, Volume II, Appendix D.10, 2000

2. Pitt, R., 1994, Small Storm Hydrology. University of Alabama - Birmingham. Unpublished manuscript. Presented at design of stormwater quality management practices. Madison, WI, May 17-19 1994.

3. Schueler, T.R. and R.A. Claytor, 1996, Design of Stormwater Filter Systems. Center for Watershed Protection, Silver Spring, MD.

4. United States Department of Agriculture (USDA), 1986. Urban Hydrology for Small Watersheds. Soil Conservation Service, Engineering Division. Technical Release 55 (TR-55).

Figure 9-1
Curve Number Calculation for Water Quality Storm Event



Chapter Ten

MISCELLANEOUS REQUIREMENTS

A. POLICY ON DAMS AND LEVEES

Dams and levees have the potential for significant, sometimes catastrophic consequences should they fail. In order to minimize the potential for loss of life and public safety, decrease the potential for increased flood damage and disaster costs, and safeguard the downstream property rights, the following shall be required by the Tippecanoe County Drainage Board and/or Tippecanoe County Surveyor for any proposed new or improvements to any existing dam or levee. These requirements are in addition to what is normally required for other development subject to the Ordinance or these Technical Standards and/or that required by State or Federal agencies.

i. Design of dams shall follow the requirements of the latest edition of IDNR-Division of Water "General Guidelines for New Dams and Improvements to Existing Dams in Indiana" as well as principles provided in the latest edition of "Indiana Dam Safety Inspection Manual".

ii. Design of levee/floodwalls shall follow the FEMA requirements and guidelines provided in 44 CFR Section 65.10 and USACE Engineer Manual 1110-2-193, Design and Construction of Levees.

iii. An Incident and Emergency Action Plan (IEAP), including a detailed dam breach inundation map, shall be developed in accordance with the template provided in the latest edition of "Indiana Dam Safety Inspection Manual" and submitted to the Tippecanoe County Drainage Board and/or Tippecanoe County Surveyor. The detailed dam breach inundation map referenced in this paragraph shall be developed for both "Sunny Day Breach" Scenario (breach during normal loading conditions) and for maximum loading condition with breach assumed to occur as the spillway system is passing the Spillway Design Flood (SDF) associated with the dam ("SDF + Breach" Scenario).

iv. Unless the "Sunny Day Breach Inundation Area" is entirely contained within the applicant's property and/ or contained within the existing 100-year floodplain, a copy of recorded flood/inundation easement or a recorded written consent for every property within the potential "Sunny Day Breach Inundation Area"

shall be submitted to the Tippecanoe County Drainage Board and/or Tippecanoe County Surveyor. In addition, all the affected property owners whose properties are located within the "SDF + Breach Inundation Area" must be notified of a hearing relevant to the proposed added flooding risk, should such a man-made structure suffer a catastrophic failure. Notification of the time and place of the hearing shall be made in person or by certified mail at least five (5) to ten (10) days prior to the hearing. Proof of notice to each landowner shall be filed by affidavit with the Tippecanoe County Drainage Board and/or Tippecanoe County Surveyor prior to the hearing.

v. A copy of a Management and Maintenance Plan for the proposed dam or levee developed in accordance with the latest edition of "Indiana Dam Safety Inspection Manual" shall be submitted to the Tippecanoe County Drainage Board and/or Tippecanoe County Surveyor.

vi. Unless the dam is subject to and regulated by IDNR, following the permitting and construction of the dam or levee, a copy of a formal periodic inspection report prepared in accordance with the recommendations contained in the latest edition of "Indiana Dam Safety Inspection Manual" shall be submitted to the Tippecanoe County Drainage Board and/or Tippecanoe County Surveyor along with evidence that the identified maintenance deficiencies have been corrected. The inspection report has to be submitted as it gets completed in accordance with the inspection frequency recommended in the latest edition of "Indiana Dam Safety Inspection Manual".

B. REQUIREMENTS ASSOCIATED WITH PROPOSED DEVELOPMENTS DOWNSTREAM OF DAMS

As indicated in the previous section, dams have the potential for significant, sometimes catastrophic consequences should they fail. Placing new development downstream of an existing dam does not only expose the future residents or users of the newly developed areas to a potential new significant risk, but could also have an impact on the hazard rating of the dam itself, which can in turn make the dam non-compliant with the state and federal standards. In order to minimize the potential for loss of life and public safety, decrease the potential for increased flood damage and disaster costs, and safeguard the upstream dam owner's rights, the following shall be required by the Tippecanoe County Drainage Board and/or Tippecanoe County Surveyor for any proposed new development or redevelopment downstream of an existing dam. These

requirements are in addition to what is normally required for new development or redevelopment subject to these Standards.

i. Dam breach inundation maps have been created for several existing dams within the State of Indiana by the dam owners, IDNR, or others as part of development of individual IEAPs for these dams. When the development location is suspected by the applicant or the Tippecanoe County Drainage Board and/or Tippecanoe County Surveyor to be within an existing dam's breach inundation zone, the applicant is required to include a copy of the breach inundation mapping associated with that dam as part of its stormwater management permit application. To locate such a mapping, the applicant should contact the dam owner, IDNR- Division of Water, Tippecanoe County Drainage Board and/or Tippecanoe County Surveyor, or other agencies to obtain the breach inundation map for the dam, if available. If no dam breach inundation map can be located for the dam, it will be the applicant's responsibility to produce a Tippecanoe County Drainage Board and/or Tippecanoe County Surveyor-acceptable dam breach mapping either through directly contracting with a qualified engineer or through funding the production of such a map by the Tippecanoe County Drainage Board and/or Tippecanoe County Surveyor review consultant in accordance with standards and guidelines established by the IDNR-Division of Water.

ii. If the location of the proposed development falls within the dam breach inundation zone on the map discussed under Item i (above), additional requirements as determined by Tippecanoe County Drainage Board and/or Tippecanoe County Surveyor may be imposed before a permit is issued and the development is allowed to occur. The noted additional requirements depend on several variables and are expected to vary case by case. Typical requirements could include relocating a portion or all of the proposed development to areas outside of the dam breach inundation zone, cost-sharing with the dam owner in necessary upgrades to the dam as a result of a potential hazard classification increase, addition of structural protection measures (such as flood protection levees), additional freeboard requirements, development and periodic exercise of warning and evacuation plans, and other measures considered necessary by Tippecanoe County Drainage Board and/or Tippecanoe County Surveyor to minimize the potential for loss of life and public safety, decrease the potential for increased flood damage and disaster costs, and safeguard the upstream dam owner's rights.

.

APPENDIX A

ABBREVIATIONS AND DEFINITIONS

APPENDIX A

ABBREVIATIONS AND DEFINITIONS

ABBREVIATIONS

BFE	Base Flood Elevation
BMP	Best Management Practice
CFS	Cubic Feet Per Second
CLOMR	Conditional Letter of Map Revision (from FEMA)
CLOMR-F	Conditional Letter of Map Revision Based on Fill (from FEMA)
CN	Curve Number
COE	United States Army Corps of Engineers
CSMP	Comprehensive Stormwater Management Program
CSO	Combined Sewer Overflow
CWA	Clean Water Act
ERM	Elevation Reference Mark
E&SC	Erosion and Sediment Control
EPA	Environmental Protection Agency
ETJ	Extraterritorial Jurisdiction
FBFM	Flood Boundary and Floodway Map
FEMA	Federal Emergency Management Agency
FHBM	Flood Hazard Boundary Map
FIRM	Flood Insurance Rate Map
FIS	Flood Insurance Study
FPG	Flood Protection Grade
FPS	Feet Per Second
GIS	Geographical Information System
GPS	Global Positioning System
HGL	Hydraulic Grade Line
HHW	Household Hazardous Waste

HUC	Hydrologic Unit Code
IDEM	Indiana Department of Environmental Management
IDNR	Indiana Department of Natural Resources
INDOT	Indiana Department of Transportation.
LAG	Lowest Adjacent Grade
LOMA	Letter of Map Amendment (from FEMA)
LOMR	Letter of Map Revision (from FEMA)
LOMR-F	Letter of Map Revision Based on Fill (from FEMA)
MCM	Minimum Control Measure
MS4	Municipal Separate Storm Sewers
NAVD	North American Vertical Datum of 1988
NFIP	National Flood Insurance Program
NGVD 1929	National Geodetic Vertical Datum of 1929
NRCS	USDA-Natural Resources Conservation Service
NPDES	National Pollution Discharge Elimination System
NPS	Non-point source
POTW	Publicly Owned Treatment Works
SFHA	Special Flood Hazard Area
SWCD	Soil and Water Conservation District
SWPPP	Stormwater Pollution Prevention Plan
SWQMP	Stormwater Quality Management Plan
Tc	Time of Concentration
TMDL	Total Maximum Daily Load
USCS	Unified Soil Classification System
USDA	United States Department of Agriculture
USFWS	United States Fish and Wildlife Service

DEFINITIONS

Acre-Foot (AF). A measure of water volume equal to the inundation of a flat one-acre area to a dept of one foot (43,560 cubic feet).

Administering authority. The designated unit of government given the authority to issue permits.

Agricultural land disturbing activity. Tillage, planting, cultivation, or harvesting operations for the production of agricultural or nursery vegetative crops. The term also includes pasture renovation and establishment, the construction of agricultural conservation practices, and the installation and maintenance of agricultural drainage tile. For purposes of this rule, the term does not include land disturbing activities for the construction of agricultural related facilities, such as barns, buildings to house livestock, roads associated with infrastructure, agricultural waste lagoons and facilities, lakes and ponds, wetlands; and other infrastructure.

Agricultural land use conservation practices. Use of land for the production of animal or plant life, including forestry, pasturing or yarding of livestock, and planting, growing, cultivating, and harvesting crops for human or livestock consumption. Practices that are constructed on agricultural land for the purposes of controlling soil erosion and sedimentation. These practices include grass waterways, sediment basins, terraces, and grade stabilization structures.

Amortization Period. The length of time used to repay a debt or mortgage or to depreciate an initial cost.

Antecedent Runoff Condition. The index of runoff potential before a storm event. The index, developed by the Soil Conservation Service (SCS), is an attempt to account for the variation of the SCS runoff curve number (CN) from storm to storm.

Backflow Preventer. Device that allows liquids to flow in only one direction in a pipe. Backflow preventers are used on sewer pipes to prevent a reverse flow during flooding situations.

Backwater. The rise in water surface elevation caused by some obstruction such as a narrow bridge opening, buildings or fill material that limits the area through which the water shall flow.

Base Flood Elevation. The water surface elevation corresponding to a flood having a one percent probability of being equaled or exceeded in a given year.

Base Flood. See "Regulatory Flood".

Base Flow. Stream discharge derived from groundwater sources as differentiated from surface runoff. Sometimes considered to include flows from regulated lakes or reservoirs.

Basement. A building story that is all or partly underground but having at least one-half of its height below the average level of the adjoining ground. A basement shall not be counted as a story for the purpose of height regulations.

Benchmark. A marked point of known elevation from which other elevations may be established.

Best Management Practices. Design, construction, and maintenance practices and criteria for stormwater facilities that minimize the impact of stormwater runoff rates and volumes, prevent erosion, and capture pollutants.

Buffer Strip. An existing, variable width strip of vegetated land intended to protect water quality and habitat.

Building. See “structure”.

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 drain or subdrain, having at its base a sediment sump designed to retain grit and detritus below the point of overflow.

Centerline of Channel. The thalweg of a channel.

Channel Improvement. Alteration, maintenance, or reconstruction of the channel area for the purpose of improving the channel capacity or overall drainage efficiency. The noted "improvement" does not necessarily imply water quality or habitat improvement within the channel or its adjacent area.

Channel Modification. Alteration of a channel by changing the physical dimensions or materials of its bed or banks. Channel modification includes damming, rip-rapping or other armoring, widening, deepening, straightening, relocating, lining, and significant removal of bottom or woody vegetation. Channel modification does not include the clearing of dead or dying vegetation, debris, or trash from the channel. Channelization is a severe form of channel modification typically involving relocation of the existing channel (e.g., straightening).

Channel Stabilization. Protecting the sides and bed of a channel from erosion by controlling flow velocities and flow directions using jetties, drops, or other structures and/or by fining the channel with vegetation, riprap, concrete, or other suitable lining material.

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.

Class V injection well. A type of well, which typically has a depth greater than its largest surface dimension, emplaces fluids into the subsurface, and does not meet the definitions of Class I through Class IV wells as defined under 40 CFR 146.5. While the term includes the specific examples described in 40 CFR 144.81, septic systems that serve more than one (1) single-family dwelling or provide service for non-domestic waste, dug wells, bored wells, improved sinkholes, french drains, infiltration sumps, and infiltration galleries, it does not include surface impoundments, trenches, or ditches that are wider than they are deep.

Closed Conduit. A pipe, tube, or tile used for transmitting water.

Combined Sewer Overflow. A system designed and used to receive and transport combined sewage so that during dry periods the wastewater is carried to a treatment facility. During storm events, the excess water is discharged directly into a river, stream, or lake without treatment.

Compensatory Storage. An artificial volume of storage within a floodplain used to balance the loss of natural flood storage capacity when artificial fill or substructures are placed within the floodplain.

Compost. Organic residue (or a mixture of organic residue and soil) that has undergone biological decomposition until it has become relatively stable humus.

Comprehensive Stormwater Management Program. A comprehensive stormwater program for effective management of stormwater quantity and quality throughout the community.

Constructed Wetland. A manmade shallow pool that creates growing conditions suitable for wetland vegetation and is designed to maximize pollutant removal.

Construction activity. Land disturbing activities, and land disturbing activities associated with the construction of infrastructure and structures. This term does not include routine ditch or road maintenance or minor landscaping projects.

Construction plan. A representation of a project site and all activities associated with the project. The plan includes the location of the project site, buildings and other infrastructure, grading activities, schedules for implementation and other pertinent information related to the project site. A storm water pollution prevention plan is a part of the construction plan.

Construction site access. A stabilized stone surface at all points of ingress or egress to a project site, for the purpose of capturing and detaining sediment carried by tires of vehicles or other equipment entering or exiting the project site.

Contiguous. Adjoining or in actual contact with.

Contour Line. Line on a map which represents a contour or points of equal elevation.

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

Contractor or subcontractor. An individual or company hired by the project site or individual lot owner, their agent, or the individual lot operator to perform services on the project site.

Control Structure. A structure designed to control the rate of flow that passes through the structure, given a specific upstream and downstream water surface elevation.

Conveyance. Any structural method for transferring stormwater between at least two points. The term includes piping, ditches, swales, curbs, gutters, catch basins, channels, storm drains, and roadways.

Convolution. The process of translating precipitation excess into a runoff hydrograph.

Crawl Space. Low space below first floor of a house where there has not been excavation deep enough for a basement, usually less than seven (7) feet in depth, but where there is access for pipes, ducts, utilities and similar equipment.

Critical Duration Analysis. The process of testing different rainfall durations to find that “critical duration”, which produces the highest peak runoff or the highest storage volume.

Cross-Section. A graph or plot of ground elevation across a stream valley or a portion of it, usually along a line perpendicular to the stream or direction of flow.

Crown of Pipe. The elevation of top of pipe.

Cubic Feet Per Second (CFS). Used to describe the amount of flow passing a given point in a stream channel. One cubic foot per second is equivalent to approximately 7.5 gallons per second.

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

Curve Number (CN). The Soil Conservation Service index that represents the combined hydrologic effect of soil, land use, land cover, hydrologic condition and antecedent runoff condition.

Dam. A barrier to confine or impound water for storage or diversion, to prevent gully erosion, or to retain soil, sediment, or other debris.

Damage. Measurable rise in flood heights on buildings currently subject to flooding, flooding of buildings currently not subject to flooding and increases in volume or velocity to the point where the rate of land lost to erosion and scour is substantially increased.

Datum. Any level surface to which elevations are referred, usually Mean Sea Level.

Dechlorinated swimming pool discharge. Chlorinated water that has either sat idle for seven (7) days following chlorination prior to discharge to the MS4 conveyance, or, by analysis, does not contain detectable concentrations (less than five-hundredths (0.05) milligram per liter) of chlorinated residual.

Depressional Storage Areas. Non-riverine depressions in the earth where stormwater collects. The volumes are often referred to in units of acre-feet.

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

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 accumulate behind the outlet.

Detention Facility. A facility designed to detain a specified amount of stormwater runoff assuming a specified release rate. The volumes are often referred to in units of acre-feet.

Detention Storage. The temporary detaining of storage of stormwater 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).

Detention. Managing stormwater runoff by temporary holding and controlled release.

Detritus. Dead or decaying organic matter; generally contributed to stormwater as fallen leaves and sticks or as dead aquatic organisms.

Developer. Any person financially responsible for construction activity, or an owner of property who sells or leases, or offers for sale or lease, any lots in a subdivision.

Development. Any man-made change to improved or unimproved real estate including but not limited to:

1. Construction, reconstruction, or placement of a building or any addition to a building;
2. Construction of flood control structures such as levees, dikes, dams or channel improvements;
3. Construction or reconstruction of bridges or culverts;
4. Installing a manufactured home on a site, preparing a site for a manufactured home, or installing a recreational vehicle on a site for more than hundred eight (180) days;
5. Installing utilities, erection of walls, construction of roads, or similar projects;
6. Mining, dredging, filling, grading, excavation, or drilling operations;

7. Storage of materials; or

8. Any other activity that might change the direction, height, or velocity of flood or surface waters.

"Development" does not include activities such as the maintenance of existing buildings and facilities such as painting, re-roofing, resurfacing roads, or gardening, plowing and similar agricultural practices that do not involve filling, grading, excavation, or the construction of permanent buildings.

Direct Release. A method of stormwater management where runoff from a part or the entire development is released directly to the receiving stream without providing detention.

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.

Disposal. The discharge, deposit, injection, spilling, leaking, or placing of any solid waste or hazardous waste into or on any land or water so that the solid waste or hazardous waste, or any constituent of the waste, may enter the environment, be emitted into the air, or be discharged into any waters, including

Ditch. A man-made, open drainageway in or into which excess surface water or groundwater drained from land, stormwater runoff, or floodwaters flow either continuously or intermittently.

Drain. A buried slotted or perforated pipe or other conduit (subsurface drain) or a ditch (open drain) for carrying off surplus groundwater or surface water.

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 Classification (soil). As a natural condition of the soil, drainage refers to both the frequency and duration of periods when the soil is free of saturation. Soil drainage conditions are defined as:

- *Well-drained*--Excess water drains away rapidly, and no mottling occurs within 36 in. of the surface.

- *Moderately well drained*--Water is removed from the soil somewhat slowly resulting in small but significant periods of wetness, and mottling occurs between 18 and 36 in.

- *Poorly drained*--Water is removed so slowly that it is wet for a large part of the time, and mottling occurs between 0 and 8 in.

- *Somewhat poorly drained*--Water is removed from the soil slowly enough to keep it wet for significant periods but not all of the time, and mottling occurs between 8 to 18 in.

- *Very poorly drained*--Water is removed so slowly that the water table remains at or near the surface for the greater part of the time; there may also be periods of surface ponding; the soil has a black to gray surface layer with mottles up to the surface.

Drainage. The removal of excess surface water or groundwater from land by means of ditches or subsurface drains. Also see Natural drainage.

Drop Manhole. Manhole having a vertical drop pipe connecting the inlet pipe to the outlet pipe. The vertical drop pipe shall be located immediately outside the manhole.

Dry Well. A type of infiltration practice that allows stormwater runoff to flow directly into the ground via a bored or otherwise excavated opening in the ground surface.

Dry-Bottom Detention Basin. A basin designed to be completely dewatered after having provided its planned detention of runoff during a storm event.

Duration. The time period of a rainfall event.

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

Elevation Certificate. A form published by the Federal Emergency Management Agency that is used to certify the 100-year or base flood elevation and the lowest elevation of usable space to which a building has been constructed.

Elevation Reference Mark (ERM). Elevation benchmark tied to the National Geodetic Vertical Datum of 1929 and identified during the preparation of a Flood Insurance Study prepared for the Federal Emergency Management Agency.

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

Energy Dissipater. A device to reduce the energy of flowing water.

Environment. The sum total of all the external conditions that may act upon a living organism or community to influence its development or existence.

Erosion and sediment control measure. A practice, or a combination of practices, to control erosion and resulting sedimentation. and/or off-site damages.

Erosion and sediment control system. The use of appropriate erosion and sediment control measures to minimize sedimentation by first reducing or eliminating erosion at the source and then as necessary, trapping sediment to prevent it from being discharged from or within a project site.

Erosion control plan. A written description and site plan of pertinent information concerning erosion control measures designed to meet the requirements of this Ordinance.

Erosion. The wearing away of the land surface by water, wind, ice, gravity, or other geological agents. The following terms are used to describe different types of water erosion:

- *Accelerated erosion*--Erosion much more rapid than normal or geologic erosion, primarily as a result of the activities of man.
- *Channel erosion* --An erosion process whereby the volume and velocity of flow wears away the bed and/or banks of a well-defined channel.
- *Gully erosion* --An erosion process whereby runoff water accumulates in narrow channels and, over relatively short periods, removes the soil to considerable depths, ranging from 1-2 ft. to as much as 75-100 ft.
- *Rill erosion*--An erosion process in which numerous small channels only several inches deep are formed; occurs mainly on recently disturbed and exposed soils (see Rill).
- *Splash erosion*--The spattering of small soil particles caused by the impact of raindrops on wet soils; the loosened and spattered particles may or may not be subsequently removed by surface runoff.

- *Sheet erosion*--The gradual removal of a fairly uniform layer of soil from the land surface by runoff water.

Extraterritorial Jurisdiction (ETJ). Areas located outside the corporate limits of a community over which the community has statutory development authority.

Farm or Field Tile. A pipe installed in an agricultural area to allow subsurface drainage of farmland for the purpose of agricultural production.

FEMA. The Federal Emergency Management Agency.

Filter Strip. Usually a long, relatively narrow area (usually, 20-75 feet wide) of undisturbed or planted vegetation used near disturbed or impervious surfaces to filter stormwater pollutants for the protection of watercourses, reservoirs, or adjacent properties.

Final stabilization. The establishment of permanent vegetative cover or the application of a permanent non-erosive material to areas where all land disturbing activities have been completed and no additional land disturbing activities are planned under the current permit.

Floatable. Any solid waste that will float on the surface of the water.

Flood (or Flood Waters). A general and temporary condition of partial or complete inundation of normally dry land areas from the overflow, the unusual and rapid accumulation, or the runoff of surface waters from any source.

Flood Boundary and Floodway Map (FBFM). A map prepared by the Federal Emergency Management Agency that depicts the FEMA designated floodways within a community. This map also includes delineation of the 100-year and 500-year floodplain boundaries and the location of the Flood Insurance Study cross-sections.

Flood Crest. The maximum stage or elevation reached or expected to be reached by the waters of a specific flood at a given time.

Flood Duration. The length of time a stream is above flood stage or overflowing its banks.

Flood Easement. Easement granted to identify areas inundated by the 100-year flood and prohibit or severely restrict development activities.

Flood Elevation. The elevation at all locations delineating the maximum level of high waters for a flood of given return period.

Flood Fighting. Actions taken immediately before or during a flood to protect human life and to reduce flood damages such as evacuation, emergency sandbagging and diking.

Flood Forecasting. The process of predicting the occurrence, magnitude and duration of an imminent flood through meteorological and hydrological observations and analysis.

Flood Frequency. A statistical expression of the average time period between floods equaling or exceeding a given magnitude. For example, a 100-year flood has a magnitude expected to be equaled or exceeded on the average of once every hundred years; such a flood has a one-percent chance of being equaled or exceeded in any given year. Often used interchangeably with "recurrence interval".

Flood Hazard Area. Any floodplain, floodway, floodway fringe, or any combination thereof which is subject to inundation by the regulatory flood; or any flood plain as delineated by Zone X on a Flood Hazard Boundary Map.

Flood Hazard Boundary Map (FHBM). A map prepared by the Federal Emergency Management Agency that depicts Special Flood Hazard Areas as a Zone A within a community. There are no study text, base flood elevations, or floodways associated with this map.

Flood Insurance Rate Map (FIRM). A map prepared by the Federal Emergency Management Agency that depicts Special Flood Hazard Areas within a community. This map also includes the 100-year or Base Flood Elevation at various locations along the watercourses. More recent versions of the FIMR may also show the FEMA designated floodway boundaries and the location of the Flood Insurance Study cross-sections.

Flood Insurance Study (FIS). A study prepared by the Federal Emergency Management agency to assist a community participating in the National Flood Insurance Program in its application of the program regulations. The study consists of a text which contains community background information with respect to flooding, a floodway data table, summary of flood discharges, flood profiles, a Flood Insurance Rate Map, and a Flood Boundary and Floodway Map.

Flood Profile. A graph showing the relationship of water surface elevation to a specific location, the latter generally expressed as distance above the mouth of a stream of water flowing in a channel. It is generally drawn to show surface elevation for the crest or a specific magnitude of flooding, but may be prepared for conditions at any given time or stage.

Flood Protection Grade (FPG). The elevation of the regulatory or 100-year flood plus two (2) feet at any given location in the Special Flood Hazard Area or 100-year floodplain and/or adjacent regulated areas, if applicable.

Flood Resistant Construction (Flood Proofing). Additions, changes or adjustments to structures or property that are designed to reduce or eliminate the potential for flood damage.

Flood Storage Areas. Depressions, basins, or other areas that normally stand empty or partially empty, but fill with rainfall runoff during storms to hold the runoff and reduce downstream flow rates. The volumes are often referred to in units or acre-feet.

Floodplain Management. The operation of a program of corrective and preventive measures for reducing flood damage, including but not limited to flood control projects, floodplain land use regulations, flood proofing of buildings, and emergency preparedness plans.

Floodplain Regulations. General term applied to the full range of codes, ordinances and other regulations relating to the use of land and construction within floodplain limits. The term encompasses zoning ordinances, subdivision regulations, building and housing codes, encroachment laws and open area (space) regulations.

Floodplain. The channel proper and the areas adjoining the channel which have been or hereafter may be covered by the regulatory or 100-year flood. Any normally dry land area that is susceptible to being inundated by water from any natural source. The floodplain includes both the floodway and the floodway fringe districts.

Floodway Fringe. That portion of the flood plain lying outside the floodway, which is inundated by the regulatory flood.

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

Footing Drain. A drain pipe installed around the exterior of a basement wall foundation to relieve water pressure caused by high groundwater elevation.

Freeboard. An increment of height added to the base flood elevation to provide a factor of safety for uncertainties in calculations, unknown local conditions, wave actions and unpredictable effects such as those caused by ice or debris jams. (See Flood Protection Grade).

French Drain. A drainage trench backfilled with a coarse, water-transmitting material; may contain a perforated pipe.

Gabion. An erosion control structure consisting of a wire cage or cages filled with rocks.

Garbage. All putrescible animal solid, vegetable solid, and semisolid wastes resulting from the processing, handling, preparation, cooking, serving, or consumption of food or food materials.

Geographical Information System. A computer system capable of assembling, storing, manipulation, and displaying geographically referenced information. This technology can be used for resource management and development planning.

Geotextile Fabric. A woven or non-woven, water-permeable synthetic material used to trap sediment particles, prevent the clogging of aggregates with fine grained soil particles, or as a separator under road aggregate.

Geotextile Liner. A synthetic, impermeable fabric used to seal impoundments against leaks.

Global Positioning System. A system that provides specially coded satellite signals that is processed by a receiver, which determines position, velocity, and time. The system is funded and controlled by the U.S. Department of Defense.

Grade. (1) The inclination or slope of a channel, canal, conduit, etc., or natural ground surface usually expressed in terms of the percentage the vertical rise (or fall) bears to the corresponding horizontal distance. (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 canal bed, roadbed, top of embankment, or bottom of excavation, or other land area to a smooth, even condition.

Grading. The cutting and filling of the land surface to a desired slope or elevation.

Grass. A member of the botanical family Graminae, characterized by blade-like leaves that originate as a sheath wrapped around the stem.

Grassed swale. A type of vegetative practice used to filter stormwater runoff via a vegetated, shallow-channel conveyance.

Grassed Waterway. A natural or constructed waterway, usually broad and shallow, covered with erosion-resistant grasses and used to conduct surface water from an area.

Ground Cover (horticulture). Low-growing, spreading plants useful for low-maintenance landscape areas.

Groundwater Recharge. The infiltration of water into the earth. It may increase the total amount of water stored underground or only replenish supplies depleted through pumping or natural discharge.

Groundwater. Accumulation of underground water, natural or artificial. The term does not include

Habitat. The environment in which the life needs of a plant or animal are supplied.

Hard Surface. See “Impervious Surface.”

High Water. Maximum designed permitted or regulated water level for an impoundment.

Household Hazardous Waste. Solid waste generated by households that is ignitable, toxic, reactive, corrosive, or otherwise poses a threat to human health or the environment.

Hydraulic Grade Line (HGL). For Channel flow, the HGL is equal to the water surface whereas for pressure flow it is the piezometric surface.

Hydraulics. A branch of science that deals with the practical application of the mechanics of water movement. A typical hydraulic study is undertaken to calculate water surface elevations.

Hydrodynamic Loads. Forces imposed on structures by floodwaters due to the impact of moving water on the upstream side of the structure, drag along its sides, and eddies or negative pressures on its downstream side.

Hydrograph. For a given point on a stream, drainage basin, or a lake, a graph showing either the discharge, stage (depth), velocity, or volume of water with respect to time.

Hydrologic Unit Code. A numeric United States Geologic Survey code that corresponds to a watershed area. Each area also has a text description associated with the numeric code.

Hydrology. The science of the behavior of water in the atmosphere, on the surface of the earth, and underground. A typical hydrologic study is undertaken to compute flow rates associated with specified flood events.

Hydrometeorologic. Water-related meteorologic data such as rainfall or runoff.

Hydrostatic Loads. Those loads or pressures resulting from the static mass of water at any point of floodwater contact with a structure. They are equal in all direction and always act perpendicular to the surface on which they are applied. Hydrostatic loads can act vertically on structural members such as floors, decks and roofs, and can act laterally on upright structural members such as walls, piers, and foundations.

IDNR. Indiana Department of Natural Resources.

Illicit Discharge. Any discharge to a conveyance that is not composed entirely of stormwater except naturally occurring floatables, such as leaves or tree limbs.

Impact Areas. Areas defined or mapped that are unlikely to be easily drained because of one or more factors including but not limited to any of the following: soil type, topography, land where there is not adequate outlet, a floodway or floodplain, land within 75 feet of each bank of any regulated drain or within 75 feet from the centerline of any regulated tile ditch.

Impaired Waters. Waters that do not or are not expected to meet applicable water quality standards, as included on IDEM's CWA Section 303(d) List of Impaired Waters.

Impervious surface. Surfaces, such as pavement and rooftops, which prevent the infiltration of stormwater into the soil.

Individual building lot. A single parcel of land within a multi-parcel development.

Individual lot operator. A contractor or subcontractor working on an individual lot.

Individual lot owner. A person who has financial control of construction activities for an individual lot.

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

Infiltration practices. Any structural BMP designed to facilitate the percolation of run-off through the soil to ground water. Examples include infiltration basins or trenches, dry wells, and porous pavement.

Infiltration. Passage or movement of water into the soil.

Infiltration Swales. A depressed earthen area that is designed to promote infiltration.

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

Intermittent Stream. An intermittent stream has flowing water during certain times of the year, when groundwater provides water for stream flow. During dry periods, intermittent streams may not have flowing water. Runoff from rainfall is a supplemental source of water for stream flow.

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

Junction Chamber. A converging section of conduit, usually large enough for a person to enter, used to facilitate the flow from one or more conduits into a main conduit.

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

Land-disturbing Activity. Any man-made change of the land surface, including removing vegetative cover that exposes the underlying soil, excavating, filling, transporting and grading.

Larger common plan of development or sale. A plan, undertaken by a single project site owner or a group of project site owners acting in concert, to offer lots for sale or lease; where such land is contiguous, or is known, designated, purchased or advertised as a common unit or by a common name, such land shall be presumed as being offered for sale or lease as part of a larger common plan. The term also includes phased or other construction activity by a single entity for its own use.

Lateral Storm Sewer. A drain that has inlets connected to it but has no other storm drain connected.

Life Cycle Cost. Cost based on the total cost incurred over the system life including research, development, testing, production, construction, operation, and maintenance. Costs are normally determined on present worth or equivalent annual cost basis.

Lowest Adjacent Grade. The elevation of the lowest grade adjacent to a structure, where the soil meets the foundation around the outside of the structure (including structural members such as basement walkout, patios, decks, porches, support posts or piers, and rim of the window well.

Major Drainage System. Drainage system carrying runoff from an area of one or more square miles.

Manhole. Storm drain structure through which a person may enter to gain access to an underground storm drain or enclosed structure.

Manning Roughness Coefficient or Manning's "n" Value. A dimensionless coefficient ("n") used in the Manning's equation to account for channel wall frictional losses in steady uniform flow.

Measurable storm event. A precipitation event that results in a total measured precipitation accumulation equal to, or greater than, one-half (0.5) inch of rainfall.

Minimum Control Measure. Minimum measures required by the NPDES Phase II program. The six (6) MCMs are: Public education and outreach, Public participation and involvement, Illicit discharge detection and elimination, Construction site runoff control, Post-construction runoff control, and Pollution prevention and good housekeeping.

Minor Drainage Systems. Drainage system carrying runoff from an area of less than one square mile.

Minor Subdivision. See Subdivision, Minor.

Mulch. A natural or artificial layer of plant residue or other materials covering the land surface which conserves moisture, holds soil in place, aids in establishing plant cover, and minimizes temperature fluctuations.

Multi-Family. Any structure which contains three or more dwelling units. A dwelling unit is any structure, or part of a structure, which is constructed to a house a family.

Municipal Separate Storm Sewers. An MS4 meets all the following criteria: (1) is a conveyance or system of conveyances owned by the state, county, city, town, or other public entity; (2) discharges to waters of the U.S.; (3) is designed or used for collecting or conveying stormwater; (4) is not a combined sewer; and, (5) is not part of a Publicly Owned Treatment Works (POTW).

Municipal, state, federal, or institutional refueling area. An operating gasoline or diesel fueling area whose primary function is to provide fuel to either municipal, state, federal, or institutional equipment or vehicles.

Mutual Drain. A drain that: (1) Is located on two or more tracts of land that are under different ownership; (2) was established by the mutual consent of all the owners; and (3) was not established under or made subject to any drainage statute.

National Flood Insurance Program (NFIP). The NFIP is a Federal program enabling property owners to purchase flood insurance. The Federal Emergency Management Agency administers the NFIP in communities throughout the Unites States. The NFIP is based on an agreement between local communities and the Federal government which states that if a community will implement floodplain management measures to reduce future flood risks to new construction and substantially improved structures in flood hazard areas, the Federal government will make flood insurance available within the community as a financial protection against flood losses that do occur.

National Geodetic Vertical Datum of 1929. The nationwide, Federal Elevation datum used to reference topographic elevations to a known value.

National Pollution Discharge Elimination System (NPDES). A permit developed by the U.S. EPA through the Clean Water Act. In Indiana, the permitting process has been delegated to IDEM. This permit covers aspects of municipal stormwater quality.

Natural Drainage. The flow patterns of stormwater run-off over the land in its pre-development state.

Nonagricultural land use. Commercial use of land for the manufacturing and wholesale or retail sale of goods or services, residential or institutional use of land intended primarily to shelter people, highway use of land including lanes, alleys, and streets, and other land uses not included in agricultural land use.

Nonpoint Source Pollution. Pollution that enters a water body from diffuse origins on the watershed and does not result from discernable, confined, or discrete conveyances.

Normal Depth. Depth of flow in an open conduit during uniform flow for the given conditions.

North American Vertical Datum of 1988 (NAVD 1988). The nationwide, federal elevation datum used to reference topographic elevations to a known value.

Nutrient(s). (1) A substance necessary for the growth and reproduction of organisms. (2) In water, those substances (chiefly nitrates and phosphates) that promote growth of algae and bacteria.

Off-site. Everything not located at or within a particular site.

Off-site Land Areas. Those areas that by virtue of existing topography naturally shed surface water onto or through the developing property.

100-Year Frequency Flood. See "regulatory flood".

On-Site. Located within the controlled or urbanized area where runoff originates.

Open Drain. A natural watercourse or constructed open channel that conveys drainage water.

Open Space. Any land area devoid of any disturbed or impervious surfaces created by industrial, commercial, residential, agricultural, or other manmade activities.

Orifice. A device which controls the rate of flow from a detention basin.

Outfall scouring. The deterioration of a streambed or lakebed from an outfall discharge to an extent that the excessive settling of solid material results and suitable aquatic habitat is diminished.

Outfall. The point, location, or structure where a pipe or open drain discharges to a receiving body of water.

Outlet. The point of water disposal from a stream, river, lake, tidewater, or artificial drain.

Overland Flow. Consists of sheet flow, shallow concentrated flow and channel flow.

Peak Discharge (or Peak Flow). The maximum instantaneous flow from a given storm condition at a specific location.

Percolation. The movement of water through soil.

Perennial Stream. A stream that maintains water in its channel throughout the year.

Permanent stabilization. The establishment, at a uniform density of seventy percent (70%) across the disturbed area, of vegetative cover or permanent non-erosive material that will ensure the resistance of the soil to erosion, sliding, or other movement.

Permeability (soil). The quality of a soil that enables water or air to move through it. Usually expressed in inches per hour or inches per day.

Pervious. Allowing movement of water.

Pesticides. Chemical compounds used for the control of undesirable plants, animals, or insects. The term includes insecticides, herbicides, algicides, rodenticides, nematicides, fungicides, and growth regulators.

pH. A numerical measure of hydrogen ion activity, the neutral point being 7.0. All pH values below 7.0 are acid, and all above 7.0 are alkaline.

Phasing of construction. Sequential development of smaller portions of a large project site, stabilizing each portion before beginning land disturbance on subsequent portions, to minimize exposure of disturbed land to erosion.

Phosphorus (available). Inorganic phosphorus that is readily available for plant growth.

Piping. The formation of "pipes" by underground erosion. Water in the soil carries the fine soil particles away, and a series of eroded tubes or tunnels develop. These openings will grow progressively larger and can cause a dam failure.

Planimetric Data. Horizontal measurements involving distances or dimensions on a diagram, map, Plat of Survey or topographic map. Normally in units of feet.

Plat of Survey. A scaled diagram showing boundaries of a tract of land or subdivision. This may constitute a legal description of the land and be used in lieu of a written description.

Point Source. Any discernible, confined, and discrete conveyance including but not limited to any pipe, ditch, channel, tunnel, conduit, well, discrete fissure, or container from which pollutants are or maybe discharged (P.L. 92-500, Section 502[14]).

Pollutant of concern. Any pollutant that has been documented via analytical data as a cause of impairment in any waterbody.

Porosity. The volume of pore space in soil or rock.

Porous pavement. A type of infiltration practice to improve the quality and reduce the quantity of storm water run-off via the use of manmade, pervious pavement which allows run-off to percolate through the pavement and into underlying soils

Private Drain. A drain that: (1) Is located on land owned by one person or by two or more persons jointly; and (2) was not established under or made subject to any drainage statute.

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

Programmatic Indicator. Any data collected by an MS4 entity that is used to indicate implementation of one (1) or more minimum control measures.

Project site owner. The person required to submit a stormwater permit application, and required to comply with the terms of this ordinance, including a developer or a person who has financial and operational control of construction activities, and project plans and specifications, including the ability to make modifications to those plans and specifications.

Project site. The entire area on which construction activity is to be performed.

Probable Maximum Flood. The most severe flood that may be expected from a combination of the most critical meteorological and hydrological conditions that are reasonably possible in the drainage basin. It is used in designing high-risk flood protection works and siting of structures and facilities that shall be subject to almost no risk of flooding. The probable maximum flood is usually much larger that the 100-year flood.

Publically Owned Treatment Works (POTW). A municipal operation that breaks down and removes contaminants in the wastewater prior to discharging to a stream through primary and/or secondary treatment systems.

Qualified professional. An individual who is trained and experienced in storm water treatment techniques and related fields as may be demonstrated by state registration, professional certification, experience, or completion of coursework that enable the individual to make sound,

professional judgments regarding storm water control or treatment and monitoring, pollutant fate and transport, and drainage planning.

Radius of Curvature. Length of radius of a circle used to define a curve.

Rain garden. A vegetative practice used to alter impervious surfaces, such as roofs, into pervious surfaces for absorption and treatment of rainfall.

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

Reach. Any length of river, channel or storm drain.

Receiving Stream or Receiving Water. The body of water into which runoff or effluent is discharged. The term does not include private drains, unnamed conveyances, retention and detention basins, or constructed wetlands used as treatment.

Recharge. Replenishment of groundwater reservoirs by infiltration and transmission from the outcrop of an aquifer or from permeable soils.

Recurrence Interval. A statistical expression of the average time between floods equaling or exceeding a given magnitude.

Redevelopment. Alterations of a property that change a site or building in such a way that there is disturbances of one (1) acre or more of land. The term does not include such activities as exterior remodeling.

Regulated Drain. A drain subject to the provisions of the Indiana Drainage Code, I.C.-36-9-27.

Regulatory or 100-Year Flood. The discharge or elevation associated with the 100-year flood as calculated by a method and procedure which is acceptable to and approved by the Indiana Department of Natural Resources and the Federal Emergency Management Agency. The "regulatory flood" is also known as the "base flood".

Regulatory Floodway. See Floodway.

Release Rate - The amount of storm water release from a storm water control facility per unit of time.

Reservoir. A natural or artificially created pond, lake or other space used for storage, regulation or control of water. May be either permanent or temporary. The term is also used in the hydrologic modeling of storage facilities.

Residential Land. Used for housing or dwelling units.

Retail gasoline outlet. An operating gasoline or diesel fueling facility whose primary function is the resale of fuels. The term applies to facilities that create five thousand (5,000) or more square feet of impervious surfaces, or generate an average daily traffic count of one hundred (100) vehicles per one thousand (1,000) square feet of land area.

Retention basin. A type of storage practice, that has no positive outlet, used to retain storm water run-off for an indefinite amount of time. Runoff from this type of basin is removed only by infiltration through a porous bottom or by evaporation.

Retention. The storage of stormwater to prevent it from leaving the development site. May be temporary or permanent.

Retention Facility. A facility designed to completely retain a specified amount of stormwater runoff without release except by means of evaporation, infiltration or pumping. The volumes are often referred to in units of acre-feet.

Return Period - The average interval of time within which a given rainfall event will be equaled or exceeded once. A flood having a return period of 100 years has a one percent probability of being equaled or exceeded in any one year.

Revetment. Facing of stone or other material, either permanent or temporary, placed along the edge of a stream to stabilize the bank and protect it from the erosive action of the stream. Also see Revetment riprap.

Right-of-Way for a County Drain. The statutory right of way as defined by Indiana Code for a regulated drain.

Riparian habitat. A land area adjacent to a waterbody that supports animal and plant life associated with that waterbody.

Riparian zone. Of, on, or pertaining to the banks of a stream, river, or pond.

Riprap. Broken rock, cobble, or boulders placed on earth surfaces, such as the face of a dam or the bank of a stream, for protection against the action of water (waves). Revetment riprap is material graded such that: (1) no individual piece weighs more than 120 lbs. and (2) 90-100% will pass through a 12-inch sieve, 20-60% through a 6-inch sieve, and not more than 10% through a 12-inch sieve.

River Restoration. Restoring the channel of a stream or ditch to its perceived original, non-obstructed capacity by means of clearing & snagging, obstruction removal, and inexpensive streambank protection measures. The term "restoration", as noted, does not necessarily imply restoration or improvement of water quality or habitat within the channel or its adjacent area.

Riverine. Relating to, formed by, or resembling a stream (including creeks and rivers).

Runoff Coefficient - A decimal fraction relating the amount of rain which appears as runoff and reaches the storm drain system to the total amount of rain falling. A coefficient of 0.5 implies that 50 percent of the rain falling on a given surface appears as storm water runoff.

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

Sand. (1) Soil particles between 0.05 and 2.0 mm in diameter. (2) A soil textural class inclusive of all soils that are at least 70% sand and 15% or less clay.

Sanitary Backup. The condition where a sanitary sewer reaches capacity and surcharges into the lowest area.

Scour. The clearing and digging action of flowing water.

Sediment. Solid material (both mineral and organic) that is in suspension, is being transported, or has been moved from its site of origin by air, water, gravity, or ice and has come to rest on the earth's surface.

Sedimentation. The process that deposits soils, debris and other unconsolidated materials either on the ground surfaces or in bodies of water or watercourses.

Seepage. The passage of water or other fluid through a porous medium, such as the passage of water through an earth embankment or masonry wall.

Sensitive Water. A water body in need of priority protection or remediation base on its:

providing habitat for threatened or endangered species,

usage as a public water supply intake,

relevant community value,

usage for full body contact recreation,

exceptional use classification as found in 327 IAC 2-1-11(b), outstanding state resource water classification as found in 327 IAC 2-1-2(3) and 327 IAC 2-1.5-19(b).

Settling Basin. An enlargement in the channel of a stream to permit the settling of debris carried in suspension.

Silt Fence. A fence constructed of wood or steel supports and either natural (e.g. burlap) or synthetic fabric stretched across area of non-concentrated flow during site development to trap and retain on-site sediment due to rainfall runoff.

Silt. (1) Soil fraction consisting of particles between 0.002 and 0.05 mm in diameter. (2) A soil textural class indicating more than 80% silt.

Siphon - A closed conduit or portion of which lies above the hydraulic grade line, resulting in a pressure less than atmospheric and requiring a vacuum within the conduit to start flow. A siphon utilizes atmospheric pressure to effect or increase the flow of water through a conduit. An inverted siphon is used to carry storm water flow under an obstruction such as a sanitary sewer.

Site. The entire area included in the legal description of the land on which land disturbing activity is to be performed.

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., 1V:2H. Slope expressions in this ordinance follow the common presentation of slopes--e.g., 2:1 with the metric presentation shown in parenthesis--e.g., (1V:2H). Slopes can also be expressed in "percents". Slopes given in percents are always expressed as (100*V/H) --e.g., a 2:1 (1V:2H) slope is a 50% slope.

Soil and Water Conservation District. A public organization created under state law as a special-purpose district to develop and carry out a program of soil, water, and related resource conservation, use, and development within its boundaries. A subdivision of state government with a local governing body, established under IC 14-32.

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.

Solid Waste. Any garbage, refuse, debris, or other discarded material.

Special Flood Hazard Area. An area that is inundated during the 100-Year flood.

Spill. The unexpected, unintended, abnormal, or unapproved dumping, leakage, drainage, seepage, discharge, or other loss of petroleum, hazardous substances, extremely hazardous substances, or objectionable substances. The term does not include releases to impervious

surfaces when the substance does not migrate off the surface or penetrate the surface and enter the soil.

Spillway - A waterway in or about a hydraulic structure, for the escape of excess water.

Standard Project Flood. A term used by the U.S. Army Corps of Engineers to designate a flood that may be expected from the most severe combination of meteorological and hydrological conditions that are considered reasonable characteristics of the geographical area in which the drainage basin is located, excluding extremely rare combinations. The peak flow for a standard project flood is generally 40 – 60 percent of the probable maximum flood for the same location.

Stilling Basin - A basin used to slow water down or dissipate its energy.

Storage practices. Any structural BMP intended to store or detain stormwater and slowly release it to receiving waters or drainage systems. The term includes detention and retention basins.

Storm drain signing. Any marking procedure that identifies a storm sewer inlet as draining directly to a receiving waterbody so as to avoid dumping pollutants. The procedures can include painted or cast messages and adhesive decals.

Storm Duration. The length of time that water may be stored in any stormwater control facility, computed from the time water first begins to be stored.

Storm 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 closed conduit for conveying collected storm water, while excluding sewage and industrial wastes. Also called a storm drain.

Stormwater Drainage System - All means, natural or man-made, used for conducting storm water to, through or from a drainage area to any of the following: conduits and appurtenant features, canals, channels, ditches, storage facilities, swales, streams, culverts, streets and pumping stations.

Stormwater Facility. All ditches, channels, conduits, levees, ponds, natural and manmade impoundments, wetlands, tiles, swales, sewers and other natural or artificial means of draining surface and subsurface water from land.

Stormwater Pollution Prevention Plan. A plan developed to minimize the impact of storm water pollutants resulting from construction activities.

Stormwater Quality Management Plan. A comprehensive written document that addresses stormwater runoff quality.

Stormwater Quality Measure. A practice, or a combination of practices, to control or minimize pollutants associated with storm water runoff.

Stormwater runoff. The water derived from rains falling within a tributary basin, flowing over the surface of the ground or collected in channels or conduits.

Stormwater. Water resulting from rain, melting or melted snow, hail, or sleet.

Stream Gauging. The quantitative determination of streamflow using gauges, current meters, weirs, or other measuring instruments at selected locations (see Gauging station').

Stream Length. The length of a stream or ditch, expressed in miles, from the confluence of the stream or ditch with the receiving stream to the upstream extremity of the stream or ditch, as indicated by the solid or dashed, blue or purple line depicting the stream or ditch on the most current edition of the seven and one-half (72) minute topographic quadrangle map published by the United States Geological Survey, measured along the meanders of the stream or ditch as depicted on the map.

Stream. See lntermittent stream, Perennial stream, Receiving stream.

Streambanks. The usual boundaries (not the flood boundaries) of a stream channel. Right and left banks are named facing downstream.

Strip development. A multi-lot project where building lots front on an existing road.

Structure. Refers to a structure that is principally above ground and is enclosed by walls and a roof. The term includes but is not limited to, a gas or liquid storage tank, a manufactured home or a prefabricated building, and recreational vehicles to be installed on a site for more than 180 days.

Structural Engineer. A person licensed under the laws of the State of Indiana to engage in the designing or supervising of construction, enlargement or alteration of structures or any part thereof.

Structural Floodplain. Management Measures. Those physical or engineering measures employed to modify the way foods behave, (e.g., dams, dikes, levees, channel enlargements and diversions).

Subarea/Subbasin. Portion of a watershed divided into homogenous drainage units which can be modeled for purposes of determining runoff rates. The subareas/subbasins have distinct boundaries, as defined by the topography of the area.

Subdivision.

1. The division of a parent tract or other piece of land into at least two smaller lots so that either now or in the future the subdivider can do any of the following with one or more of the subdivided lots:
    a. Transfer ownership;
    b. Construct buildings;
    c. Create new building sites for leasehold.
2. The actual location, shape and size of a parent tract to be divided is determined by the official record of the last transfer of its ownership transacted before this chapter was enacted or by its last conditional transfer of ownership by recorded contract transacted before this chapter was enacted. The following kinds of divisions are not subdivisions and are exempt from the rules of this chapter:
    a. A division of land into two or more tracts all of which are at least ten acres in size;
    b. A division of land for the sale or exchange of tracts to correct errors in an existing legal description; provided, that no additional building sites other than for accessory buildings are created by the division;
    c. A division of land pursuant to an allocation of land in the settlement of a decedent's estate or a court decree for the distribution of property;
    d. A division of land for the acquisition of street right-of-way, or easement; and
    e. A division of land for the sale or exchange of tracts between adjoining land owners, provided that no additional building sites other than for accessory buildings are created by the division.

3. Additionally, any division of land complying fully with Section 14.02.050 is not a subdivision and shall be called a parcelization.

Subdivision, Minor. Any subdivision of not more than four lots, all with frontage on a perimeter street, or any further subdivision or re-subdivision of a nonresidential development whose lots may or may not have frontage on a perimeter street which does not include any improvement to a public road; provided, such subdivision activity involves neither the construction of any new street or road, nor the imposition of any adverse effect upon the use of the remainder of the land or adjoining property as determined by the Commission; and provided, such activity conflicts with neither any provision or portion of the Comprehensive Plan, official map, or unified zoning code, unified subdivision ordinance or any of the regulations set forth herein.

Subsoil. The B horizons of soils with distinct profiles. In soils with weak profile development, the subsoil can be defined as the soil below which roots do not normally grow.

Subsurface Drain. A pervious backfield trench, usually containing stone and perforated pipe, for intercepting groundwater or seepage.

Subwatershed. A watershed subdivision of unspecified size that forms a convenient natural unit. See also Subarea.

Sump Failure. A failure of the sump pump that results in inundation of crawl space or basement.

Sump Pump. A pump that discharges seepage from foundation footing drains.

Surcharge. Backup of water in a sanitary or storm sewer system in excess of the design capacity of the system.

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.

Suspended Solids. Solids either floating or suspended in water.

Swale. An elongated depression in the land surface that is at least seasonally wet, is usually heavily vegetated, and is normally without flowing water. Swales conduct stormwater into primary drainage channels and may provide some groundwater recharge.

Tailwater. The water surface elevation at the downstream side of a hydraulic structure (i.e. culvert, bridge, weir, dam, etc.).

Temporary Stabilization. The covering of soil to ensure its resistance to erosion, sliding, or other movement. The term includes vegetative cover, anchored mulch, or other non-erosive material applied at a uniform density of seventy percent (70%) across the disturbed area.

Thalweg. The deepest point (or centerline) of a channel.

Tile Drain. Pipe made of perforated plastic, burned clay, concrete, or similar material, laid to a designed grade and depth, to collect and carry excess water from the soil.

Tile Drainage. Land drainage by means of a series of tile lines laid at a specified depth, grade, and spacing.

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.

Topographic Map. Graphical portrayal of the topographic features of a land area, showing both the horizontal distances between the features and their elevations above a given datum.

Topography. The representation of a portion of the earth's surface showing natural and man-made features of a give locality such as rivers, streams, ditches, lakes, roads, buildings and most importantly, variations in ground elevations for the terrain of the area.

Topsoil. (1) The dark-colored surface layer, or a horizon, of a soil; when present it ranges in depth from a fraction of an inch to 2-3 ft. (2) Equivalent to the plow layer of cultivated soils. (3) Commonly used to refer to the surface layer(s), enriched in organic matter and having textural and structural characteristics favorable for plant growth.

Total Maximum Daily Load. Method used to establish allowable loadings for specified pollutants in a surface water resource to meet established water quality standards.

Toxicity. The characteristic of being poisonous or harmful to plant or animal life. The relative degree or severity of this characteristic.

TP-40 Rainfall. Design storm rainfall depth data for various durations published by the National Weather Service in their Technical Paper 40 dated 1961.

Trained individual. An individual who is trained and experienced in the principles of storm water quality, including erosion and sediment control as may be demonstrated by state registration, professional certification, experience, or completion of coursework that enable the individual to make judgments regarding storm water control or treatment and monitoring.

Transition Section. Reaches of the stream of floodway where water flows from a narrow cross-section to a wide cross-section or vice-versa.

Tributary. Based on the size of the contributing drainage area, a smaller watercourse which flows into a larger watercourse.

Turbidity. (1) Cloudiness of a liquid, caused by suspended solids. (2) A measure of the suspended solids in a liquid.

Underdrain. A small diameter perforated pipe that allows the bottom of a detention basin, channel or swale to drain.

Unified Soil Classification System. A system of classifying soils that is based on their identification according to particle size, gradation, plasticity index, and liquid limit.

Uniform Flow. A state of steady flow when the mean velocity and cross-sectional area remain constant in all sections of a reach.

Unit Hydrograph. A unit hydrograph is the hydrograph that results from one inch of precipitation excess generated uniformly over the watershed at a uniform rate during a specified period of time.

Urban Drain. A drain defined as “Urban Drain” in Indiana Drainage Code.

Urbanization The development, change or improvement of any parcel of land consisting of one or more lots for residential, commercial, industrial, institutional, recreational or public utility purposes.

Vegetative practices. Any nonstructural or structural BMP that, with optimal design and good soil conditions, utilizes various forms of vegetation to enhance pollutant removal, maintain and improve natural site hydrology, promote healthier habitats, and increase aesthetic appeal. Examples include grass swales, filter strips, buffer strips, constructed wetlands, and rain gardens.

Vegetative Stabilization. Protection of erodible or sediment producing areas with: permanent seeding (producing long-term vegetative cover), short-term seeding (producing temporary vegetative cover), or sodding (producing areas covered with a turf of perennial sod-forming grass).

Water Course. Any river, stream, creek, brook, branch, natural or man-made drainage way in or into which stormwater runoff or floodwaters flow either regularly or intermittently.

Water Quality. A term used to describe the chemical, physical, and biological characteristics of water, usually in respect to its suitability for a particular purpose.

Water Resources. The supply of groundwater and surface water in a given area.

Water Table. (1) The free surface of the groundwater. (2) That surface subject to atmospheric pressure under the ground, generally rising and failing with the season or from other conditions such as water withdrawal.

Waterbody. Any accumulation of water, surface, or underground, natural or artificial.

Watercourse. Any river, stream, creek, brook, branch, natural or man-made drainageway in or into which stormwater runoff or floodwaters flow either continuously or intermittently.

Watershed Area. All land and water within the confines of a drainage divide. See also Watershed.

Watershed. The region drained by or contributing water to a specific point that could be along a stream, lake or other stormwater facilities. Watersheds are often broken down into subareas for the purpose of hydrologic modeling.

Waterway. A naturally existing or manmade open conduit or channel utilized for the conveyance of water.

Weir. A channel-spanning structure for measuring or regulating the flow of water.

Wellhead protection area. Has the meaning set forth at 327 IAC 8-4.1-1(27).

Wet-Bottom Detention Basin (Retention Basin) - A basin designed to retain a permanent pool of water after having provided its planned detention of runoff during a storm event.

Wetlands. Areas that are inundated or saturated by surface water or groundwater at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions.

APPENDIX B

FORMS

Application Checklist
Construction Inspection Log
Closeout Inspection
Post-Construction BMP Inspection Checklists

City of Lafayette
Storm Water Review Checklist
(to be completed by Applicant)

Project Name:		
Project Location:		
Applicant:		Date Completed:

1. Application Fee

N/A	Payment Attached

2. Notice of Intent

	Draft Version of Completed Notice of Intent (State Form 47487)
	Draft Version of Newspaper Publication Notice

3. Construction Plans

	Project narrative and supporting documents, including the following information:	
		An index indicating the location, in the construction plans, of all information required by this subsection.
		Description of the nature and purpose of the project.
		Legal description of the project site. The description should be to the nearest quarter section, township, and range, and include the civil township.
		Soil properties, characteristics, limitations, and hazards associated with the project site and the measures that will be integrated into the project to overcome or minimize adverse soil conditions.
		General construction sequence of how the project site will be built, including phases of construction.
		14-Digit Watershed Hydrologic Unit Code.
		A reduced plat or project site map showing the lot numbers, lot boundaries, and road layout and names. The reduced map must be legible and submitted on a sheet or sheets no larger than eleven (11) inches by seventeen (17) inches for all phases or sections of the project site.
		A general site plan exhibit with the proposed construction area superimposed on a county GIS ortho-aerial map at a scale of 1"=100'. The exhibit should provide 2-foot contour information and include all roads and buildings within a minimum 500' radius beyond the project boundaries.
		Identification of any other state or federal water quality permits that are required for construction activities associated with the owner's project site.
	Vicinity map depicting the project site location in relationship to recognizable local landmarks, towns, and major roads, such as a USGS topographic quadrangle map, or county or municipal road map.	
	An existing project site layout that must include the following information:	
		Location, name, and normal water level of all wetlands, lakes, ponds, and water courses on, or adjacent to, the project site.
		Location of all existing structures on the project site.
		One hundred (100) year floodplains, floodway fringes, and floodways. Please note if none exists.
		Soil map of the predominant soil types, as determined by the United States Department of Agriculture (USDA), Natural Resources Conservation Service (NRCS) Soil Survey, or as determined by a soil scientist. Hydrologic classification for soils should be shown when hydrologic methods requiring soils information are used. A soil legend must be included with the soil map.
		Identification and delineation of vegetative cover such as grass, weeds, brush, and trees on the project site.

		Location of storm, sanitary, combined sewer, and septic tank systems and outfalls.
		Land use of all adjacent properties.
		Identification and delineation of sensitive areas.
		Existing topography at a contour interval appropriate to indicate drainage patterns.
		The location of regulated drains, farm drains, inlets and outfalls, if any of record.
	Final project site layout, including the following information:	
		Location of all proposed site improvements, including roads, utilities, lot delineation and identification, proposed structures, and common areas.
		One hundred (100) year floodplains, floodway fringes, and floodways. Please note if none exists.
		Proposed final topography, at a contour interval appropriate to indicate drainage patterns.
	A grading plan, including the following information:	
		Delineation of all proposed land disturbing activities, including off-site activities that will provide services to the project site.
		Location of all soil stockpiles and borrow areas.
		Information regarding any off-site borrow, stockpile, or disposal areas that are associated with a project site, and under the control of the project site owner.
		Existing and proposed topographic information.
	A drainage plan, including the following information:	
		An estimate of the peak discharge, based on the ten (10) year storm event, of the project site for both pre-construction and post-construction conditions.
		Calculation showing peak runoff rate after development for the 10-year and 100-year return period storms of critical duration do not exceed the two (2) year and 10-year return period pre-development peak runoff rates, respectively.
		Location, size, and dimensions of all existing streams to be maintained, and new drainage systems such as culverts, bridges, storm sewers, and conveyance channels, along with all associated easements.
		Locations where stormwater may be directly discharged into groundwater, such as abandoned wells or sinkholes. Please note if none exists.
		Locations of specific points where stormwater discharge will leave the project site.
		Name of all receiving waters. If the discharge is to a separate municipal storm sewer, identify the name of the municipal operator and the ultimate receiving water.
		Location, size, and dimensions of features such as permanent retention or detention facilities, including natural or constructed wetlands, used for the purpose of stormwater management. Include existing retention or detention facilities that will be maintained, enlarged, or otherwise altered and new ponds or basins to be built and the basis of their design.
		The estimated depth and amount of storage required by design of the new ponds or basins.
		One or more typical cross sections of all existing and proposed channels or other open drainage facilities carried to a point above the 100-year high water and showing the elevation of the existing land and the proposed changes, together with the high water elevations expected from the 100 year storm under the controlled conditions called for by the City Stormwater Ordinance and the Technical Standards, and the relationship of structures, streets, and other facilities.
4. Stormwater Drainage Technical Report		
	A summary report, including the following information:	
		The significant drainage problems associated with the project.
		The analysis procedure used to evaluate these problems and to propose solutions.
		Any assumptions or special conditions associated with the use of these procedures, especially the hydrologic or hydraulic methods.
		The proposed design of the drainage control system.
		The results of the analysis of the proposed drainage control system showing that it does solve the project's drainage problems. Any hydrologic or hydraulic calculations or modeling results must be adequately cited and described in the summary description. If hydrologic or hydraulic models are used, input and output files for all necessary runs must be attached.

		A map showing any drainage area subdivisions used in the analysis must accompany the report.
	A hydrologic/hydraulic analysis, consistent with the methodologies and calculation included in the Technical Standards, and including the following information:	
		A hydraulic report detailing existing and proposed drainage patterns on the subject site. The report should include a description of present land use and proposed land use. Any off-site drainage entering the site should be addressed as well. This report should be comprehensive and detail all of the steps the engineer took during the design process.
		All hydrologic and hydraulic computations should be included in the submittal. These calculations should include, but are not limited to: runoff curve numbers and runoff coefficients, runoff calculations, stage-discharge relationships, times-of-concentration and storage volumes.
		Copies of all computer runs. These computer runs should include both the input and the outputs. Electronic copies of the computer runs with input files will expedite the review process.
		A set of exhibits should be included showing the drainage sub-areas and a schematic detailing of how the computer models were set up.
		A conclusion which summarizes the hydraulic design and details how this design satisfies the City Stormwater Ordinance and Technical Standards.
5. Stormwater Pollution Prevention Plan for Construction Sites		
	Location, dimensions, detailed specifications, and construction details of all temporary and permanent stormwater quality measures.	
	Temporary stabilization plans and sequence of implementation.	
	Permanent stabilization plans and sequence of implementation.	
	Temporary and permanent stabilization plans shall include the following:	
		Specifications and application rates for soil amendments and seed mixtures.
		The type and application rate for anchored mulch.
	Construction sequence describing the relationship between implementation of stormwater quality measures and stages of construction activities.	
	A typical erosion and sediment control plan for individual lot development.	
	Self-monitoring program including plan and procedures.	
	A description of potential pollutant sources associated with the construction activities, which may reasonably be expected to add a significant amount of pollutants to stormwater discharges.	
	Material handling and storage associated with construction activity shall meet the spill prevention and spill response requirements in 327 IAC 2-6.1.	
6. Post-Construction Storm Water Pollution Prevention Plan		
	A description of potential pollutant sources from the proposed land use, which may reasonably be expected to add a significant amount of pollutants to stormwater discharges.	
	Location, dimensions, detailed specifications, and construction details of all post-construction stormwater quality measures.	
	A description of measures that will be installed to control pollutants in stormwater discharges that will occur after construction activities have been completed. Such practices include infiltration of run-off, flow reduction by use of open vegetated swales and natural depressions, buffer strip and riparian zone preservation, filter strip creation, minimization of land disturbance and surface imperviousness, maximization of open space, and stormwater retention and detention ponds.	
	A sequence describing when each post-construction stormwater quality measure will be installed.	
	Stormwater quality measures that will remove or minimize pollutants from stormwater run-off.	
	Stormwater quality measures that will be implemented to prevent or minimize adverse impacts to stream and riparian habitat.	
	A narrative description of the maintenance guidelines for all post-construction stormwater quality measures to facilitate their proper long term function.	

7. Operation and Maintenance Manual	
	The Operation and Maintenance Manual will be kept on file by the City of Lafayette for use during inspections. A copy shall also be provided to the landowner for inspection and maintenance purposes.
	Prepare the inspection and maintenance guidelines for the proposed post-construction stormwater quality measures per the Technical Standards appendices.

Date: _____
Project: _____
Inspected by: _____

Type of Inspection: ☐ Scheduled Weekly ☐ Rain Event

CONSTRUCTION SITE INSPECTION AND MAINTENANCE LOG
(To be Completed by Property Owner or Agent)

All stormwater pollution prevention BMP's shall be inspected and maintained as needed to ensure continued performance of their intended function during construction and shall continue until the entire site has been stabilized and a Notice of Termination has been issued. An inspection of the project site must be completed by the end of the next business day following each measurable storm event. If there are no measurable storm events within a given week, the site should be monitored at least once in that week. Maintenance and repair shall be conducted in accordance with the approved site plans. This log shall be kept as a permanent record and must be made available to City of Lafayette, in an organized fashion, within forty-eight (48) hours of a request.

Yes	No	N/A	
			1. Are all sediment control barriers, inlet protection and silt fences in place and functioning properly?
			2. Are all erodible slopes protected from erosion through the implementation of acceptable soil stabilization practices?
			3. Are all dewatering structures functioning properly?
			4. Are all discharge points free of any noticeable pollutant discharges?
			5. Are all discharge points free of any noticeable erosion or sediment transport?
			6. Are designated equipment washout areas properly sited, clearly marked, and being utilized?
			7. Are construction staging and parking areas restricted to areas designated as such on the plans?
			8. Are temporary soil stockpiles in approved areas and properly protected?
			9. Are construction entrances properly installed and being used and maintained?
			10. Are "Do Not Disturb" areas designated on plan sheets clearly marked on-site and avoided?
			11. Are public roads at intersections with site access roads being kept clear of sediment, debris, and mud?
			12. Is spill response equipment on-site, logically located, and easily accessed in an emergency?
			13. Are emergency response procedures and contact information clearly posted?
			14. Is solid waste properly contained?
			15. Is a stable access provided to the solid waste storage and pick-up area?
			16. Are hazardous materials, waste or otherwise, being properly handled and stored?
			17. Have previously recommended corrective actions been implemented?

If you answered "no" to any of the above questions, describe any corrective action which must be taken to remedy the problem and when the corrective actions are to be completed.

Date: _____
Project: _____
Inspected by: _____

NOTICE OF TERMINATION INSPECTION
(To be Completed by City of Lafayette or Agent)

All construction sites shall undergo a final inspection by the City of Lafayette following submittal of a Notice of Termination (NOT) by the project owner to ensure the site is stabilized and that post construction BMPs have been properly installed.

Yes	No	N/A	
			1. Have all earth disturbing activities been completed?
			2. Are all soils stabilized with either vegetation or mulch?
			3. Are all drainageways stabilized with either vegetation, rip rap, or other armament?
			4. Have all temporary erosion and sediment control measures been removed?
			5. Has all construction waste, trash, and debris been removed from the site?
			6. Have all permanent stormwater quality BMPs been installed in accordance with the plans, specifications, and details?
			7. Are all permanent BMPs free of sediment accumulation resulting from construction activities?

If you answered “no” to any of the above questions, describe any corrective action which must be taken to remedy the problem and when the corrective actions are to be completed.

Bioretention Operation, Maintenance, and Management Inspection Checklist

Project: _____

Location: _____

Date: _____ **Time:** _____

Inspector: _____ **Title:** _____

Signature: _____

Maintenance Item	Satisfactory/ Unsatisfactory	Comments
1. Debris Cleanout		
Bioretention and contributing areas clean of debris (litter, branches, etc.)		
No dumping of yard wastes into BMP		
2. Vegetation		
Plant height not less than design water depth but not greater than 6 inches		
Observed plant types consistent with approved plans		
Plants covering greater than 85% of total BMP surface area		
Plant community appears thick and healthy		
No evidence of erosion		
3. Sediment Deposits/Accumulation		
No evidence of sediment buildup around check dams or energy dissipaters.		
Sumps are not more than 50% full of sediment		
Sediment is not >20% of BMP design depth.		

4. Filter Bed		
Dewaters between storms		
Filter bed is not blocked or filled inappropriately.		
5. Outlet/Overflow Spillway		
Good Condition, no need for repair		
No evidence of erosion or downstream scour.		
Outlets are free of blockages.		

Actions to be Taken:

Wetland Operation, Maintenance, and Management Inspection Checklist

Project: _____

Location: _____

Date: _____ **Time:** _____

Inspector: _____ **Title:** _____

Signature: _____

Maintenance Item	Satisfactory/ Unsatisfactory	Comments
1. Embankment and Emergency Spillway		
Healthy vegetation with at least 85% ground cover.		
No signs of erosion on embankment.		
No animal burrows.		
Embankment is free of cracking, bulging, or sliding.		
Embankment is free of woody vegetation.		
Embankment is free of leaks or seeps		
Emergency spillway is clear of obstructions.		
2. Riser and Principal Spillway		
Low flow outlet free of obstruction.		
Trash rack is not blocked or damaged.		
Riser is free of excessive sediment buildup		
Outlet pipe is in good condition.		

Control valve is operational		
Outfall channels are stable and free of scouring.		
3. Wetland		
Plants covering greater than 85% of total wetland surface area (excluding open water areas)		
Observed plant types consistent with approved plans		
No evidence of excessive sediment accumulation in wetland area		
Water depths consistent with approved plans		
No evidence of erosion on banks.		
Wetland areas clean of debris (litter, branches, etc.)		
No evidence of dumping of yard wastes into BMP		
4. Forebay		
Sediment is being collected by forebay(s)		
Forebay is not in need of cleanout (less than 50% full)		

Actions to be Taken:_____

Infiltration Trench Operation, Maintenance, and Management Inspection Checklist

Project: _____

Location: _____

Date: _____ **Time:** _____

Inspector: _____ **Title:** _____

Signature: _____

Maintenance Item	Satisfactory/ Unsatisfactory	Comments
1. Debris Cleanout		
Trench surface clear of debris		
Inflow pipes clear of debris		
Overflow spillway clear of debris		
Inlet area clear of debris		
2. Sediment Traps or Forebays		
Obviously trapping sediment		
Greater than 50% of storage volume remaining		
3. Trench		
Trench dewaters between storms		
No evidence of sedimentation in trench		
Sediment accumulation doesn't yet require cleanout		
4. Inlets		
Good condition		
No evidence of erosion		

Maintenance Item	Satisfactory/ Unsatisfactory	Comments
5. Outlet/Overflow Spillway		
Good condition, no need for repair		
No evidence of erosion		
6. Aggregate Repairs		
Surface of aggregate clean		
Top layer of stone does not need replacement		
Trench does not need rehabilitation		

Actions to be Taken:

Infiltration Basin Operation, Maintenance, and Management Inspection Checklist

Project: _____

Location: _____

Date: _____ **Time:** _____

Inspector: _____ **Title:** _____

Signature: _____

Maintenance Item	Satisfactory/ Unsatisfactory	Comments
1. Debris Cleanout		
Basin bottom clear of debris		
Inlet clear of debris		
Outlet clear of debris		
Emergency spillway clear of debris		
2. Sediment Traps or Forebays		
Obviously trapping sediment		
Greater than 50% of storage volume remaining		
3. Vegetation		
Mowing done when needed		
No evidence of erosion		
4. Dewatering		
Basin dewatered between storms		

Maintenance Item	Satisfactory/ Unsatisfactory	Comments
5. Sediment Cleanout of Basin		
No evidence of sedimentation		
Sediment accumulation does not yet require cleanout		
6. Inlets		
Good condition		
No evidence of erosion		
7. Outlets/Overflow Spillway		
Good condition, no need for repair		
No evidence of erosion		
8. Structural Repairs		
Embankment in good repair		
Side slopes are stable		
No evidence of erosion		
9. Fences/Access Repairs		
Fences in good condition		
No damage which would allow undesirable entry		
Lock and gate function adequate		
Access point in good condition		

Actions to be Taken:

Media Filtration Operation, Maintenance, and Management Inspection Checklist

Project: _____

Location: _____

Date: _____ **Time:** _____

Inspector: _____ **Title:** _____

Signature: _____

Maintenance Item	Satisfactory/ Unsatisfactory	Comments
1. Debris Cleanout		
Contributing areas clean of debris		
Filtration facility clean of debris		
Inlet and outlets clear of debris		
2. Oil and Grease		
No evidence of filter surface clogging		
Activities in drainage area minimize oil and grease entry		
3. Vegetation		
Contributing drainage area stabilized		
No evidence of erosion		
Area mowed and clippings removed		
4. Water Retention Where Required		
Water holding chambers at normal pool		
No evidence of leakage		

Actions to be Taken: _____

Filter Strip Operation, Maintenance, and Management Inspection Checklist

Project: _____

Location: _____

Date: _____ **Time:** _____

Inspector: _____ **Title:** _____

Signature: _____

Maintenance Item	Satisfactory/ Unsatisfactory	Comments
1. Vegetation		
Observed plant types consistent with approved plans		
Vegetation is healthy		
Plants covering greater than 85% of total BMP surface area		
Grass height not more than 6 inches		
No evidence of concentrated flows		
No evidence of erosion		
2. Level Spreader		
Lip of spreader showing no signs of erosion		
Sediment noted in spreader?		

Actions to be Taken: _____

Vegetated Swale Operation, Maintenance, and Management Inspection Checklist

Project: _____

Location: _____

Date: _____ **Time:** _____

Inspector: _____ **Title:** _____

Signature: _____

Maintenance Item	Satisfactory/ Unsatisfactory	Comments
1. Debris Cleanout		
Contributing drainage areas free from debris		
2. Vegetation		
Mowing performed when needed		
No evidence of erosion		
3. Check Dams or Energy Dissipaters		
No evidence of flow going around structure		
No evidence of erosion at the downstream toe		
Soil permeability		
4. Sediment Forebay		
Sediment cleanout not needed (clean out when 50% full)		

Actions to be Taken: _____

Detention Pond Operation, Maintenance, and Management Inspection Checklist

Project: _____

Location: _____

Date: _____ **Time:** _____

Inspector: _____ **Title:** _____

Signature: _____

Maintenance Item	Satisfactory/ Unsatisfactory	Comments
1. Embankment and emergency spillway		
Healthy vegetation with at least 85% ground cover.		
No signs of erosion on embankment.		
No animal burrows.		
Embankment is free of cracking, bulging, or sliding.		
Embankment is free of woody vegetation.		
Embankment is free of leaks or seeps		
Emergency spillway is clear of obstructions.		
Vertical/horizontal alignment of top of dam “As-Built”		
2. Riser and principal spillway		
Low flow outlet free of obstruction.		
Trash rack is not blocked or damaged.		
Riser is free of excessive sediment buildup		
Outlet pipe is in good condition.		
Control valve is operational		
Outfall channels are stable and free of scouring.		

Maintenance Item	Satisfactory/ Unsatisfactory	Comments
3. Permanent Pool (Wet Ponds)		
No Evidence of undesirable vegetation		
No accumulation of floating or floatable debris		
No evidence of shoreline scour or erosion		
4. Sediment Forebays		
Sediment is being collected by forebay(s)		
Forebay is not in need of cleanout (less than 50% full)		
5. Dry Pond Areas		
Healthy vegetation with at least 85% ground cover.		
No undesirable woody vegetation		
Low flow channels clear of obstructions		
No evidence of sediment and/or trash accumulation		
6. Condition of Outfall into Ponds		
No riprap failures		
No evidence of slope erosion or scouring		
Storm drain pipes are in good condition, with no evidence of non-stormwater discharges		
Endwalls/Headwalls are in good condition		

Actions to be Taken:_____

APPENDIX C

CONSTRUCTION BMPs

BMP CN – 101
WHEEL WASH

DESCRIPTION

When a stabilized construction entrance is not preventing sediment from being tracked onto pavement, a wheel wash may be installed. Wheel washing is generally an effective BMP when installed with careful attention to topography. For example, a wheel wash can be detrimental if installed at the top of a slope abutting a right-of-way where the water from the dripping truck can run unimpeded into the street. Pressure washing combined with an adequately sized and surfaced pad with direct drainage to a large 10-foot x 10-foot sump can be very effective.

ADVANTAGES

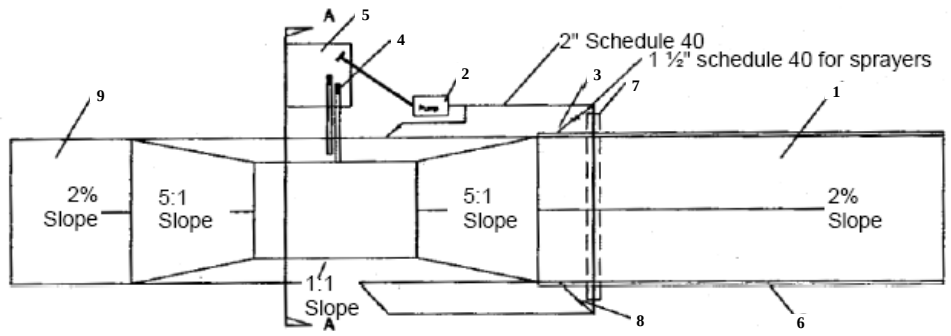
1. Wheel washes reduce the amount of sediment transported onto paved roads by motor vehicles.

DESIGN CRITERIA

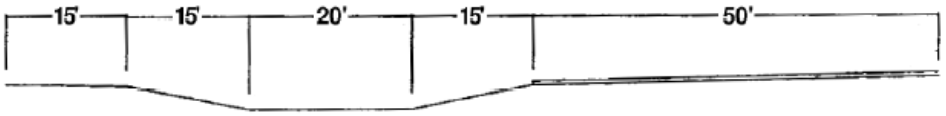
1. Suggested details are shown in Figure CN-102-A. The City of Lafayette may allow other designs.
2. A minimum of 6 inches of asphalt treated base (ATB) over crushed base material or 8 inches over a good subgrade is recommended to pave the wheel wash.
3. Use a low clearance truck to test the wheel wash before paving. Either a belly dump or lowboy will work well to test clearance.
4. Keep the water level from 12 to 14 inches deep to avoid damage to truck hubs and filling the truck tongues with water.
5. Midpoint spray nozzles are only needed in extremely muddy conditions.
6. Wheel wash systems should be designed with a small grade change, 6 to 12 inches for a 10-foot-wide pond, to allow sediment to flow to the low side of pond to help prevent re-suspension of sediment.
7. A drainpipe with a 2- to 3-foot riser should be installed on the low side of the pond to allow for easy cleaning and refilling.
8. Polymers may be used to promote coagulation and flocculation in a closed-loop system. Polyacrylamide (PAM) added to the wheel wash water at a rate of 0.25 - 0.5 pounds per 1,000 gallons of water increases effectiveness and reduces cleanup time.
9. If PAM is already being used for dust or erosion control and is being applied by a water truck, the same truck can be used to change the wash water.
10. The wheel wash should start out the day with fresh water. The wash water should be changed a minimum of once per day.
11. On large earthwork jobs where more than 10-20 trucks per hour are expected, the wash water will need to be changed more often.
12. Wheel wash or tire bath wastewater shall be discharged to a separate on-site treatment system, such as closed-loop recirculation or land application, or to the sanitary sewer with proper local sewer utility approval.

REFERENCE

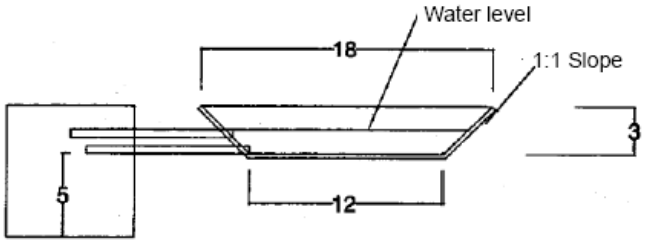
City of Tacoma, Surface Water Management Manual, 2003 or later



Wheel Wash Plan



Elevation View



Section A-A
NTS

Notes:

1. Asphalt construction entrance 6 in. asphalt treated base (ATB).
2. 3-inch trash pump with floats on the suction hose.
3. Midpoint spray nozzles, if needed.
4. 6-inch sewer pipe with butterfly valves. Bottom one is a drain. Locate top pipe's invert 1 foot above bottom of wheel wash.
5. 8 foot x 8 foot sump with 5 feet of catch. Build so can be cleaned with trackhoe.
6. Asphalt curb on the low road side to direct water back to pond.
7. 6-inch sleeve under road.
8. Ball valves.
9. 15 foot. ATB apron to protect ground from splashing water.

Figure CN-102-A

BMP CN – 102
DEWATERING STRUCTURE

DESCRIPTION

Water which is pumped from a construction site usually contains a large amount of sediment. A dewatering structure is designed to remove the sediment before water is released off-site.

This practice includes several types of dewatering structures which have different applications dependent upon site conditions and types of operation. Other innovative techniques for accomplishing the same purpose are encouraged, but only after specific plans and details are submitted to and approved by the City of Lafayette.

DESIGN CRITERIA

1. A dewatering structure must be sized (and operated) to allow pumped water to flow through the filtering device without overtopping the structure.
2. Material from any required excavation shall be stored in an area and protected in a manner that will prevent sediments from eroding and moving off-site.
3. An excavated basin (applicable to "Straw Bale/Silt Fence Pit") may be lined with filter fabric to help reduce scour and to prevent the inclusion of soil from within the structure.
4. Design criteria more specific to each particular dewatering device can be found in Figures CN-103-A through CN-103-C.
5. A dewatering structure may not be needed if there is a well-stabilized, vegetated area onsite to which water may be discharged. The area must be stabilized so that it can filter sediment and at the same time withstand the velocity of the discharged water without eroding. A minimum filtering length of 75 feet must be available in order for such a method to be feasible.
6. The filtering devices must be inspected frequently and repaired or replaced once the sediment build-up prevents the structure from functioning as designed.
7. The accumulated sediment which is removed from a dewatering device must be spread on-site and stabilized or disposed of at an approved disposal site as per approved plan.

<u>Portable Sediment Tank (see Figure CN103-A)</u>

- The structure may be constructed with steel drums, sturdy wood or other material suitable for handling the pressure exerted by the volume of water.
- Sediment tanks will have a minimum depth of 2 ft.
- The sediment tank shall be located for easy clean-out and disposal of the trapped sediment and to minimize the interference with construction activities.
- The following formula shall be used to determine the storage volume of the sediment tank:

  Pump discharge (gallons/min.) x 16 = cubic feet of storage required

- Once the water level nears the top of the tank, the pump must be shut off while the tank drains and additional capacity is made available.
- The tank shall be designed to allow for emergency flow over top of the tank. Clean-out of the tank is required once one-third of the original capacity is depleted due to sediment accumulation. The tank shall be clearly marked showing the clean-out point.

Filter Box (see Figure CN-103-B)

- The box selected should be made of steel, sturdy wood or other materials suitable to handle the pressure requirements imposed by the volume of water. Normally readily available 55 gallon drums welded top to bottom will suffice in most cases.
- Bottom of the box shall be made porous by drilling holes (or some other method).
- Coarse aggregate shall be placed over the holes at a minimum depth of 12 inches, metal "hardware" cloth may need to be placed between the aggregate and the holes if holes are drilled larger than the majority of the stone.
- As a result of the fast rate of flow of sediment-laden water through the aggregate, the effluent must be directed over a we!l-veqetated strip of at least 50 feet after Ieavinq the base of the filter box.
- The box shall be sized as follows:

  Pump discharge (gallons/min.) x 16 = cubic feet of storage required

- Once the water level nears the top of the box, the pump must be shut off while the box drains and additional capacity is made available.
- The box shall be designed/constructed to allow for emergency flow over the top of this box.
- Clean-out of the box is required once one-third of the original capacity is depleted due to sediment accumulation. The tank shall be clearly marked showing the clean-out point.
- If the stone filter does become clogged with sediment so that it no longer adequately performs its function, the stones must be pulled away from the inlet, cleaned and replaced.
- Using a filter box only allows for minimal settling time for sediment particles; therefore, it should only be used when site conditions restrict the use of the other methods.

Straw Bale/Silt Fence Pit (see Figure CN-103-C)

- Measure shall consist of straw bales, silt fence, a stone outlet (a combination of riprap and aggregate) and a wet storage pit oriented as shown in Figure CN-103-C.
- The structure must have a capacity which is dictated by the following formula:

  Pump discharge (gallons/min.) x 16 = cubic feet of storage required

- In calculating the capacity, one should include the volume available from the floor of the excavation to the crest of the stone weir.
- In any case, the excavated area should be a minimum of 3 feet below the base of the perimeter measures (straw bales or silt fence).
- The perimeter measures must be installed as per the guidelines found in BMP-4, STRAW BALE BARRIER and BMP-5, SILT FENCE.
- Once the water level nears the crest of the stone weir (emergency overflow), the pump must be shut off while the structure drains down to the elevation of the wet storage.
- The wet storage pit may be dewatered onlv after a minimum of 6 hours of sediment settling time. This effluent should be pumped across a well vegetated area or through a silt fence prior to entering a watercourse.
- Once the wet storage area becomes filled to one-half of the, excavated depth, accumulated sediment shall be removed and properly disposed of.

- Once the device has been removed, ground contours will be returned to original condition.

REFERENCE

United States Army Corps of Engineers, Handbook for the Preparation of Storm Water Pollution Prevention Plans for Construction Activities, 1997 or later

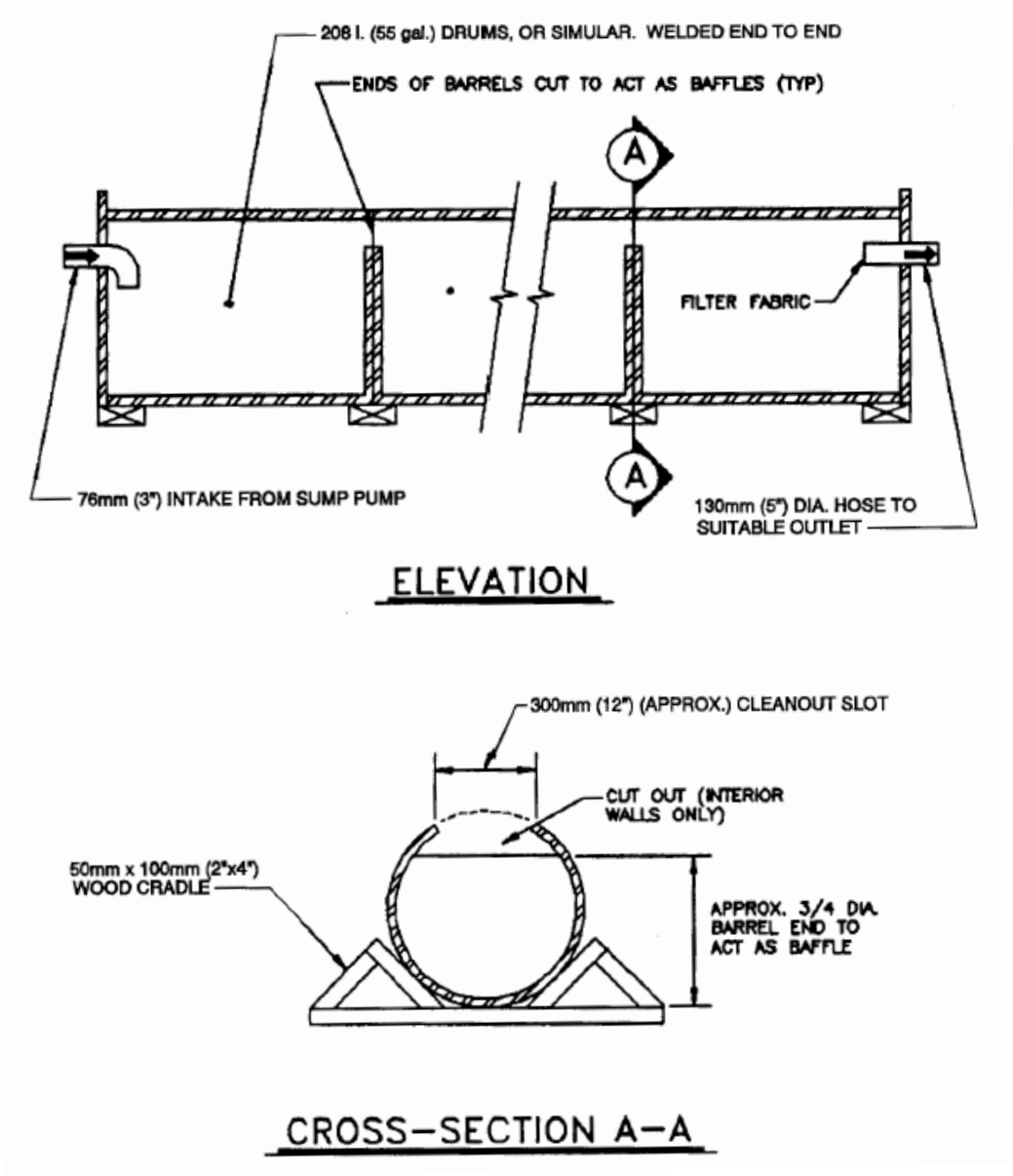


Figure CN-103-A
Portable Sediment Tank

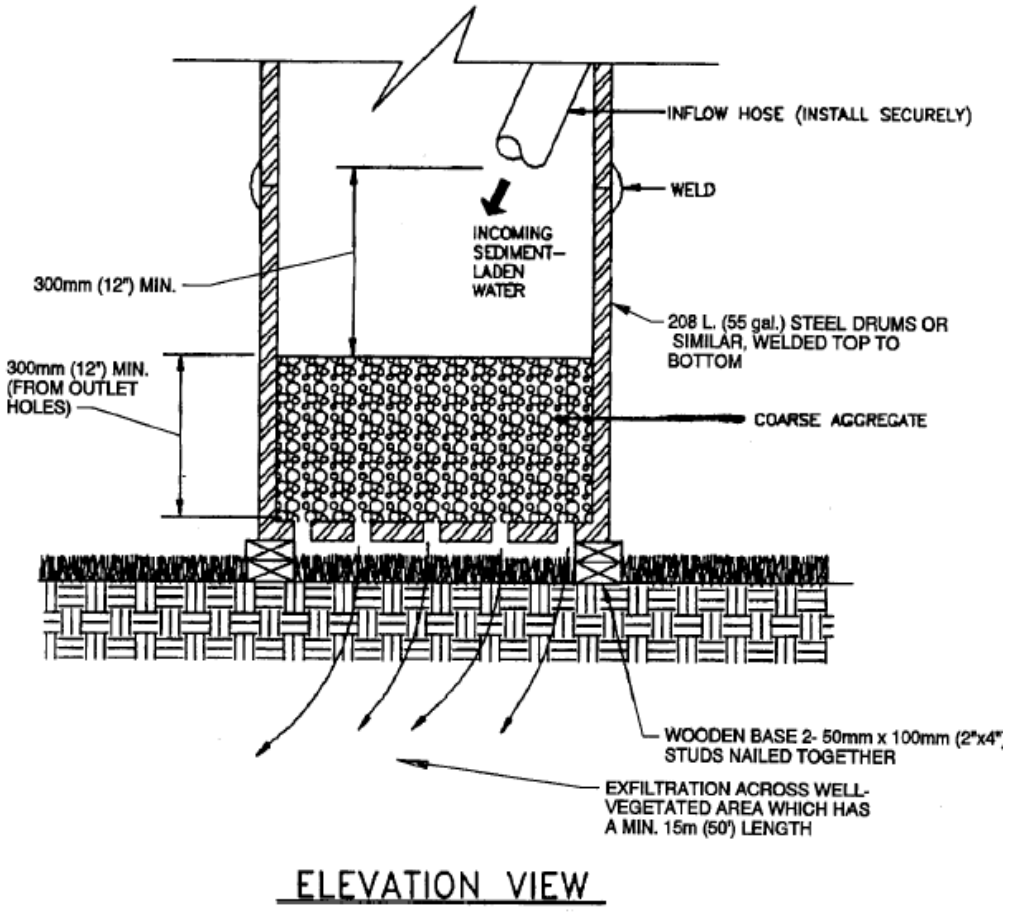
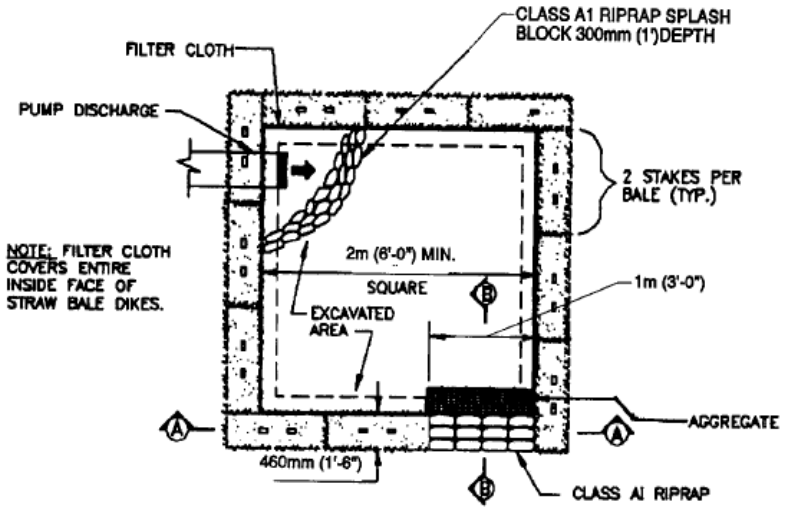
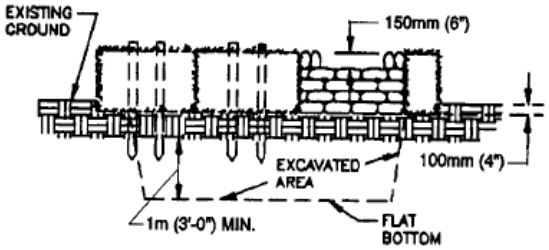


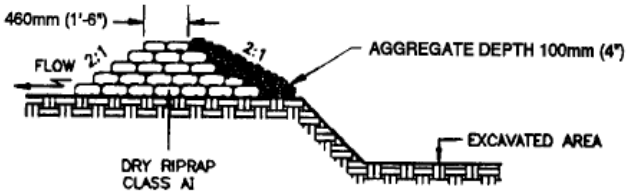
Figure CN-103-B
Filter Box



PLAN VIEW



CROSS-SECTION A-A



CROSS-SECTION B-B

Figure CN-103-C
Straw Bale/Silt Fence Pit

BMP CN – 103
SPILL PREVENTION AND CONTROL

DESCRIPTION

These procedures and practices are implemented to prevent and control spills in a manner that minimizes or prevents the discharge of spilled material to the drainage system or watercourses.

This best management practice (BMP) applies to all construction projects. Spill control procedures are implemented anytime chemicals and/or hazardous substances are stored. Substances may include, but are not limited to:

- Soil stabilizers/binders
- Dust Palliatives
- Herbicides
- Growth inhibitors
- Fertilizers
- Deicing/anti-icing chemicals
- Fuels
- Lubricants
- Other petroleum distillates

To the extent that the work can be accomplished safely, spills of oil, petroleum products, sanitary and septic wastes, and substances listed under 40 CFR parts 110, 117, and 302, and shall be contained and cleaned up immediately.

LIMITATIONS

1. This BMP only applies to spills caused by the contractor.
2. Procedures and practices presented in this BMP are general. Contractor shall identify appropriate practices for the specific materials used or stored on-site in advance of their arrival at the site.

DESIGN CRITERIA

1. To the extent that it doesn't compromise clean up activities, spills shall be covered and protected from stormwater runoff during rainfall.
2. Spills shall not be buried or washed with water.
3. Used clean up materials, contaminated materials, and recovered spill material that is no longer suitable for the intended purpose shall be stored and disposed of in conformance with BMP CN-106: Hazardous Waste Management.
4. Water used for cleaning and decontamination shall not be allowed to enter storm drains or watercourses and shall be collected and disposed of in accordance with BMP CN-106: Hazardous Waste Management.
5. Water overflow or minor water spillage shall be contained and shall not be allowed to discharge into drainage facilities or watercourses.

6. Proper storage, clean-up and spill reporting instruction for hazardous materials stored or used on the project site shall be posted at all times in an open, conspicuous and accessible location.
7. Waste storage areas shall be kept clean, well organized and equipped with ample clean-up supplies as appropriate for the materials being stored. Perimeter controls, containment structures, covers and liners shall be repaired or replaced as needed to maintain proper function.
8. Verify weekly that spill control and clean up materials are located near material storage, unloading, and use areas.
9. Update spill prevention and control plans and stock appropriate clean-up materials whenever changes occur in the types of chemicals used or stored onsite.

Cleanup and Storage Procedures for Minor Spills

- Minor spills typically involve small quantities of oil, gasoline, paint, etc., which can be controlled by the first responder at the discovery of the spill.
- Use absorbent materials on small spills rather than hosing down or burying the spill.
- Remove the absorbent materials promptly and dispose of properly.
- The practice commonly followed for a minor spill is:
    - Contain the spread of the spill.
    - Recover spilled materials.
    - Clean the contaminated area and/or properly dispose of contaminated materials.

Cleanup and Storage Procedures for Semi-Significant Spills

- Semi-significant spills still can be controlled by the first responder along with the aid of other personnel such as laborers and the foreman, etc. This response may require the cessation of all other activities.
- Clean up spills immediately:
- Notify the project foreman immediately. The foreman shall notify the Tippecanoe County Emergency Management Agency's (TEMA) Hazardous Materials Response Team at (765) 742-1334.
- Contain spread of the spill.
- If the spill occurs on paved or impermeable surfaces, clean up using "dry" methods (absorbent materials, cat litter and/or rags). Contain the spill by encircling with absorbent materials and do not let the spill spread widely.
- If the spill occurs in dirt areas, immediately contain the spill by constructing an earthen dike. Dig up and properly dispose of contaminated soil.
- If the spill occurs during rain, cover spill with tarps or other material to prevent contaminating runoff.

Cleanup and Storage Procedures for Significant/Hazardous Spills

- For significant or hazardous spills that cannot be controlled by personnel in the immediate vicinity, notify the local emergency response by dialing 911. In addition to 911, the contractor will notify the proper county officials. It is the contractor's responsibility to have all emergency phone numbers at the construction site.

- For spills of federal reportable quantities, in conformance with the requirements in 40 CFR parts 110,119, and 302, the contractor shall notify the National Response Center at (800) 424-8802.
- Notification shall first be made by telephone and followed up with a written report.
- The services of a spills contractor or a Haz-Mat team shall be obtained immediately. Construction personnel shall not attempt to clean up the spill until the appropriate and qualified personnel have arrived at the job site.

REFERENCE

California Department of Transportation, Construction Site BMP Manual, 2000 or later

BMP CN – 104
SOLID WASTE MANAGEMENT

DESCRIPTION

Solid waste management procedures and practices are designed to minimize or eliminate the discharge of pollutants to the drainage system or to watercourses as a result of the creation, stockpiling, or removal of construction site wastes.

Solid waste management procedures and practices are implemented on all construction projects that generate solid wastes.

Solid wastes include but are not limited to:

1. Construction wastes including brick, mortar, timber, steel and metal scraps, sawdust, pipe and electrical cuttings, non-hazardous equipment parts, styrofoam and other materials used to transport and package construction materials.
2. Landscaping wastes, including vegetative material, plant containers, and packaging materials.
3. Litter, including food containers, beverage cans, coffee cups, paper bags, plastic wrappers, and smoking materials, including litter generated by the public.

LIMITATIONS

1. Temporary stockpiling of certain construction wastes may not necessitate stringent drainage related controls during the non-rainy season.

DESIGN CRITERIA

1. Dumpsters of sufficient size and number shall be provided to contain the solid waste generated by the project and properly serviced.
2. Littering on the project site shall be prohibited.
3. To prevent clogging of the storm drainage system, litter and debris removal from drainage grates, trash racks, and ditch lines shall be a priority.
4. Trash receptacles with lids shall be provided in the Contractor's yard, field trailer areas, and at locations where workers congregate for lunch and break periods.
5. Construction debris and litter from work areas within the construction limits of the project site shall be collected and placed in watertight dumpsters at least weekly regardless of whether the litter was generated by the Contractor, the public, or others. Collected litter and debris shall not be placed in or next to drain inlets, storm water drainage systems or watercourses.
6. Full dumpsters shall be removed from the project site and the contents shall be disposed of, off-site, in an appropriate manner.;
7. Litter stored in collection areas and containers shall be handled and disposed of by trash hauling contractors.
8. Construction debris and waste shall be removed from the site every two weeks.
9. Stormwater run-off shall be prevented from contacting stored solid waste through the use of berms, dikes, or other temporary diversion structures or through the use of measures to elevate waste from site surfaces.
10. Solid waste storage areas shall be located at least 50 ft from drainage facilities and watercourses and shall not be located in areas prone to flooding or ponding.

11. Except during fair weather, construction and landscaping waste not stored in watertight dumpsters shall be securely covered from wind and rain by covering the waste with tarps, plastic sheeting, or equivalent.
12. Dumpster washout on the project site is not allowed.
13. Notify trash hauling contractors that only watertight dumpsters are acceptable for use on-site.
14. Plan for additional containers during the demolition phase of construction.
15. Plan for more frequent pickup during the demolition phase of construction.
16. Construction waste shall be stored in a designated area. Access to the designated area shall either be well vegetated ground, a concrete or asphalt road or drive, or a gravel construction entrance, to avoid mud tracking by trash hauling contractors.
17. Segregate potentially hazardous waste from non-hazardous construction site waste.
18. Keep the site clean of litter debris.
19. Make sure that toxic liquid wastes (e.g., used oils, solvents, and paints) and chemicals (e.g., acids, pesticides, additives, curing compounds) are not disposed of in dumpsters designated for construction debris.
20. For disposal of hazardous waste, see BMP CN-106: Hazardous Waste Management. Have hazardous waste hauled to an appropriate disposal and/or recycling facility.
21. Salvage or recycle useful vegetation debris, packaging and/or surplus building materials when practical. For example, trees and shrubs from land clearing can be converted into wood chips, then used as mulch on graded areas. Wood pallets, cardboard boxes, and construction scraps can also be recycled.
22. Prohibit littering by employees, subcontractors, and visitors.
23. Wherever possible, minimize production of solid waste materials.

REFERENCE

California Department of Transportation, Construction Site BMP Manual, 2000 or later

BMP CN – 105
HAZARDOUS WASTE MANAGEMENT

DESCRIPTION

These are procedures and practices to minimize or eliminate the discharge of pollutants from construction site hazardous waste to the storm drain systems or to watercourses.

This best management practice (BMP) applies to all construction projects.

Hazardous waste management practices are implemented on construction projects that generate waste from the use of:

- Petroleum Products,
- Asphalt Products,
- Concrete Curing Compounds,
- Pesticides,
- Acids,
- Paints,
- Stains,
- Solvents,
- Wood Preservatives,
- Roofing Tar, or
- Any materials deemed a hazardous waste in 40 CFR Parts 110, 117, 261, or 302.

DESIGN CRITERIA

Storage Procedures

1. Wastes shall be stored in sealed containers constructed of a suitable material and shall be labeled as required by 49 CFR Parts 172,173, 178, and 179.
2. All hazardous waste shall be stored, transported, and disposed as required in 49 CFR 261-263.
3. Waste containers shall be stored in temporary containment facilities that shall comply with the following requirements:
   - Temporary containment facility shall provide for a spill containment volume able to contain precipitation from a 24-hour, 25 year storm event, plus the greater of 10% of the aggregate volume of all containers or 100% of the capacity of the largest tank within its boundary, whichever is greater.
   - Temporary containment facility shall be impervious to the materials stored there for a minimum contact time of 72 hours.
   - Temporary containment facilities shall be maintained free of accumulated rainwater and spills. In the event of spills or leaks accumulated rainwater and spills shall be placed into drums after each rainfall. These liquids shall be handled as a hazardous waste unless testing determines them to be non-hazardous. Non-hazardous liquids shall be sent to an approved disposal site.
   - Sufficient separation shall be provided between stored containers to allow for spill cleanup and emergency response access.
   - Incompatible materials, such as chlorine and ammonia, shall not be stored in the same temporary containment facility.

- Throughout the rainy season, temporary containment facilities shall be covered during non-working days, and prior to rain events. Covered facilities may include use of plastic tarps for small facilities or constructed roofs with overhangs. A storage facility having a solid cover and sides is preferred to a temporary tarp. Storage facilities shall be equipped with adequate ventilation.

4. Drums shall not be overfilled and wastes shall not be mixed.
5. Unless watertight, containers of dry waste shall be stored on pallets.
6. Paint brushes and equipment for water and oil based paints shall be cleaned within a contained area and shall not be allowed to contaminate site soils, watercourses or drainage systems. Waste paints, thinners, solvents, residues, and sludges that cannot be recycled or reused shall be disposed of as hazardous waste. When thoroughly dry, latex paint and paint cans, used brushes, rags, absorbent materials, and drop cloths shall be disposed of as solid waste.
7. Ensure that adequate hazardous waste storage volume is available.
8. Ensure that hazardous waste collection containers are conveniently located.
9. Designate hazardous waste storage areas on site away from storm drains or watercourses and away from moving vehicles and equipment to prevent accidental spills.
10. Minimize production or generation of hazardous materials and hazardous waste on the job site.
11. Use containment berms in fueling and maintenance areas and where the potential for spills is high.
12. Segregate potentially hazardous waste from non-hazardous construction site debris.
13. Keep liquid or semi-liquid hazardous waste in appropriate containers (closed drums or similar) and under cover.
14. Clearly label all hazardous waste containers with the waste being stored and the date of accumulation.
15. Place hazardous waste containers in secondary containment.
16. Do not allow potentially hazardous waste materials to accumulate on the ground.
17. Do not mix wastes.

<u>Disposal Procedures</u>

1. Waste shall be removed from the site within 90 days of being generated.
2. Waste shall be disposed of by a licensed hazardous waste transporter at an authorized and licensed disposal facility or recycling facility utilizing properly completed Uniform Hazardous Waste Manifest forms.
3. A certified laboratory shall sample waste and classify it to determine the appropriate disposal facility.
4. Make sure that toxic liquid wastes (e.g., used oils, solvents, and paints) and chemicals (e.g., acids, pesticides, additives, curing compounds) are not disposed of in dumpsters designated for solid waste construction debris.
5. Properly dispose of rainwater in secondary containment that may have mixed with hazardous waste.
6. Recycle any useful material such as used oil or water-based paint when practical.

<u>Maintenance and Inspection</u>

1. A foreman and/or construction supervisor shall monitor on-site hazardous waste storage and disposal procedures.
2. Waste storage areas shall be kept clean, well organized, and equipped with ample clean-up supplies as appropriate for the materials being stored.

3. Storage areas shall be inspected in conformance with the provisions in the contract documents.
4. Perimeter controls, containment structures, covers, and liners shall be repaired or replaced as needed to maintain proper function.
5. Hazardous spills shall be cleaned up and reported in conformance with the applicable Material Safety Data Sheet (MSDS) and the instructions posted at the project site.
6. The National Response Center, at (800) 424-8802, shall be notified of spills of Federal reportable quantities in conformance with the requirements in 40 CFR parts 110, 117, and 302.
7. Copy of the hazardous waste manifests shall be provided to the Owner.

REFERENCE

California Department of Transportation, Construction Site BMP Manual, 2000 or later