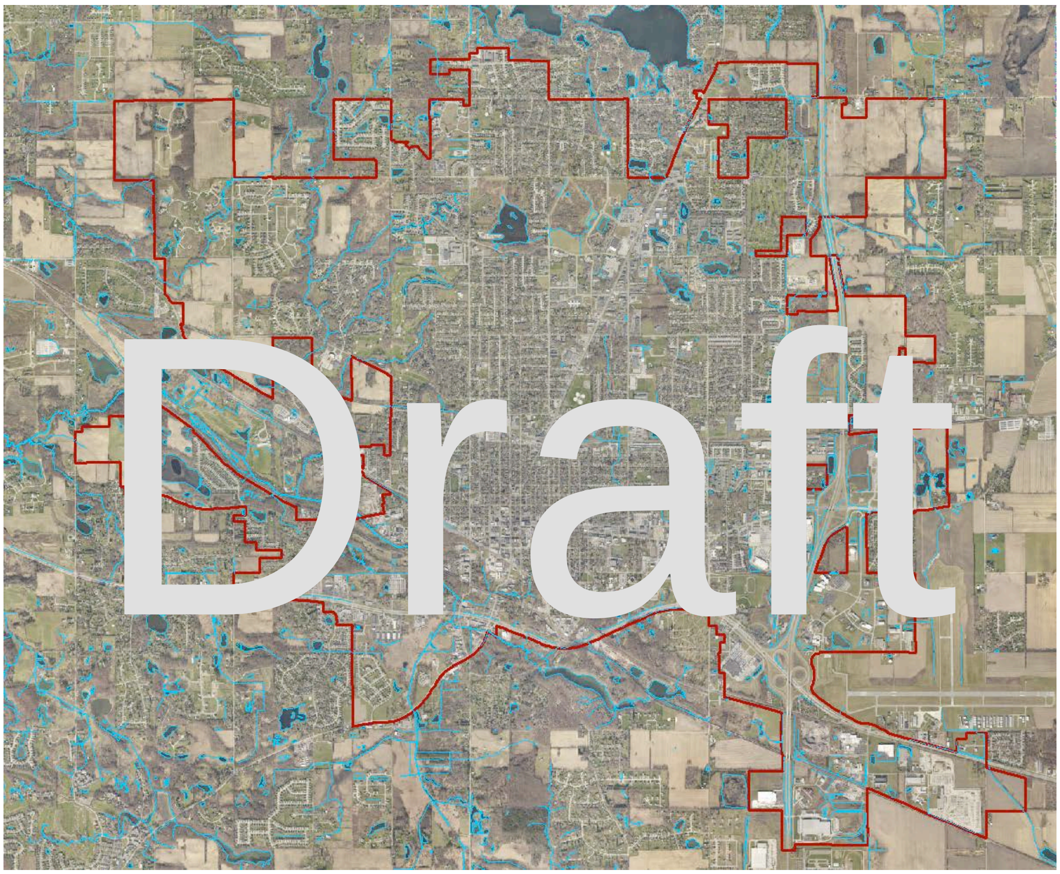
# CITY OF VALPARAISO
# STORMWATER MANAGEMENT MANUAL





PREPARED BY: VALPARAISO ENGINEERING DEPARTMENT
ADOPTED BY: VALPARAISO CITY UTILITIES
DATE: PENDING PUBLIC REVIEW

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# SECTION I: INTRODUCTION

## i. PURPOSE AND INTENT

The purpose of this document is to establish minimum stormwater management specifications and standards to protect the public well-being and water resources of the City of Valparaiso (City) through runoff volume and quality management and appropriate erosion control.

## ii. LIABILITY

This document does not impose any liability on the City due to damage incurred under reliance on this document. This document does not ensure that developments will remain free of stormwater damage caused by increased amounts of runoff outside of the scientific and historic scope used as a standard.

## iii. APPLICABILTY

All development, construction, or renovation/addition shall provide appropriate stormwater runoff and erosion control as outlined in this document.



# SECTION II: SUBMITTED DRAINAGE PLAN SET REQUIREMENTS

## i. GENERAL REQUIREMENT

Drainage plans shall be submitted for any land development within the City. All drainage plans must be approved by the City Engineer prior to the issuance of a building, site, or erosion control permit. It shall be noted that approval by the City Engineer does not hold that person or the City liable if stormwater damage should occur on a development.

All drainage plans for a site with acreage less than one (1) acre or no unusual drainage circumstances, shall be drawn by an architect, landscape architect, Indiana certified professional engineer or land surveyor unless required differently by the City Engineer. For a site with one (1) acre or greater of acreage or unusual drainage circumstances plans shall be prepared by an Indiana certified professional engineer.

## ii. DRAINAGE PLAN CONTENT

All drainage plans shall be designed with the goal of adequately controlling the rate, volume, and quality of stormwater runoff. Plans shall include sufficient site information, such as but not limited to topographic maps, utility locations, unusual site characteristics, and existing drainage structures/courses, in order to assess all potential impacts and the overall effectiveness of the proposed drainage plan.

## iii. CALCULATIONS

Sufficient calculations analyzing all existing and proposed drainage courses, drainage control measures, or detention/retention ponds shall be provided, as required by the City Engineer, to assess potential impacts.

## iv. LONG-TERM MAINTENANCE PLAN

A long-term maintenance plan shall be provided for all existing and proposed drainage courses, drainage control measures, Best Management Practices (BMPs), or detention/retention ponds. The party in charge of maintaining the development will be decided prior to any construction. In the case that a party other than the City is in charge of maintenance, the City reserves the right to conduct any routine inspection or emergency maintenance as deemed necessary.

## v. EROSION AND SEDIMENTATION CONTROL PLAN

### a. GENERAL

A Stormwater Pollution Prevention Plan (SWPPP) shall be required with the submittal of an application for an Erosion Control Permit. A Rule 5 Permit shall be obtained for all sites greater than or equal to one acre (1-acre) in area. All plans submitted shall be drawn in a manner to accurately convey all site characteristics and proposed erosion control measures. The minimum scale for drawn plans shall be 1 inch = 100 feet.

### b. SITES NOT UNDER RULE 5 JURISDICTION

As a minimum, plans shall include:

1. Direction of surface slopes
2. Watercourses (with sizes)

3. Soil seeding and stabilization methods
4. Locations for proposed erosion control installations, such as silt fences, inlet protection, diversions, silt traps, filters

### c. SITES UNDER RULE 5 JURISDICTION

Submitted plans shall be in accordance with the requirements of Rule 5.

## SECTION III: RUNOFF DETERMINATION

Runoff rates shall be calculated for the area of the site under development plus the area of the watershed flowing into the site. The following methodologies are approved for calculating runoff:

### i. Rational Method

For sites of an area less than or equal to five (5) acres with no depressional storage, the Rational Method should be employed. The equation is as follows:

$$Q=C\ I\ A$$

| | | | |
|---|---|---|---|
| Where: | Q | = | Peak Discharge (cfs) |
| | C | = | Runoff Coefficient |
| | I | = | Rainfall Intensity (in/hr) |
| | A | = | Contributing Drainage Area (acres) |

In Table III-1 and Table III-2, Runoff Coefficient “C” values are available. If a composite “C” value is required, a weighted average of distinct surface type area over total area should be calculated. Intensity “I” values are available in Table III-3.



Table III-1

## 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 |



Table III-2

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 |



Table III-3
RAINFAL DEPTHS FOR VALPARAISO, IN (in.)

| Duration | Frequency of Recurrence | | | | | |
|---|---|---|---|---|---|---|
| | 2-yr | 5-yr | 10-yr | 25-yr | 50-yr | 100-yr |
| 24-hr | 2.89 | 3.72 | 4.42 | 5.42 | 6.27 | 7.19 |
| 12-hr | 2.45 | 3.14 | 3.73 | 4.56 | 5.28 | 6.03 |
| 6-hr | 2.10 | 2.70 | 3.22 | 3.97 | 4.60 | 5.28 |
| 3-hr | 1.74 | 2.24 | 2.67 | 3.26 | 3.77 | 4.31 |
| 2-hr | 1.61 | 2.08 | 2.46 | 2.99 | 3.45 | 3.92 |
| 1-hr | 1.39 | 1.73 | 2.00 | 2.36 | 2.66 | 2.96 |
| 30-min | 1.13 | 1.38 | 1.57 | 1.82 | 2.02 | 2.22 |
| 15-min | 0.847 | 1.01 | 1.13 | 1.29 | 1.41 | 1.53 |
| 10-min | 0.693 | 0.820 | 0.921 | 1.04 | 1.14 | 1.24 |
| 5-min | 0.444 | 0.527 | 0.597 | 0.683 | 0.753 | 0.820 |

Data was obtained from NOAA Precipitation Frequency Data Server

Table III-4
RAINFALL INTENSITY TABULATED VALUES FOR VALPARAISO, IN (in./hr.)

| Duration | Frequency of Recurrence | | | | | |
|---|---|---|---|---|---|---|
| | 2-yr | 5-yr | 10-yr | 25-yr | 50-yr | 100-yr |
| 24-hr | 0.120 | 0.155 | 0.184 | 0.226 | 0.261 | 0.300 |
| 12-hr | 0.204 | 0.262 | 0.311 | 0.380 | 0.440 | 0.503 |
| 6-hr | 0.350 | 0.450 | 0.537 | 0.662 | 0.767 | 0.880 |
| 3-hr | 0.580 | 0.747 | 0.890 | 1.087 | 1.257 | 1.437 |
| 2-hr | 0.805 | 1.04 | 1.23 | 1.50 | 1.73 | 1.96 |
| 1-hr | 1.39 | 1.73 | 2.00 | 2.36 | 2.66 | 2.96 |
| 30-min | 2.26 | 2.76 | 3.14 | 3.64 | 4.04 | 4.44 |
| 15-min | 3.39 | 4.04 | 4.52 | 5.16 | 5.64 | 6.12 |
| 10-min | 4.16 | 4.92 | 5.53 | 6.24 | 6.84 | 7.44 |
| 5-min | 5.33 | 6.32 | 7.16 | 8.20 | 9.04 | 9.84 |

Data used in the determination of these values was obtained from NOAA Precipitation Frequency Data Server



## ii. HYDROGRAPH METHOD

For sites greater than five acres in area or a site with depressional storage, the hydrograph method modeled by computer programs capable of generating a hydrograph, such as but not limited to TR-20 or XPSWMM, should be used. Typical curve number values may be found in Table III-5 and the SCS Type II Rainfall Distribution Data may be found in Table III-6.

Table III-5
TYPICAL LAND USE AND HYDROLOGIC SOIL GROUP CURVE NUMBERS

| **Land Use Description** | | **Hydrologic Soil Group** | | | |
|---|---|---|---|---|---|
| | | A | B | C | D |
| Cultivated land: Without Conservation Treatment | | 72 | 81 | 88 | 91 |
| With Conservation Treatment | | 62 | 71 | 78 | 81 |
| Pasture or Range Land: Poor Condition | | 68 | 79 | 86 | 89 |
| Good Condition | | 39 | 61 | 74 | 80 |
| Meadow: Good Condition | | 30 | 58 | 71 | 78 |
| Wood or Forest Land: Thin Stand, Poor Cover, No Mulch | | 45 | 66 | 77 | 83 |
| Good Cover | | 25 | 55 | 70 | 77 |
| Open spaces, lawns, parks, golf courses, cemeteries, etc. | | | | | |
| Good Condition: Grass Cover on 75% or more of area | | 39 | 61 | 74 | 80 |
| Fair Condition: Grass cover on 50% to 75% of area | | 49 | 69 | 79 | 84 |
| Commercial and Business Areas (85% Impervious) | | 89 | 92 | 94 | 95 |
| Industrial Districts (70% Impervious) | | 81 | 88 | 91 | 93 |
| Residential (Including House, Driveway, and Lawn): | | | | | |
| Average Lot Size | Average % Impervious | | | | |
| 1/8 acre or less | 65 | 77 | 85 | 90 | 92 |
| 1/4 acre | 38 | 61 | 75 | 83 | 87 |
| 1/3 acre | 30 | 57 | 72 | 81 | 86 |
| 3/4 acre | 25 | 54 | 70 | 80 | 85 |
| 1 acre or less | 20 | 51 | 68 | 79 | 84 |
| Detention Basins, Wetlands, Ponds, and Lakes | | 98 | 98 | 98 | 98 |
| Paved Parking Lots, Roofs, Driveways, etc. | | 98 | 98 | 98 | 98 |
| Streets and Roads | | | | | |
| Paved with Curbs and Storm Sewers | | 98 | 98 | 98 | 98 |
| Gravel | | 76 | 85 | 89 | 91 |
| Dirt | | 72 | 82 | 87 | 89 |

Table III-6
SCS TYPE II DISTRIBUTION DATA

| Hour | Percent Of Total Rainfall (%) |
|---|---|
| 1 | 1.33 |
| 2 | 2.66 |
| 3 | 4.00 |
| 4 | 5.33 |
| 5 | 6.66 |
| 6 | 8.00 |
| 7 | 9.33 |
| 8 | 11.33 |
| 9 | 14.00 |
| 10 | 18.00 |
| 11 | 24.00 |
| 12 | 50.00 |
| 13 | 76.00 |
| 14 | 82.00 |
| 15 | 86.00 |
| 16 | 88.66 |
| 17 | 90.66 |
| 18 | 92.00 |
| 19 | 93.33 |
| 20 | 94.66 |
| 21 | 96.00 |
| 22 | 97.33 |
| 23 | 98.66 |
| 24 | 100.00 |

Both the rational method and hydrograph method outlined in this document are intended as a general guideline for design. For further detail on these methodologies, please reference the Local Technical Assistance Program (LTAP) Stormwater Drainage Manual.



## SECTION IV: DETENTION/RETENTION BASIN DESIGN

### i. REQUIREMENT OF BASIN

Detention/Retention basins shall be required when necessary for any proposed new development in order to control the effects of urbanization and the rate of stormwater entering the City's storm drainage system and receiving waters.

### ii. STORAGE VOLUME DETERMINATION

#### a. RATIONAL METHOD

For sites of an area less than or equal to five (5) acres with no depressional storage, the Rational Method should be employed. The Rational Method is outlined in the following steps:

1. Determine the total site drainage area, A, in acres.
2. Multiply the area, A, by the 0.2 cfs/acre release rate standard to determine the peak allowable release rate for the site, $Q_R$
3. Determine the 100-year return rainfall intensity, $I_d$, for storm durations, $t_d$, from 5 minutes to 24 hours for the developed area using Table III-4.
4. Compute developed inflow rate, $Q_d$, for various storm durations (in hours) using the equation:

$$Q_d = C_d \, I_d \, A$$

5. Compute the storage rate $S_{td}$ for various storm durations, $t_d$, through the time of concentration of the developed area using the equation:

$$S_{td} = Q_d - Q_R$$

6. Compute the required storage volume, $S_r$, in acre-feet for each storm duration, $t_d$ using the equation:

$$S_r = S_{td} \, (t_d/12)$$

7. Select the greatest storage volume calculated to use for detention/retention design. The pond should be sized to store this amount of runoff.

### b. HYDROGRAPH METHOD

For sites of an area greater than five acres or depressional storage, the Hydrograph Method should be employed via computer programs capable of generating a hydrograph, such as but not limited to TR-20 or XPSWMM. The SCS Curve Number Methodology and Type 2 rainfall distribution shall be utilized to determine the appropriate pond storage requirements.

## iii. ALLOWABLE RELEASE RATES

### a. GENERAL RELEASE RATES

All detention/retention basins shall be designed to adequately store runoff from the 100-year critical duration storm event occurring under developed circumstances. The post-development release rate shall not exceed 0.2 cubic feet per second per acre (0.2 cfs/acre) for 0-100 year frequency storms. The City Engineer may deviate from this requirement for smaller sites where the low discharge rate may cause pond maintenance concerns. For sites where pre-developed conditions consisted of more than one discharge outlet, the release rate for each outlet shall be calculated based on the pre-developed discharge at each outlet.

#### b. DEPRESSIONAL STORAGE

For sites with depressional storage, the runoff rate should be modeled so as to treat the depressional storage as a pond whose outlet is a weir at the elevation that stormwater runoff would overflow the depressional storage into existing designed conditions. The initial state of the depressional storage shall be assumed at an accepted water level depth.



### iv. MANAGEMENT OF OFF-SITE RUNOFF

All runoff from upstream land tributaries (off-site land areas) may be bypassed around or routed through a channel separate from the primary channel of the detention/retention basin. The primary outlet structure location and the invert elevation of the emergency overflow weir shall be determined by considering on-site runoff only, unless the basin is acting as a regional detention/retention basin. Once the outlet structure location and emergency overflow weir elevation have been determined, both on-site and off-site flow shall be routed through the basin to determine the 100-year pond elevation.

### v. EMERGENCY OVERFLOW

An emergency overflow spillway shall be located at the 100-year pond elevation with an additional one-foot freeboard in the design of any proposed detention/retention basin. At a minimum, the emergency overflow spillway shall have the capacity to handle one and one-quarter (1.25) times the peak inflow rate from the 100-year storm under developed conditions.

### vi. GEOMETRIC REQUIREMENTS AND AESTHETICS

Detention/Retention basins shall be designed according to the following geometric and aesthetic requirements:

1. Side slopes of the basin shall not exceed a ratio of 3:1 (horizontal: vertical).
2. Depth at the center of the basin shall not exceed fifteen feet (15-ft.) below the freeboard unless permitted otherwise by the City Engineer.
3. One foot of freeboard shall be provided above the 100-year pond level.
4. The bottom slope toward the outlet shall not exceed one-percent (1%).
5. Distance between inlet and outlet shall be optimized to the greatest extent feasible.
6. Forebays shall be used at the entry of the basin as a pretreatment to help capture solids.
7. Basins shall be designed in an aesthetically pleasing manner through the use of native landscaping, varying slopes, and curved lines reflecting a natural appearance.

## vii. SAFTEY REQUIREMENTS

Detention/Retention basins shall be designed according to the following safety requirements:

1. A safety ledge with a maximum slope ratio of 6:1 (horizontal: vertical) shall be provided around all retention basins over five feet deep. The ledge shall be located one foot below the normal water level in a wet basin.
2. Pipe screens shall be used to cover all pipe outfalls in order to prevent animals or people from entering the structure.
3. The use of fences is suggested in the design of retention basins to protect public safety. In lieu of a fence, vegetation may be used around the basin to inhibit people from entering.
4. Proper signage shall be provided to inform the public of deep water and potential flooding conditions.

## viii. MAINTENANCE

Appropriate maintenance techniques shall be employed to promote the proper operation of the basin throughout its use. Basin maintenance is generally the responsibility of the development property owner or property owner association. These techniques include but are not limited to vegetation maintenance, forebay cleaning/inspection, and debris/garbage removal. Easements shall be provided, as outlined in SECTION VII, to allow required maintenance to occur.

## ix. SPECIAL APPROVAL BASINS

### a. PAVED AREA BASINS

Paved areas such as parking lots may be used for detention basins where the City Engineer determines that they contribute to the function of the overall stormwater management system for the proposed development. The paved area basin shall be designed with a maximum stored water depth of six inches (6-in.) to prevent damage to vehicles or adjacent property. Generally, the basin should be located in the more remote area of the paved lot and/or in service drives.

### b. UNDERGROUND BASINS

Underground detention basins are permitted, but should be used only when no other options are available. Underground basins shall be designed using vaults, water quality isolator rows, pipe networks, or other means that allow access for inspection, cleaning, and/or maintenance. Maintenance of the underground basins is generally the responsibility of the individual property owner.

# SECTION V: OPEN CHANNEL DESIGN

## i. DESIGN STORM FREQUENCY

All channels, swales, ditches, overland flow paths, and culverts shall be designed to contain the runoff produced by the 100-year storm. All storm sewers shall be designed to contain the runoff produced by the 10-year storm. A flood routing grading plan will be required to detail provisions in the case of the 100-yr storm.

## ii. MANNING'S "n" DESIGN METHOD

All open channels shall be designed according to Manning's "n" equation:

$$Q = (1.49/n)(A)(R^{2/3})(S^{1/2})$$

Where: Q = Peak Discharge (cfs)
n = Manning's Roughness Coefficient
A = Wetted Area ($ft^2$)

| | | |
|---|---|---|
| R | = | Hydraulic Radius (ft) |
| S | = | Slope (ft/ft) |

The hydraulic radius, R, shall be calculated by dividing the cross-sectional area of flow by the wetted perimeter. Acceptable Manning's "n" values are available in Table V-1. For further detail on this methodology, please reference the LTAP Stormwater Drainage Manual.



Table V-1
TYPICAL MANNING'S "n" VALUES

| Material | Manning's "n" |
|---|---|
| **Closed Conduits** | |
| Concrete | 0.013 |
| Vitrified Clay | 0.013 |
| Brick | 0.015 |
| Cast Iron | 0.013 |
| HDPE | 0.012 |
| PVC | 0.011 |
| **Circular CMP, Annular Corrugations, 2 ⅔ x ½ in.** | |
| Unpaved | 0.024 |
| 25% Paved | 0.021 |
| 50% Paved | 0.018 |
| 100% Paved | 0.013 |
| HDPE or PVC | 0.012 |
| **Circular CMP, Helical, 2 ⅔ x ½ in., Unpaved Corrugations** | |
| 12 in. | 0.011 |
| 18 in. | 0.013 |
| 24 in. | 0.015 |
| 36 in. | 0.018 |
| 48 in. | 0.020 |
| 60 in. or larger | 0.021 |
| Corrugated Polyethylene, Smooth Interior Pipe | 0.012 |
| Concrete Culverts | 0.013 |
| **Open Channels** | |
| Concrete, Trowel Finish | 0.013 |
| Concrete, Broom or Float Finish | 0.015 |
| Gunite | 0.018 |
| Riprap Placed | 0.030 |
| Riprap Dumped | 0.035 |
| Gabion | 0.028 |
| New Earth (Uniform, sodded, clay) | 0.025 |
| Existing Earth (Faintly uniform, with some weeds) | 0.030 |
| Dense Growth of Weeds | 0.040 |
| Dense Weeds and Brush | 0.040 |
| Swale with Grass | 0.035 |



## iii. GEOMETRY AND GENERAL DESIGN REQUIREMENTS

All open channel designs shall adhere to the following geometry and general design requirements:

1. The minimum velocity for storm sewers flowing full shall be two feet per second (2 ft/s).
2. Minimum storm sewer diameter shall be twelve inches (12in.).
3. All swales, ditches, channels, and overflow paths shall have a maximum side slope of 3:1 (horizontal: vertical).
4. All swales, ditches, channels, and overflow paths shall have minimum bottom slope of 0.5%.
5. All swales, ditches, channels, and overflow paths shall contain the 100-year stormwater runoff with two feet (2-ft.) of freeboard between the 100-year storm elevation and the lowest adjacent structure opening.
6. Common swales, a swale that serves as a drainage course carrying the runoff from two or more lots or properties, shall have a minimum top width of ten feet.
7. All common swales shall be designed to contain a minimum depth of nine inches.
8. Residential rear and side lot swales shall not exceed a flow rate of four cubic feet per second (4 cfs) for the 10-year storm.
9. Street drainage collection points shall be spaced appropriately so that stormwater runoff shall not be have an unacceptable lateral spread into the roadway.
10. Sump pumps, perimeter drains, roof drainage, garage drains, basements drains, and swimming pool drains shall not be connected to the stormwater drainage system.

## SECTION VI: LOT DRAINAGE

### i. MINIMUM GRADE REQUIREMENTS

Site characteristics shall be the main determinant for lot grading. The minimum grades for all lots are as follows:

1. Surface grades - 1% minimum
2. Lot line swale grades – 1% minimum
3. Cross lot swale grades – 0.5% minimum

### ii. MINIMUM DESIGN FREQUENCY OF RECCURENCE RUN COEFFICIENTS

Minimum design frequencies for lot drainage shall correspond to those used for the drainage design of the streets serving those lots. The finish grade of the ground surrounding the residence or building on the lot shall be no less than eighteen inches (18-in.) above the top of the curb on the street side of the building and eighteen inches (18-in.) above the flowline of the major drainage swale on the swale side of the building. The flowline of a major drainage swale shall be considered to be a minimum of twelve inches (12-in.) above the bottom of the swale.

## SECTION VII: EASEMENTS

### i. REQUIREMENT OF EASEMENT

Recorded easements shall be provided over all components of public and private drainage systems, and when the development requires platting, shall be shown and annotated on the recorded plat.

### ii. WIDTH REQUIREMENT

All proposed easements shall be designed to have a minimum width of fifteen feet (15-ft.) to allow for ease of maintenance and inspection.

### iii. MAINTENANCE AND INSPECTION

The responsibility of maintenance and inspection shall be determined prior to approval and construction. The determined party shall fulfill all appropriate measures of maintenance. The City reserves the right to conduct any emergency maintenance or inspection.

## SECTION VII: EROSION CONTROL AND SEDIMENTATION

### i. PURPOSE

Land development accelerates the natural process of soil erosion. With this increase in erosion, comes an increase in sediment and other pollutants contaminating the downstream receiving waters. In order protect the overall health of the community and natural resources, the following regulations have been implemented to prevent against accelerated erosion from land development.

### ii. APPLICABILITY

The following design principles and requirements outlined in this section apply to all land disturbing activities, including those associated with agricultural, commercial, industrial, residential, and highway development.

## iii. GENERAL DESIGN PRINCIPLES AND REQUIREMENTS

Erosion control and sedimentation facilities required by this document shall be designed following the regulations and requirements found in the Indiana Storm Water Quality Manual.

The following principles apply to all land disturbing activities within the City, and shall be considered when preparing construction plans and/or submissions as required by this document:

1. To minimize the potential for soil erosion, developments should fit the topography and soils of the site. Areas with steep slopes where deep cuts and fill would be required should be avoided.
2. Natural vegetation should be maintained and protected wherever and whenever possible. Areas immediately adjacent to watercourses, wetlands, and lakes should be left undisturbed whenever possible.
3. The selection of soil erosion and sedimentation control measures should be based on the size of the project, the frequency of climactic events likely to accelerate erosion, the season during which the project is being constructed, and the potential for damage should erosion and sedimentation occur.
4. In the design of erosion and sedimentation control measures sediment removal prior to stormwater leaving the site and the requirements for proper maintenance should be considered.
5. Provision should be made to accommodate the increased runoff caused by changed surface and soil condition both during and after development. Drainageways should be designed so that their final gradients and velocities will not cause erosion.
6. Provision should be made for the proper transport of soil from the site without tracking or spilling soil along the transport route.
7. Exposed soil areas shall be as small as practical for development during the construction process.
8. Site waste or debris shall be contained so as to not contaminate the stormwater runoff.

The following erosion control and sedimentation measures shall be utilized where required to provide the necessary control:

1. Runoff from off-site, flowing through the site proposed for development, shall be diverted around the land disturbing activity by means of swales, channels, ditches, culverts, or storm sewers. The diversion may be a temporary installation, utilized only until the land disturbing activity is complete, or it may be a permanent part of the proposed improvement on the land. Such diversion shall not be such that it causes drainage or erosion problems downstream.
2. Any proposed detention basin shall be utilized during construction as a sediment basin to trap as much soil as possible during the land disturbing activity. Such basins shall be designed for this purpose, utilizing over-excavation for temporary sediment storage, temporary perforated pipes and/or stone filters as required by proper engineering design. The City Engineer may waive this requirement if it is demonstrated that an alternative strategy for trapping sediment will perform better.
3. Temporary sediment traps may be required in areas where runoff exits the site proposed for development, and is likely to carry sediment from eroded soils. The temporary traps shall be sized proportionally with the expected flow rate from the site.
4. Ingress and egress to the site proposed for development shall be by way of coarse stone drive(s) of sufficient length to cause soil pick up by the tires of the vehicles to be dropped before the vehicle enters the roadway. Drives shall be designed and situated so that they provide maximum protection against tracking of soil or mud onto the street. For single family and duplex home sites, the stone drive should coincide with the final location of the drive to the residence.
5. Drain inlets and entrances to culverts shall be protected with an installation of silt fence or rock check dam.
6. All disturbed ground left inactive for a period of fifteen (15) days shall be seeded, sodded or stabilized with mulch or equivalent. Between the dates of October 1 and the release of the frost law in the following year, the disturbed ground shall be established with the use of silt fence or approved equivalent.
7. Storage piles of soil left for longer than three (3) days shall be completely encircled with silt fence. If left inactive or unused for longer than fifteen (15) days the pile shall be seeded, sodded, or covered with a mulching fabric or tarpaulins.
8. Silt fence shall be installed along the down slope edges of all disturbed areas on site. In general, a silt fence shall be installed at the edges of pavements, adjoining properties and open watercourses whenever the adjacent ground slopes toward that street, adjoining property or watercourse.
9. Ditches, channels, swales, and detention basins are highly advised to install erosion control blankets.

10. Storm drain inlets shall have silt fences or an approved equivalent installed to prevent sedimentation within the storm sewer system.

### iv. MAINTENANCE

All erosion control and sedimentation facilities shall be maintained during the span of time that they are required as outlined in this section and the Indiana Stormwater Design Manual. The party in charge of maintenance shall be determined prior to any issuance of permit or construction.

## SECTION IX: POST-CONSTRUCTION BMPs

### i. GENERAL

One of the main pollutants of concern in stormwater quality is Total Suspended Solids (TSS). TSS is the presence of suspended particles, such as sediment, trash debris, and decayed organic material, in water. TSS can also act as a carrier of other various pollutants. In accordance with USEPA guidance, the City aims to reduce the volume of TSS in incoming runoff by 80% before exiting a site. This requirement shall serve as the standard by which Best Management Practices (BMPs) shall be utilized. At Rule 5 sites, BMPs shall be used singularly or in combination to reduce TSS by 80%, or as much as plausible given the site restrictions. The City Engineer shall determine the necessity of BMPs on a site-by-site basis for sites less than one acre and not under Rule 5.

### ii. TYPICAL BMPs

Typical BMPs are listed in Table IX-1. These BMPs may be used singularly or in combination to remove approximately 80% of the incoming TSS. Removal efficiencies are highly variable due to design techniques and site characteristics so exact removal percents may not be able to be accurately determined.

Table IX-1
TYPICAL BMP PERCENT (%) TSS REMOVAL

| BMP | Estimated TSS % Removal | Reference |
|---|---|---|
| Bioretention Pond | 90 | ISWQM, 2007 |
| Infiltration Trench | 90 | ISWQM, 2007 |
| Extended Detention Wet Pond | 76 | Yu & Benelmouffok, 1988 |
| Constructed Wetlands | 67 | ISWQM, 2007 |
| Dry Detention Pond | 67-93 | Yu et al, 1993 |
| Sand Filter | 70 | ISWQM, 2007 |
| Infiltration Basin | 74-90 | ISWQM, 2007 |
| Wet Detention Basin | 50-90 | ISWQM, 2007 |
| Vegetated Swale | 81 | Yu et al, 1993 |

References:


1. IDEM. 2007. *Indiana Storm Water Quality Manual.* Indiana Department of Environmental Management, Indianapolis, IN.
2. Yu, S.L., and D.E. Benelmouffok. 1988. Field Testing of Selected Urban BMPs in Critical Water Issues and Computer Applications. In *Proceedings of the 15th Annual Water Resources Conference*. American Society of Civil Engineers, New York, NY.
3. Yu, S.L., S.L. Barnes, and V.W. Gerde. 1993. *Testing of Best Management Practices for Controlling Highway Runoff.* Virginia Department of Transportation, Report No. FHWA/VA-93-R16, Richmond, VA.


## iii. BMP SIZING

BMPs shall be designed appropriately to detain and treat the water quality volume. The water quality volume is the volume of water received from an area after the first one inch (1-in.) of rainfall. During the first inch of rainfall, the majority of pollutants are transparted in the runoff. This high presence of pollutants in runoff is most commonly referred to as the “first flush”. In order to determine the water quality volume of the first flush, the following equation shall be utilized:

$$WQv = (P)(A)(I)(1ft./12in.)$$

Where:

| | | |
|---|---|---|
| WQv | = | Water Quality Volume (ac.-ft.) |
| P | = | One Inch (1-in.) of Precipitation |
| A | = | Contributing Drainage Area (ac.) |
| I | = | Percent of Impervious Area expressed as a Decimal or Ratio |

# SECTION X: GREEN INFRASTRUCTURE DESIGN

When development occurs, a general increase in runoff and pollution is seen due to the decrease in pervious surfaces. Pervious surfaces allow for stormwater infiltration. When pervious surfaces are replaced with impervious surfaces, the stormwater that would have naturally infiltrated is now concentrated into runoff containing contaminants attained during its flow path.

In order to address this runoff problem, stormwater regulations and restrictions advocating runoff control and management have been instituted. However, further improvement of stormwater runoff quality and reduction of quantity can be achieved through the implementation of Green Infrastructure (GI). GI practices aim to reduce the presence of pervious surfaces in developments by mimicking natural conditions. GI practices include:

1. Green Roofs
2. Rain Gardens/Bioretention Basins
3. Pervious Pavement
4. Rain Harvesting (i.e. Rain Barrels, Cisterns)
5. Infiltration Trenches along Curbless Streets
6. Tree Cells
7. Tree Planting

Through the naturalized conditions of such GI practices, significant decreases in curve number, runoff quantity, runoff contamination, and flows can be seen.

The City of Valparaiso has taken initiative to provide GI product programs and has implemented GI throughout The City. The Valparaiso MS4 Coordinator has recently instituted a rain barrel program. This program offers a simple rain harvesting technique to the public at an affordable price (see Figure X-1). Also, various other GI such as bioswales, pervious pavement, and bioretention basins, seen in Figure X-2 through Figure X-5 below, can be found throughout The City to act as templates for future private development GI projects.


Figure X-1: Rain Barrel Distribution

Figure X-2: Calumet Ave. Bioswale

Figure X-3: Pervious Concrete Strip

Figure X-4: Newly Installed Wall St. Bioretention Basin

Figure X-5: Jefferson St. Bioswale

Figure X-6: Central Park Plaza Tree Cell

Figure X-7: Central Park Plaza Rain Garden

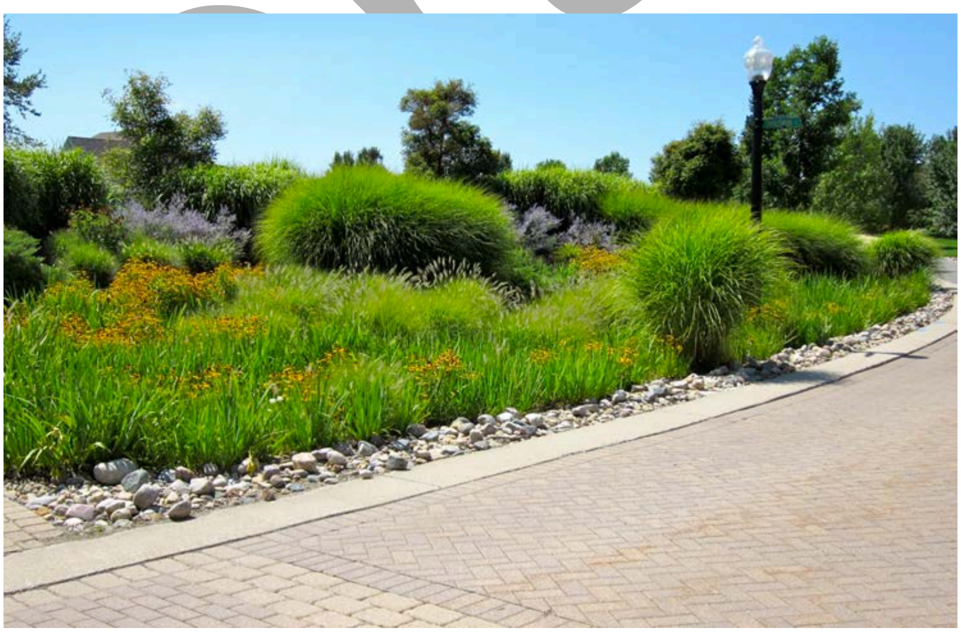
Figure X-8: Infiltration Trench along Curbless Street