“ATTACHMENT A”

MINIMUM DRAINAGE STANDARDS

FOR THE

CITY OF VAN BUREN, ARKANSAS

September 2023

1. SCOPE

1.1 These Minimum Storm Drainage Standards shall apply to all storm drainage facilities, whether an enclosed structure, pipe, open channel, detention basin, ditch or stream.

1.2 These Minimum Storm Drainage Standards are those referred to in Ordinance No. 7-2003 as amended, (Subdivision Regulations) Section IV, IMPROVEMENTS, c. Storm Drainage.

2. GENERAL DESIGN REQUIREMENTS AND DESIGN SUBMITTALS

2.1 All designs, plans and specifications submitted to the Planning Director for Planning Commission approval shall be prepared by a registered professional engineer, licensed in the state of Arkansas.

2.1.A PLAN REQUIRMENTS

Two (2) hardcopies of the plans shall be submitted on 24" by 36" sheets and along with a portable document format (PDF) file either by e-mail or on electronic media. The plans shall include:

- Locations of the project with respect to well-known roads, streets, subdivision or survey lines on a key map of the entire project.
- Plans and profiles for each storm sewer line shall be provided which show location, size, flow line elevations, gradients, materials and any soil boring information. Plan profiles submitted shall have a vertical scale of not less than one inch equal to five feet.
- All easements, storm sewers (enclosed or open channel), utilities and facilities, both existing and proposed shall be shown.
- Elevations submitted shall use NAVD 1988. Location and elevation of all benchmarks shall be indicated on the plans.
- Details of special drainage structures not included in the Van Buren Standard Drawings for Public Works Construction shall be provided.

2.1.B DRAINAGE AREA MAP

An area map showing topography shall be furnished with the drainage basin and subareas outlined. The drainage area map shall be at a scale of 1"=100' or larger and shall have a maximum two (2) foot contour interval unless otherwise approved.

The drainage map shall show a minimum of the following information:

- North arrow and scale
- Project limits, property boundary, street rights of way and and/or platted lots
- Predevelopment and postdevelopment drainage areas with sizes indicated
- Locations of study points for pre and post development scenarios
- Locations of drainage inlets, open channels and detention basins
- Limits of regulatory 100-year floodplains and floodways

2.1.C BASIS OF DESIGN

One (1) hardcopy and a PDF of the Basis of Design shall be submitted to the Planning Director for all drainage facilities in public rights-of-way and easements and for detention basins in private developments. The Basis of Design shall be prepared by a professional engineer licensed in the State of Arkansas and shall be sealed, signed and dated and shall include:

- A narrative description of the project, its discharge points, proposed drainage facilities and existing downstream drainage facilities and deficiencies thereof (if any)
- A statement of hydrologic methods and computer software (if any) employed in the calculations.
- Drainage area maps as described in 2.1.B.
- Hydraulic and hydrologic calculations for storm drains and culverts shall be provided for each design storm required to be examined by applicable sections of these Minimum Design Standards. Calculations for pipes, pipe ends and junctions may be compiled into tabular forms and as a minimum shall include:
    - ✓ tributary and cumulative drainage area, runoff coefficients and time of concentration calculations
    - ✓ invert, hydraulic and energy grade line elevations
    - ✓ junction and entrance loss coefficient and head loss calculations
    - ✓ top of curb, top of road or top of inlet elevations
    - ✓ indication whether inlet is in a sump or grade condition

- ✓ longitudinal and cross slopes of pavements
- ✓ flow in pipe velocity
- ✓ inlet length, gutter flow depth, gutter spread, flow captured and flow bypassed at curb inlets
- ✓ grate size, opening area and capture efficiency at grated inlets

- o Hydraulic and hydrologic calculations for the capacity evaluation of existing drainage infrastructure downstream of system discharge(s).

- o Hydraulic and hydrologic calculations for detention basins shall be provided for each design storm required to be examined by applicable sections of these Minimum Design Standards. Calculations for each pond shall include:

  - ✓ hydrologic calculations for pre and post development conditions including runoff parameters, times of concentration, drainage areas and peak flows
  - ✓ elevation vs. volume curve for the selected pond geometry
  - ✓ discharge flow for each element of the outlet structure
  - ✓ peak water surface elevation for each storm examined
  - ✓ for Modified Rational Method, calculations for determining the duration factor that yields the maximum detention volume

2.2 DESIGN FLOWS

Storm sewer systems shall be designed to contain the peak flow from a 10-year, storm with minimum freeboard as required by applicable sections of these regulations. The effects of the peak 100-year storm shall also be evaluated to ensure that existing and proposed finished floor elevations of structures of adjacent or affected properties are two (2) or more feet above the 100-year water surface elevation.

2.3 FLOW TOWARD STREETS.

Any concentration of surface flow in excess of 6 cubic feet per second (cfs) shall be intercepted before crossing the curb (or curb line) and carried by enclosed storm sewers. No storm water concentration will be allowed to empty into the street except as stated above.

2.4 METHODS OF CONVEYING WATER

2.4.A All flows within the right-of-way of non-estate streets not carried in the gutter and side lot flows to drainage channels at the rear of lots shall be in storm sewers.

2.4.B Storm flows in areas not listed in 2.4.A. may be carried in open channels as defined in Section 5.

2.4.C Natural drainage channels (not relocated or channelized) may be used in new developments providing the channel will carry the storm runoff used in the design storm without erosion problems and sufficient land for a one-foot (1') freeboard is included in a drainage easement.

2.5 SYSTEM DISCHARGE

2.5.A All storm sewer systems in new developments shall be adequate to contain the design storm runoff to the discharge point or points at the down-stream property line. The location(s) of point(s) of storm water discharge from the developed property shall generally be the same as the pre-development discharge point. All reasonable effort should be taken to ensure that storm water discharge volume and velocity will be limited to the predevelopment discharge conditions in the 2, 10, 50 and 100-year storm events for developments with property boundary areas greater than one (1) acre, including future phases.

If the existing infrastructure downstream of the system discharge(s) lacks hydraulic capacity to carry the peak 10-year flow, downstream improvements may be required.

2.5.B Hydrologic methods used in the design of detention ponds shall conform to Section 3.1. The Modified Rational Method may be used for ponds where the tributary area is twenty (20) acres or less. For tributary areas greater than 20 acres, one of the methods listed in Section 3.1 shall be used.

2.5.C If detention ponds are used to meet the requirements of Section 2.5.A then the following standards apply to the detention pond:

1. Detention ponds in subdivisions containing two or more building lots shall be located on a platted lot and its use shall be clearly specified on the plat. The lot will not be subject to area and frontage requirements of the Zoning Code, but shall be of a size sufficient to allow operation and maintenance of the pond within its boundary.

2. Detention ponds shall be designed to meet the objectives of Section 2.5.A and provide a minimum of (1) foot of freeboard above the peak 100-year water surface elevation.

3. Outlet structures shall be designed to control the outflow from the pond in the design storms. Outlet structures may consist of box structures, pipes, orifices, weirs or any combination thereof. All elements of the structure shall be constructed from reinforced concrete. Enclosed structures greater than 4 feet in depth shall include permanent means of access for maintenance such as steps and manholes. Steps shall be made of steel reinforced copolymer polypropylene.

4. All embankments and the top six (6) inches of excavated surfaces shall be compacted to 95% standard Proctor density. Earthen surfaces shall be covered with a minimum of four (4) inches of topsoil and sodded.

5. Grassed earthen pond side slopes shall not be steeper than 4H:1V. Steeper side slopes in combination with slope stability measures will be considered on a case-by-case basis. Slope stability measures may include, but are not limited to concrete lining, rip-rap lining, reinforced earth and retaining wall systems.

6. A minimum eight (8) foot wide clear and flat maintenance access shall be provided at the tops of berms and around the pond perimeter.

7. Trickle channels shall be provided from each discharge point to the outlet structure to transmit frequent, small flows and for grade control. Trickle channels shall be six (6) inch thick Class AAA (4,000 psi) concrete, a minimum of four (4) feet wide, six (6) inches deep and have a minimum longitudinal slope of 0.50 percent.

8. The pond bottom shall have a minimum one (1) percent slope from the toe of slope toward the trickle channel(s).

9. Underground detention systems, retention ponds and parking lot detention will be considered on a case-by-case basis.

10. Access from a public street to a detention pond shall be provided via a minimum of twenty (20) feet of frontage on a public street or by a twenty (20) foot dedicated access road easement between the pond lot and public street. Other means and/or widths of access may be considered by the City on a case-by-case basis. The access road shall be all-weather and a minimum of twelve (12) feet wide. A concrete driveway approach conforming to the requirements of Ordinance No. 23-1996 shall also be provided at the connection to the public street.

11. Fencing is not required but will be allowed. Fencing and gates shall conform to the Standard Drawings for Public Works Construction with the exception that the fabric be four (4) foot polymer coated woven wire and installed with a 10-inch gap between the ground and the bottom of the fabric. Gates shall be provided as necessary for maintenance access.

12. After completion of construction, an “as-built” survey of the detention facility shall be conducted to verify that it conforms to the approved design. A record of the survey in the form of a scale drawing sealed and signed by a professional engineer or land surveyor licensed to practice in the State of Arkansas shall be submitted to the City. As a minimum, the as-built drawing shall include the following:

a. Date of survey, scale and north arrow;
b. Boundary of the detention basin parcel, if applicable;
c. Elevation contours of the surface at an interval not exceeding one foot;
d. The elevations of berms, pipe inverts, weirs, boxes, trickle channels and other elements of the pond;
e. A table showing the elevation vs. volume relationship from the lowest elevation of the pond to the top of the berm.
f. Material testing reports for concrete structures and compacted earthen embankments showing that the materials meet the minimum requirements of the approved plans and specifications shall be provided. Testing shall be done by a certified materials testing laboratory.

If the as-built features of the detention pond are determined by the City to be significantly different from the approved design, corrective action may be required, or an analysis by a professional engineer demonstrating that the pond, as constructed, meets the objectives of the Minimum Drainage Standards.

2.5.D Ownership of detention ponds for single tract developments shall be vested in the property owner. In residential subdivisions containing two or more lots, the City of Van Buren will assume ownership of the detention pond(s) after the following requirements are met:

1. At least eighty (80) percent of the lots in all phases of the subdivision shall have been developed for their intended use.

2. The detention pond maintenance items listed in Section 2.5.E are current.

2.5.E Routine maintenance items shall include:

- Sediment removal
- Repair of eroded areas and areas that do not support grass cover
- Outlet structure cleaning and maintenance
- Mowing and weed control
- Litter and debris removal
- Access road and fence maintenance

If the property owner fails to maintain a detention pond as specified above, the City of Van Buren Code Enforcement Officer may determine the property owner to be in violation of Section 504 of the Van Buren Municipal Code.

2.6 EASEMENTS

All storm sewers shall be located in street rights-of-way or in an easement dedicated to public use. Easement widths shall conform to the following:

2.6.A Easements for enclosed drainage systems shall have a minimum width of fifteen (15) feet. For larger or deeper systems, the easement width shall be width of the drainage conduit plus ten (10) feet or fifteen (15) feet plus the amount of depth in excess of five (5) feet, whichever is greater.

2.6.B Open channel easements shall be required to contain the entire channel design width including freeboard and maintenance accessway with the minimum width being fifteen (15) feet.

3. HYDROLOGY

3.1 HYDROLOGIC DESIGN METHOD

The Rational Method may be used to determine storm water runoff characteristics for storm sewer design when tributary drainage area is 200 acres or less. Other methods such as the SCS Method, the US EPA Storm Water Management Model (SWMM) and adaptations thereof and US Army Corps of Engineers HEC-HMS may be used for tributary areas of any size.

The Rational Method uses the basic formula Q = CiA for estimating runoff from rainfall, where:

Q = Rate of runoff in cubic feet per second

i = Average rainfall intensity in inches per hour for the design storm having duration equal to the time of concentration for the critical upstream drainage area

C = Runoff coefficient, which is the fraction of the rainfall which becomes runoff

A = Tributary drainage area in acres

3.2 RAINFALL AND INTENSITY

3.2.A. If the Rational Method is used for design, the duration–intensity relationships from the Arkansas Department of Transportation (ArDOT) Drainage manual for Area IV (see Figure 1) shall apply.

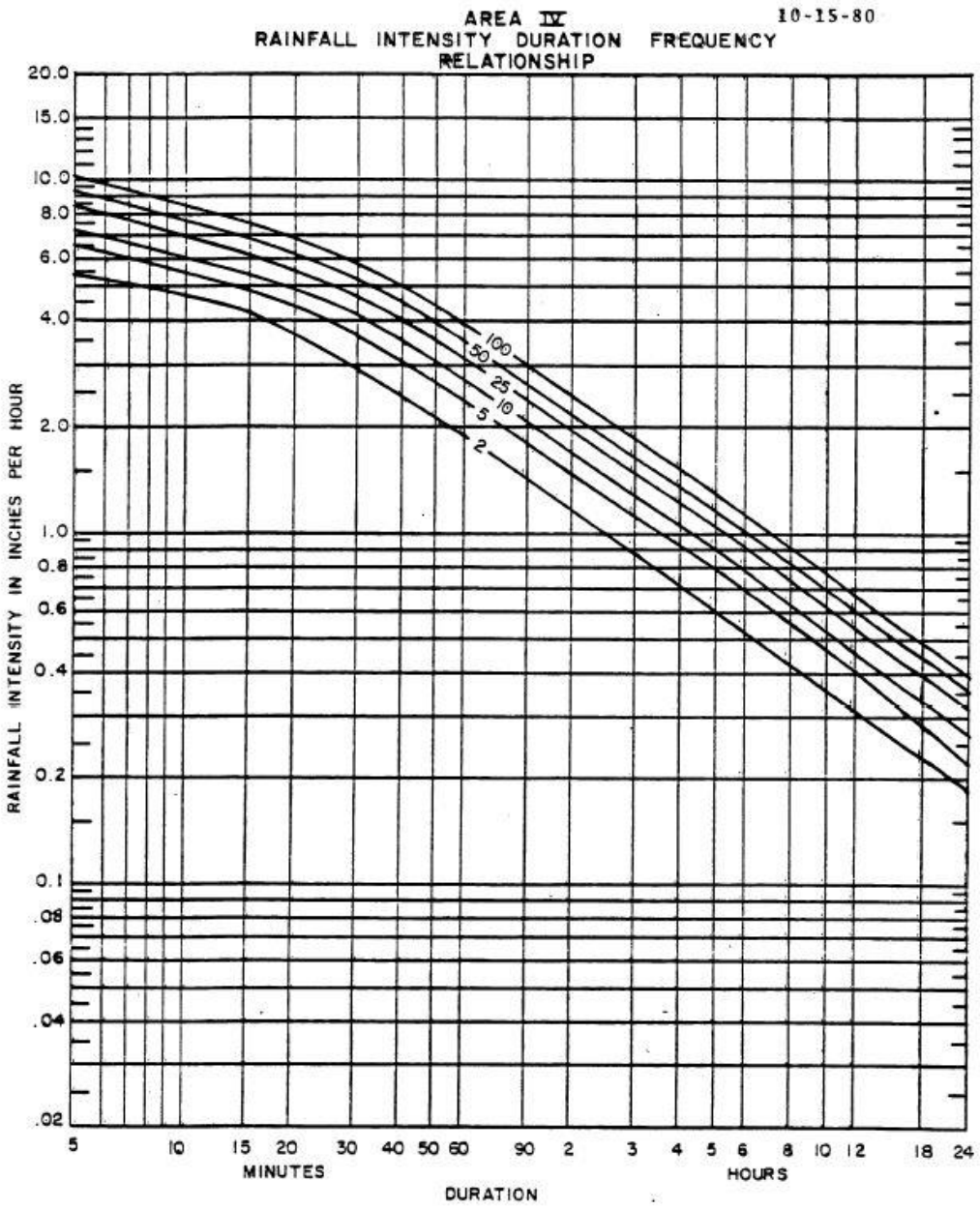

FIGURE 1: ArDOT IDF Curves for Area IV

3.2.B. The time of concentration equals the overland flow time plus (if applicable) shallow concentrated flow time and the time for the water to flow down the pipe or channel to the point in question.

The overland flow time, T_c, may be calculated using the following equation:

$$T_c = \frac{0.93\,[(n)(L)/(S)^{0.5}]^{0.6}}{I^{0.4}}$$

Where:

n = Manning's n of flow path (See Table 1)

S = Slope of flow path, feet per foot

I = Rainfall intensity for a storm with a return period equal to T_c, in./hr.

TABLE 1: Manning's n for Overland Flow (AASHTO)	
0.011	Smooth surfaces (concrete, asphalt, gravel, bare soil)
0.05	Fallow (no residue)
0.06 0.17	Cultivated soils: Residue cover ≤ 20 percent Residue cover > 20 percent
0.15 0.24 0.41	Grasses: Short grass prairie Dense grasses Bermuda grass
0.13	Range (natural)Grassed waterway
0.40 0.80	Woods: Light Underbrush Dense Underbrush

The shallow concentrated flow time, T_t, may be calculated using the following equation:

$$T_t = \frac{L}{(K)(S^{0.5})}$$

Where:

T_t = overland flow time, seconds

L = shallow concentrated flow path length, feet

K = conveyance factor which depends on ground cover (See Table 2)

S = ground slope, percent

TABLE 2: Conveyance Factors for Shallow Concentrated Flow (K)	
0.25	Forest with heavy ground litter and meadow
0.47	Fallow or minimum tillage cultivations
0.71	Short grass pasture and lawns
1.00	Nearly bare ground
1.52	Grassed waterway
2.00	Paved area (sheet flow) and shallow gutter flow

Open channel flow time shall be estimated using the Manning equation as presented in Section 4.1 of these design standards.

Other methods for estimate time of concentration may be used with the prior approval of the City.

3.3 RUNOFF COEFFICIENT

If the Rational Method is used in storm sewer design, a runoff coefficient for the ultimate development of an onsite drainage area must be used. For offsite areas (areas outside the project property boundary), the runoff coefficient shall reflect the current condition of the area. The values listed in Table 3 shall be used as a guide in selecting the runoff coefficient:

TABLE 3: Rational Method Runoff Coefficients	
Description of Area	**Runoff Coefficient (C)**
Single Family Residential	0.30 to 0.50
Multi-units, detached	0.40 to 0.60
Multi-units, attached	0.60 to 0.75
Residential, 1 acre or more	0.25 to 0.40
Apartments	0.50 to 0.70
Industrial - light	0.50 to 0.80
Industrial – heavy	0.60 to 0.90
Parks and cemeteries	0.10 to 0.25
Playgrounds	0.20 to 0.35
Railroad yard	0.20 to 0.35
Unimproved	0.10 to 0.30

In some cases, it may be necessary to develop a composite runoff coefficient, in which case the following value should be used:

TABLE 4: Runoff Coefficients for Developing Composite C	
Character of Surface	**Runoff Coefficient (C)**
Pavement, asphalt and concrete	0.70 to 0.95
Pavement, brick	0.70 to 0.85
Roofs	0.75 to 0.95
Lawns, sandy soil Flat, < 2 percent Average, 2 to 7 percent Steep, > 7 percent	 0.05 to 0.10 0.10 to 0.15 0.15 to 0.20
Lawns, clayey soil Flat, < 2 percent Average, 2 to 7 percent Steep, > 7 percent	 0.13 to 0.17 0.18 to 0.22 0.25 to 0.35

4. PIPES AND CULVERTS – GENERAL REQUIREMENTS AND DESIGN CRITERIA

4.1 CULVERT HYDRAULICS

Culvert flow may be limited by conditions existing at either the inlet or the outlet of the pipe. When inlet control governs the cross-sectional area of the barrel, the shape of the inlet and the amount of ponding (headwater) at the inlet are primary design considerations. Outlet control is dependent upon the depth of water in the outlet channel (tailwater), the slope of the barrel, type of culvert material and length of the barrel. The basis for all hydraulic design calculations will be Manning's Formula and the Continuity Equation:

$$V = \frac{1.486\ (R^{0.67})\ (S^{0.5})}{n}$$

$$Q = AV$$

Where:

V = Mean velocity of flow in feet per second, ft./sec.

n = Manning's coefficient of roughness

R = hydraulic radius, feet

S = Slope, ft./ft.

Q = Flow, cfs

A = Flow area, sq. ft.

4.1A Coefficients of Roughness

The coefficients of roughness to be used for evaluating capacity of culverts of the various kinds of conduit shall be selected according to Table 5:

TABLE 5: Coefficients of Roughness for Pipe (n)

Type of Pipe	Roughness Coefficient (n)
Reinforced concrete	0.013
Corrugated metal pipe	0.024
Smooth wall corrugated metal pipe	0.013
Smooth wall plastic or HDPE pipe	0.012

4.1.A Inlet and Outlet Control

Culverts and drainage inlets shall be designed so that the greater of inlet or outlet control headwater is provided plus freeboard. The minimum freeboard shall be one (1) foot below the top of road for culverts, or the top of curb for curb inlets or the top of grate for grated inlets in the 10-year storm.

4.2 CULVERT TYPES AND SIZES

The permissible types of culverts are reinforced concrete box, round pipe, elliptical pipe and pipe arch. The minimum size of pipe for all culverts shall be fifteen (15) inches or the equivalent thereof. Box culverts may be constructed in sizes equal to or larger than 4 feet by 2 feet (span vs. height).

4.4 VELOCITY

All storm drainage pipes and culverts shall be designed to maintain a minimum velocity of 2.0 feet per second and a maximum velocity of 15 feet per second in the peak 10-year storm flow.

4.6 STRUCTURAL CONSIDERATIONS

The minimum allowable fill or cover for structures (RCP, CMP, concrete culverts) under roadways shall be one foot or a minimum clearance of six inches from top of structures to the bottom of pavement base, except for a special box culvert designed to carry traffic on the top slab. Structural protection, such as special bedding, shall be provided where adequate cover cannot be attained. Maximum fill shall be determined on the basis of structural strength of pipe and design loads. Outside of street rights-of-way, a minimum cover of twelve (12) inches is required for vegetation and protection against unusual loading.

5 OPEN CHANNELS – GENERAL REQUIREMENTS AND DESIGN CRITERIA

5.4 OPEN CHANNELS

Open channels may only be used when the 10-year peak flow is greater than fifty (50) cfs unless otherwise approved by the City. Open channels shall be designed using the Manning formula and “n” values shown in Table 6.

TABLE 6: Manning's Roughness Coefficients for Open Channel Flow (n)	
Channel Lining	**n**
Grass	0.03 to 0.05
Concrete	0.013 to 0.015
Rip-Rap	0.017 to 0.03

All open channels shall have a minimum of one (1) foot of freeboard or ample freeboard to contain the 100-year storm, whichever is less.

All open channels shall have a maintenance accessway along one side of the channel conforming to the following:

- The accessway shall have a minimum width of eight (8) feet for channel less than or equal to three (3) feet deep including freeboard. For channels segments greater than three (3) feet deep, the accessway width shall be three (3) times the depth with a maximum width of twenty (20) feet.

- The accessway shall be constructed with a 2% cross slope toward the toward the channel.

- The accessway shall be contained within the drainage easement and shall provide access points to public streets at intervals not greater than six hundred (600) feet.

- The accessway shall be free of obstructions, including utility poles and pedestals, fences, landscaping or other items that interfere with maintenance operations.

5.2. OPEN CHANNELS (EARTHEN)

Earthen (grass lined) channels may be used where the velocities during the peak 10-year storm runoff are less than or equal to six (6) feet per second. The sideslopes shall not be steeper than 3H:1V. All earthen channels shall have a minimum longitudinal slope of 0.50 percent and shall be sodded immediately after their construction and adequate measures taken to prevent erosion.

5.3. OPEN CHANNELS (LINED)

Where velocities are greater than 6 feet per second, the channel section shall be lined with concrete, rip-rap or other approved nonerosive materials. The lined channel may have either vertical sides or sloped sidewalls with a slope not steeper than 1.5H:1V.

Channels with vertical sides greater than thirty (30) inches in height shall have barrier rails conforming to the Van Buren Standard Drawings for Public Works Construction installed at the top of the walls unless the vertical drop is adjacent to a sidewalk or pedestrian way. If the vertical drop is adjacent to a sidewalk or other type of pedestrian way, guardrails conforming to the Arkansas Fire Prevention Code shall be installed at the top of the walls.

The minimum flat bottom width for lined channels shall be three (3) feet and the minimum longitudinal slope shall be 0.30 percent.

5.4 OPEN CHANNEL EROSION PROTECTION

Special protection such as headwalls, riprap, energy dissipators, or concrete lining will be required in places such as bends, junctions, and inlets and outlets for storm sewers where erosion is likely.

5.5 SUPERELEVATION OF HORIZONTAL CURVES IN OPEN CHANNELS

The amount of superelevation of raised water surfaces on walls of horizontal curves of open channels shall be calculated and the height of the outside channel side shall be increased accordingly to protect against overflow. The inside channel wall may not be reduced due to superelevation. The freeboard criterion of Section 5.1 shall apply to superelevated sections.

6 CURB INLETS – GENERAL REQUIREMENTS AND DESIGN CRITERIA

6.1. CURB INLETS

Curb inlets and extensions thereof shall be constructed in accordance with the Van Buren Standard Drawings for Public Works Construction. Curb inlets will be required at low points of streets, angle changes in storm drain alignment, and at all other locations where water is removed from street gutters.

The maximum length of a curb inlet opening shall be sixteen (16) feet unless otherwise approved by the City.

6.2. INLETS NEAR PEDESTRIAN AREAS

Inlets shall be required near intersections to keep crosswalks free of storm water.

6.3. ARTERIAL STREETS

Curb inlets shall be located on arterial streets so that the center two lanes are free from water during runoff from a 50-year storm.

6.4. MINOR AND COLLECTOR STREETS

Curb inlets shall be located on minor and collector streets so that depth of runoff from a 10-year storm does not exceed the top of standard 6-inch curbs.

6.5. INTERSECTION SWALES

Intersection swales shall be constructed in accordance with the Van Buren Standard Drawings for Public Works Construction. Swales shall not be permitted across through streets.