2A-4 Stormwater Management Criteria

A. Development criteria

This section presents a set of recommended minimum criteria for stormwater management for development activities in the state of Iowa in those communities with regulations. The overall aim is to provide an integrated approach to address both the water quality and quantity problems associated with stormwater runoff due to urban development.

The goal of a set of minimum stormwater management criteria for areas of new development and significant redevelopment is to reduce the impact of post-construction stormwater runoff on the watershed. This can be achieved, as discussed in Section 2A-1, by

- Maximizing the use of site design and nonstructural methods to reduce the generation of runoff and pollutants
- Managing and treating stormwater runoff though the use of structural stormwater controls
- Implementing pollution prevention practices to limit potential stormwater contaminants

It should be noted that the criteria presented here may be used in all communities in Iowa. They may be adopted by local jurisdictions as stormwater management development requirements as part of the jurisdiction post-construction runoff control ordinance and/or may be modified to meet local or watershed-specific stormwater management goals and objectives. Please consult your local review authority for more information.

The minimum guidelines for development are designed to assist local governments that are regulated, to comply with regulatory and programmatic requirements for various state and federal programs, including the National Pollutant Discharge Elimination System (NPDES) Municipal Separate Storm Sewer System (MS4) permit program, and the National Flood Insurance Program under FEMA.

1. **Applicability.** The stormwater management guidelines for new development and redevelopment are intended to apply to any development site in a regulated agency that meets one or more of the following criteria and are intended to assist in the development of measurable goals for the post-construction runoff minimum control measure:

   a. New development and/or redevelopment that involves land disturbing activity of 1 acre or more. Based on local conditions and the need for additional measurable water quality improvement, jurisdictions may consider including controls on development based on the addition of a threshold amount of impervious area. Examples of impervious area threshold values in other states are 5,000 ft^2 and 10,000 ft^2. A jurisdiction may consider an impervious area threshold to provide an incentive to reduce the increase in developed impervious area and encourage better site design planning.

   b. Any commercial or industrial new development or redevelopment, regardless of size, with a Standard Industrial Classification (SIC) code that falls under the NPDES Industrial Stormwater Permit program or a hotspot land use as defined below.

2. **Definitions.**

   a. **New development** is defined as land disturbing activities, structural development (construction, installation, or expansion of a building or other structure), and/or creation of impervious surfaces on a previously undeveloped site.

   b. **Redevelopment** is defined as structural development (construction, installation, or expansion of a building or other structure), creation or addition of impervious surfaces, replacement of impervious surface not part of routine maintenance, and land disturbing activities associated with structural or impervious development. Redevelopment does not include such activities as exterior remodeling.

   c. **Hotspot** is defined as a land use or activity on a site that produces higher concentrations of trace metals, hydrocarbons or other priority pollutants than are normally found in urban stormwater runoff. Examples of hotspots include gas stations, vehicle service and maintenance areas, salvage yards, material storage sites, garbage transfer facilities, and commercial parking lots with high-intensity use.

3. **Special Requirements.** New development or redevelopment in critical or sensitive areas, or as identified through a watershed study or plan, may be subject to additional performance and/or regulatory criteria. Furthermore, these sites may need to utilize or restrict certain structural controls in order to protect a special resource or address certain water quality or drainage problems identified for a drainage area.

B. Minimum stormwater management guidelines

The following guidelines are recommended minimum stormwater management requirements for new development or redevelopment sites falling under the applicability criteria.

1. **Use of enhanced design practices for stormwater management.** Site designs are developed to preserve the natural drainage and treatment systems and reduce the generation of additional stormwater runoff and pollutants to the fullest extent practicable. All site designs are encouraged to implement a set of practices collectively known as “stormwater better site design” and/or “low impact development” (LID) to the fullest extent possible. Through the use of these practices and techniques, the impacts of urbanization on the natural hydrology of the site and water quality can be significantly reduced. The goal is to reduce the amount of stormwater runoff and pollutants that are generated, provide for natural on-site control and treatment of runoff, and optimize the location of stormwater management facilities. Better site design concepts can be viewed as both water quantity and water quality management tools and can reduce the size and cost of required structural stormwater controls.

2. **Stormwater runoff quality.** The post-construction stormwater runoff from the development site is managed to improve the water quality. A common water quality goal is to remove at least 80% of the calculated average annual post-development loading of total suspended solids (TSS) from the site. However, based on local water quality conditions, jurisdictions might use other parameters, i.e., nutrients. This can be achieved through the use of site design practices and structural stormwater controls. This requirement may be quantified and expressed in terms of engineering design criteria through the specification of a water quality volume (WQv) that is treated to the 80% TSS removal performance goal. The water quality volume is equal to the runoff generated on a site from the design rainfall event. The water quality volume is one of the unified stormwater sizing criteria, which are used in conjunction to size and design stormwater

management facilities to address stormwater impacts. The unified stormwater sizing criteria and methods to calculate the WQv are discussed in Part 2B.

It is presumed that a stormwater management system complies with this guideline if:

a. It is sized to capture and treat the prescribed WQv. The design rainfall event that is recommended for computing the WQv is 1.25 inches and is equal to the 90% cumulative frequency rainfall depth for the area. In numerical terms, it is equivalent to the rainfall depth in inches (the 90% cumulative frequency rainfall depth) multiplied by the volumetric runoff coefficient (Rv) for the site, and the site drainage area. A statewide WQv of 1.25 inches is recommended for use or jurisdictions can use a similar value derived from an analysis of local historical rainfall data, i.e., adjusted based on location factors in Iowa (climate districts 1-9).

b. Appropriate structural stormwater controls are selected, designed, constructed, and maintained according to the specific criteria in this manual.

c. This design guideline is based on treatment of the WQv from a site to reduce post-development TSS loadings by 80%, as measured on an average annual basis. This performance goal is based upon EPA guidance and has been adopted nationwide by many local and statewide agencies. TSS is used as the representative stormwater pollutant for measuring treatment effectiveness for several reasons:
    1) The use of TSS as an indicator pollutant is well established.
    2) Sediment and turbidity, as well as other pollutants of concern that adhere to suspended solids, are a major source of water quality impairment in Iowa surface waters due to urban development and agricultural production activities.
    3) A large fraction of many other pollutants of concern are either removed along with TSS, or at rates proportional to the TSS removal.
    4) The 80% TSS removal level is reasonably attainable using well-designed structural stormwater controls (for typical ranges of TSS concentration found in stormwater runoff).

d. Runoff from hotspot land uses and activities is adequately treated and addressed through the use of appropriate structural stormwater controls and pollution prevention practices.

Provide for treatment of the WQv for all developments where stormwater management is required. A minimum WQ_v of 0.2 inches per acre should be met at sites or in drainage areas that have less than 15% impervious cover. Drainage areas having no impervious cover and no proposed disturbance during development may be excluded from the WQv calculations. Designers are encouraged to use these areas as non-structural practices for WQv treatment. Structural stormwater controls are sized and designed to treat the WQv. Depending on their removal efficiency or site constraints, more than one structural control may need to be used in parallel or in series (treatment train) to meet the water quality treatment requirement. Further, this guideline assumes that structural stormwater controls will be designed, constructed and maintained according to the criteria in this manual. Stormwater discharges from land uses or activities with higher or special potential pollutant loadings may require the use of specific structural controls and pollution prevention practices. A detailed overview of structural stormwater controls is provided in Part 2D.

3. **Stream channel protection.** Protection of stream channels is accomplished through three complementary criteria:

   a. Extended detention of the 1-year, 24-hour storm for a period of 24 hours using structural stormwater controls. It is known that the increase in runoff due to development can dramatically increase stream channel erosion. This standard is intended to reduce the frequency, magnitude, and duration of post-development bank full flow conditions. The volume to be detained is also known as the channel protection volume (CPv). The channel protection volume is one of the unified stormwater sizing criteria which are used in conjunction to size and design stormwater management facilities to address stormwater impacts. The use of nonstructural site design practices that reduce the total amount of runoff will also reduce CPv by a proportional amount. This requirement may be waived by a local jurisdiction for sites that discharge directly into piped stormwater drainage systems, larger streams, rivers, wetlands, lakes, or other situations where the reduction in the smaller flows will not have an impact on streambank or channel integrity.

   b. Implement velocity control, energy dissipation, streambank stabilization, and erosion prevention practices and structures as necessary in the stormwater management system to prevent downstream erosion and streambank damage.

   c. Establishment of riparian stream buffers on the development site. Stream buffers not only provide channel protection but also water quality benefits and protection of streamside properties from flooding. It is recommended that 100-foot buffers be established where feasible. For new development, an appropriate stream buffer is established by requiring a development setback from the centerline of the stream. In previously developed areas, where erosion of the bank material is an issue, structural controls may be required for bank stabilization. Providing a buffer strip planted with native vegetation in the boundary area between the developed property and the streambank can provide effective control.

4. **Overbank flood protection.** Overbank flood protection for downstream channels, and/or flooding from surcharging of downstream piped conveyances, is provided by controlling the post-development 5-year, 24-hour storm peak discharge rate (denoted Qp5) from exceeding the predevelopment (or natural conditions) discharge rate using structural stormwater controls. The overbank flood protection peak rate is one of the unified stormwater sizing criteria, which are used in conjunction to size and design stormwater management facilities to address stormwater impacts. The use of nonstructural site design practices that reduce the total amount of runoff will also reduce Qp5 by a proportional amount. See also the related discussion on minor and major design storms later in this section.

   Smaller storm events (e.g., 2-year and 10-year) are often effectively controlled through the combination of the extended detention for the 1-year, 24-hour event (channel protection criterion) and the control of the 25-year peak rate for overbank flood protection. These design guidelines are intended to be used together. If the control of the 1-year, 24-hour storm under guideline #3 is exempted, then for overbank flood protection, peak flow attenuation of the 2-year (Qp2) through the 50-year (Qp-50) return frequency storm events must be provided. This guideline may be adjusted by a local jurisdiction for areas where all downstream conveyances and receiving waters have the natural capacity to handle the full build-out 50-year storm through a combination of channel capacity and overbank flood storage without causing flood damage. Evaluation of the impact of peak rate control under this guideline is evaluated in conjunction with guideline #6 to ensure the downstream effect on timing of release rates from single or multiple detention structures does not increase downstream flooding.

5. **Extreme flood protection.** Extreme flood protection is provided by controlling and/or safely conveying the 100-year, 24-hour storm event (denoted Qf). This is accomplished either by:

    - Controlling Qf through structural stormwater controls to maintain the existing 100-year floodplain, or
    - Sizing the onsite conveyance system to safely pass Qf and allowing it to discharge into a receiving water whose protected floodplain is sufficiently sized to account for extreme flow increases without causing damage. In this case, the extreme flood protection criterion may be waived by a local jurisdiction in lieu of provision of safe and effective conveyance to receiving waters that have the capacity to handle flow increases at the 100-year level.

    The extreme flood protection peak rate is one of the unified stormwater sizing criteria, which are used in conjunction to size and design stormwater management facilities to address stormwater impacts. The use of nonstructural site design practices that reduce the total amount of runoff will also reduce Qf by a proportional amount.

6. **Downstream analysis.** A downstream hydrologic analysis is performed to determine if there are any additional impacts in terms of peak flow increase or downstream flooding while meeting guidelines #1-#5. Due to peak flow timing and runoff volume effects, some structural controls fail to reduce discharge peaks to predevelopment levels downstream from the development site. A downstream peak flow analysis may be needed to the point in the watershed downstream of the site or the stormwater management system where the area of the site comprises 10% of the total drainage area. This is to help ensure that there are minimal downstream impacts from the developed site. The downstream analysis may result in the need to resize structural stormwater controls, or may allow the waiving of some unnecessary peak flow controls altogether. The use of a downstream analysis and the "ten-percent" rule are discussed in Part 2C.

7. **Groundwater recharge.** Recharge to groundwater is implemented to the extent practicable through the use of nonstructural better site design techniques that allow for recharge of stormwater runoff into the soil. The annual recharge from the post-development site should approximate the annual recharge from the pre-development or existing site conditions, based on soil types. Stormwater runoff from a hotspot should not be infiltrated without effective pretreatment.

    The recommended stormwater runoff volume to be recharged to groundwater should be determined using the existing site (pre-development) soil conditions. The recommended rates of recharge for various hydrologic soil groups are as follows:

NRCS Hydrologic Soil Group	**Volume to Recharge (x total impervious area)** *(in acre-inches of runoff)*
A	0.51
B	0.34
C	0.17
D	0.08

Groundwater recharge is included as part of the water quality volume and is computed as recharge volume (Rev). Additional information is provided in Part 2B.

More information on site design practices that promote infiltration is found in Part 2E. Annual groundwater recharge rates should be maintained to the extent practicable through the use of nonstructural methods.

8. **Construction erosion and sediment control.** All new development and redevelopment sites should meet the regulatory requirements for land disturbance activities under the "Iowa Erosion Regulations" (i.e. < 5 tons/acre/year). See Iowa Code Section 161A.64, subsection 2 and/or the applicable NPDES General Permit #2 for construction activities. This involves the preparation and implementation of an approved Stormwater Pollution Prevention Plan (SWPPP), including appropriate best management practices, during the construction phase of development. Further guidance on practices for construction site erosion and sediment control can be found in Chapter 7 – Erosion and Sediment Control, and IDNR's Iowa Construction Site Erosion Control Manual, which can be found at www.ctre.iastate.edu/erosion.

   Better site design practices and techniques that can reduce the total amount of area that needs to be cleared and graded should be implemented wherever possible. It is essential that erosion and sediment control be considered and implemented in stormwater concept plans and throughout the construction phase to prevent damage to natural stormwater drainage systems and previously constructed structural stormwater controls and conveyance facilities.

9. **Stormwater management system operation and maintenance.** Implement a comprehensive operation and maintenance plan for the stormwater management system. An operation and maintenance plan is one of the required components of the post-construction minimum control measure for permitted MS4 jurisdictions. This is to include all of the stormwater management system components, including drainage facilities, structural stormwater controls, and conveyance systems. To ensure that stormwater management systems function as they were designed and constructed, the operation and maintenance plan provides:

   - A clear assignment of stormwater inspection and maintenance responsibilities
   - The routine and non-routine maintenance tasks to be undertaken
   - A schedule for inspection and maintenance
   - Any necessary legally binding maintenance agreements

10. **Pollution prevention.** Consider pollution prevention measures in the design and operation for new development and redevelopment sites, and prepare a stormwater pollution prevention plan. Specific land use types and hotspots may need to implement more rigorous pollution prevention practices.

11. **Stormwater management plan.** Develop a stormwater management site plan for all new development and redevelopment sites. The stormwater site plan provides a narrative, technical information, and analysis, indicating how the proposed development meets minimum guidelines #1-10 (or the applicable local jurisdiction stormwater requirements).

C. Minor and major design storms

The concept of minor and major design storms is related primarily to the conveyance capacity design for storm sewer and surface drainage systems. Part 2C provides a discussion of rainfall/runoff analysis and the selection of the appropriate design storm for a particular component of the stormwater management system. The concept of the unified sizing criteria is covered in Part 2B. This discussion of minor and major design storms is related to the selection of the overbank flood protection (Qp), which is one of the five components of the unified sizing criteria. Every urban area has two separate and distinct drainage systems, whether or not they are actually planned for and designed. One is the minor system corresponding to the minor (or ordinary) storm recurring at regular intervals, generally two to 10 years. The other is the major system corresponding to the major or extraordinary storm, generally 50- to 100-year or greater storm event. Since the effects and routing of stormwater for the major storm may not be the same for the minor storm, all storm drainage plans submitted for approval should be submitted showing the routing path and effects of the major storm.

Table 1: Chance of a storm equaling or exceeding a given frequency during a given time period

	Time Period in Years					
Frequency (years)	1	5	10	25	50	100
2	50%	97%	99.9%	99.9%	99.9%	99.9%
5	20%	67%	89%	99.9%	99.9%	99.9%
10	10%	41%	65%	94%	99.9%	99.9%
25	4%	18%	34%	64%	87%	98%
50	2%	10%	18%	40%	60%	86%
100	1%	5%	9.6%	22%	39%	64%

1. **Minor storm provisions.** The minor storm drainage system should be designed to provide protection against regularly recurring damage, to reduce street and stormwater conveyance maintenance costs, to provide an orderly urban drainage system, and to provide convenience and protection to the urban residents. Storm sewer systems consisting of underground piping, natural drainage ways and other required appurtenances should be considered as part of the minor storm drainage system.

2. **Major storm provisions.** The major storm drainage system should be designed to not cause major property damage or loss of life from storm runoff expected from the major storm. The effects of the major storm on the minor drainage system should be noted.

D. Design frequencies for conveyance facilities

Design storms for drainage facilities are described below. A minimum cleaning velocity of 2 ft/s should be used for the 2-year storm, and 3 ft/s for the design storm. When detention or overland flow provisions for storms greater than 10 years are not available, regardless of the street system, the 100-year or greater storm is required for the design to minimize impact to private properties.

1. **Intakes** should have a minimum capacity to convey the 5-year storm under developed conditions for local streets and minor collectors during the peak flow rate. The Engineer may require 10-year frequency for intakes for major collectors, arterials, expressways, and freeways.

2. **Storm sewers** should have capacity to convey a 5-year storm under developed conditions within the pipe for local streets and minor collectors. The Engineer may require 10-year frequency for storm sewers for major collectors, arterials, expressways, and freeways. Provisions should be made for the minimum 100-year storm, greater in critical areas, when overland flow is not allowed or available to prevent damaging private property. Storm and/or surface water conveyance easements should be provided to the Jurisdiction.

3. For those storm sewers that will handle footing drains, the following discharge (Q) values should be used:

   a. For less than 50 houses, Q=5.0 gpm per house.

   b. For greater than 50 houses, Q=250 gpm plus 2.5 gpm per house for each additional house over 50.

4. **Culverts** should have capacity to convey the following:

   a. 10-year storm without the headwater depth exceeding the diameter of the culvert

   b. 50-year storm without the headwater depth exceeding 1 foot over the top of the culvert

   c. 100-year storms should be conveyed through the culvert without the headwater depth exceeding one foot below the low point of the roadway/embankment, unless there are other, more restrictive elevations.

   d. For culverts that drain areas over two square miles, the IDNR rules and regulations will apply.

5. **Ditches** should have capacity to convey a 50-year storm within the ditch banks. Provisions should be made for the 100-year storm to flow overland within the flowage easement. Surface water flowage easements should be provided to the Jurisdiction for all designed drainageways. For ditches that drain areas over two square miles, the IDNR rules and regulations will apply. Additional design guidance for vegetated swale BMPs is provided in Part 2I.

6. **Detention basins** should have the capacity to retain a 100-year storm at critical duration or safely pass the 100-yr discharge over an auxiliary spillway. The top of the detention dike should be a minimum of 1 foot above the 100-year storage elevation. The detention basin design requires the IDNR approval for 18 acre-feet of storage or greater. Additional design guidance for detention basins is provided in Parts 2C and 2G.

E. Street flow criteria

1. **Street capacity for minor storms.**

   a. Pavement encroachment for minor design storms should not exceed the limitations set forth in Table 2:

Table 2: Allowable pavement encroachment and depth of flow for minor storm runoff

Street Classification	Maximum Encroachment[1]
Local	No curb overtopping. Flow may spread to crown of street.
Collector/Minor Arterial	No curb overtopping. Flow spread must not encroach to within 8 feet of the centerline of a two-lane street. The flow spread for more than two-lane streets must leave the equivalent of two 12-foot driving lanes clear of water; one lane in each direction. For one-way streets, a single 12-foot lane is allowed.
Major Arterials (4 lanes or greater)	No curb overtopping. Flow spread must not exceed 10 feet from the face of the curb of the outside lane. The flow spread for more than two-lane streets must leave the equivalent of two 12-foot driving lanes clear of water; one lane in each direction. For one-way streets, two 12-foot lanes are required. For special conditions, when an intake is necessary in a raised median, the flow spread should not exceed four feet from the face of the median curb for an inside lane.
[1] Where no curbing exists, encroachment shall not extend past property lines.	

b. The storm sewer system will commence upstream from the point where the maximum allowable encroachment occurs. When the allowable pavement encroachment has been determined, the theoretical gutter carrying capacity for a particular encroachment will be computed using the modified Manning's formula for flow in a small triangular channel as shown in Part 2M. An "n" value of 0.016 will be used unless special considerations exist.

2. **Street capacity for major storms.** The allowable depth of flow and inundated area for the major design storm should not exceed the limitations set forth in Table 3:

Table 3: Allowable depth of flow and inundated area for 100-year storm runoff

Street Classification	Allowable Depth and Ponded Area
Local and Collector	The ponded area should not exceed the street right-of-way and the depth of water above the street crown should not exceed 6-in. There may be situations where other restrictions are necessary.
Major and Minor Arterial	A 12-ft lane is the minimum travel lane to be passable in the center of the street.

3. **Cross street flow.** Cross street flow (called cross pan) can occur by two separate means. One is runoff which has been flowing in a gutter and then flows across the street to the opposite gutter or inlet. The second case is flow across the crown of the street when the conduit capacity beneath the street is exceeded. If the inundated area exceeds the street right of way, flow easements must be obtained. The maximum allowable cross street flow depth based on the worst condition should not exceed the limitation stipulated in Table 4.

Table 4: Allowable cross street flow

Street Classification	Initial Design Storm Runoff	100-Year Design Storm Runoff
Local	6-inch depth at crown or in cross pan	9-inch depth at crown or in cross pan
Collector	Where cross pans are allowed, depth of flow or in cross pan should not exceed 3”	6-inch depth at crown
Arterial	None	3-inch or less over crown