



FOR OFFICE USE ONLY

Stormwater Management Criteria
Form #PWU005 (rev. 11/16)

Stormwater Management Criteria	
Approving Agency	The designs for all storm sewers, stormwater detention basins, and all other stormwater management practices to be constructed in the City of Kenosha shall be subject to review and approval by the City Engineer and designees from the Engineering Division of the City of Kenosha Department of Public Works.
Performance Standards	The stormwater management plan shall meet the performance standards as outlined in Chapter 36 of the Code of General Ordinances, Section 281.16 and 283.33 of Wisconsin Statutes and Section V of Chapter NR151 of the Wisconsin Administrative Code. Where these standards differ the more restrictive standard shall be used.
Applicability for Control of Stormwater Pollution	The City of Kenosha Stormwater Management Criteria applies to all new development, redevelopment, or in-fill development 1 acre or more in area or as determined by the Director of the Stormwater Utility. A composite development of separate parcels, which totals 1 acre or more in area, must meet the same requirements as if it was a single parcel. This shall apply even though the parcels may be held by different owners or developed over an extended period of time. (example: a commercial strip along a major highway). Total suspended solids (TSS) shall be reduced by 80% or to the maximum extent practicable, based on average annual rainfall for new development and in-fill development as compared to no runoff management controls. For redevelopment (defined as replacing or adding to the building area by 50% or more or increasing the impervious area by 1 acre or more) the total suspended solids (TSS) must be reduced by 40%. New development sites of less than 1 acre, which are the source of significant pollution, such as soil, stone, or mineral stockpiles or the dispensing of fuels, must treat stormwater runoff to remove 40% of total suspended solids (TSS) and any perceptible petroleum product.
Applicability for Control of Peak Runoff Rates <i>(Contact the Kenosha Stormwater Utility to determine if the development is in an area covered by a regional stormwater management plan and what the requirements of this plan are.)</i>	For development in areas not covered by a regional stormwater management plan; control of peak runoff for the 2 year 24 hour storm shall be required for all new development, in-fill development, composite development, or redevelopment consisting of 1 acre or more to maintain the post development runoff for this design storm to no more than the predevelopment level. Control of the 10 through 100 year 24 hour storms is also required in any area where there is inadequate storm sewer or drainage-way capacity. Stormwater detention is the only approved practice for the control of the peak runoff rate from a site excepting credit will be given for runoff removed due to required infiltration where suitable hydrologic soil groups exist. Control of the peak runoff for the 10 through 100 year 24 hour storms will be required for all areas draining to navigable streams or to storm sewer systems that do not have at least capacity for the 5 year rational method storm or as determined by the Director of the Stormwater Utility.
Basis for Stormwater Detention Basin Design	The design of stormwater detention basins shall be based on the principles of the document "Urban Hydrology for Small Watersheds" (Technical Release 55, Soil Conservation Service, United States Department of Agriculture.) The rainfall distribution used in the design shall be the type II distribution (the rainfall type curve which was established in the "United States Department of Agriculture, Soil Conservation Service, Technical Paper 149, published 1973) that is applicable to all

	of Wisconsin and represents the most intense storm pattern.
Stormwater Detention Basin Design Methodology	<p>The methodology set forth in Technical Release 55 (TR-55) shall be used to determine times of concentration and peak flows and to develop hydrographs for the various design storms. The required stormwater detention shall be determined by routing these hydrographs through the proposed detention basin design using the Modified Puls Method. The maximum allowable predevelopment runoff curve numbers (RCN) for hydrologic soil groups shall be: RCN 56 for soil group A, RCN 70 for soil group B, RCN 71 for soil group C, and RCN 71 for soil group D. The design allowable release rate and required detention for the two year 24 hour storm shall be the more restrictive of the predevelopment runoff for this storm or the first 0.08 feet of runoff from the site released over a period of 24 hours. When control of peak runoff rates is required under criteria no. 4 the maximum allowable release rate for the 10 through 100 year 24 hour design storms shall be the predevelopment runoff for the 10 year storm. Any site with inadequate capacity downstream shall have the peak discharge for the 10 through 100 year 24 hour design storms reduced to a proportional share of the available downstream capacity based on the ratio of the development's area to the total drainage area. The available capacity downstream shall be determined by the capacity of storm sewer pipes flowing full or the overflow level for ditches or the top of the upstream end of the pipe for any culverts. None of these criteria shall preempt more stringent release rates which may be required by other governmental agencies. The methodology set forth in WinSLAMM shall be used to determine the total suspended solids (TSS) removal in stormwater detention basins and the pond area and or release rate adjusted as necessary to achieve the required TSS removal. If the required TSS removal is exceeded due to other design requirements the more conservative design shall be used. The Average Annual rainfall for use in the WinSLAMM model shall be the precipitation for Milwaukee during the year 1969, excluding the snow duration of December 6 to March 28.</p>
Elements of Stormwater Detention Basin Construction	<p><i>Permanent Pond Requirement:</i> Except for the listed exceptions, all stormwater detention basins shall have a permanent body of water or pond to enhance removal of suspended solids. For above ground detention basins constructed within one-half mile of an airport runway, approval by the Airport Director shall be required for any permanent water area. All stormwater detention basins located more than one-half mile from an airport runway shall have a permanent pond area calculated using Appendix A (Calculation of Preliminary Permanent Pool Surface area for TSS Reduction) of Wisconsin Department of Natural Resources Conservation Practice Standard "Wet Detention Pond (1001)". Using this table, under the category of 80% TSS removal, a percentage of the areas of the various types of development is used to determine the recommended pond area. The final pond area shall be determined using the WinSLAMM model. In cases where a dry bottom detention basin is to be constructed or where the inlet pipe does not discharge at the waters edge a low flow concrete pipe or concrete channel shall be required. For underground detention tanks the permanent water surface area should be the same as the bottom area of the structure. No permanent water surface is required for other types of underground storm water detention such as buried pipe systems except for a 4 foot deep sump (with a minimum area equal or greater than that produced by a 4 foot diameter manhole riser) immediately in front of the first stage outlet orifice.</p> <p><i>Permanent Pond Depth:</i> A minimum water depth of 4 feet shall be required excepting where the extension of a 4 to 1 embankment slope down from the maximum water level meets at a lesser depth. A minimum depth of 3 feet is required for suspended solids removal plus additional depth for storage of the sediment.</p>

While greater depths are allowed; a 4 foot depth is recommended in order to reduce the drowning hazard. If the deepest part of any basin has less than 2 feet of water, a poured reinforced concrete basin, with a uniform depth of 18 inches, with vertical or near vertical walls, and covering the area of the permanent pond will be required. Minimum thickness for the walls and bottom of this concrete lined pond shall be 6 inches.

Aerators or Fountains in Stormwater Detention Basin Ponds: Aerators or fountains in ponds of less than five feet depth are prohibited. Aerators designed to mix the contents of the permanent pond are prohibited for all ponds. The pump for the aerator or fountain must draw water mainly from the horizontal plane to minimize the re-suspension of sediments. The area of the pond must be increased by the amount of the area affected by the aerator or fountain or the device must have an automatic shutoff that functions during and for 24 hours after storm events.

Overflow Capacity: Overflow capacity must be provided for all stormwater detention basins. Where the detention volume is impounded behind a berm an overflow chute or inlet structure must be provided. This chute or inlet must be capable of passing the TR-55 100 year 24 hour storm routed through the basin under a blocked outlet condition. When an overflow inlet is required, but lacks adequate capacity, an overflow chute shall be constructed to provide the rest of the needed capacity. Either a 4 inch thick reinforced concrete slab or sod and turf reinforcement over an 18 inch thickness of medium size rip-rap buried under a thin layer of topsoil are acceptable for the bottom and sides of an overflow chute. The concrete slab or buried riprap must cover the bottom of the chute and its extensions to the top of the berm and extend down the outside face of the berm. A minimum freeboard of 1 foot from the top of the water outflow to the top of the berm is required. Where the stormwater detention basin lies in an excavated depression with no berm, an adequately sized grassed swale at one side of the basin will suffice for an overflow. For all overflow discharges a minimum of 6 inches of freeboard will be required between the water surface and any building or electrical enclosure. The extent of the water flow and the water surface elevation must be provided along the overflow route until the overland flow reaches a major drainage way.

Maximum and Minimum Slopes: Maximum slopes for the inside of the stormwater detention basin, the side slopes of the permanent pond, and the outside of any berm may not exceed 4 to 1. Flatter slopes may be used to make for easier maintenance or to provide a safety shelf above the permanent pond level adjacent to the water's edge. The use of slopes flatter than 4 to 1 shall not be used to decrease the required water surface area or the required minimum depth of the permanent pond. If a berm is constructed around the detention basin it must have a minimum top width of 10 feet and be flat across the top. Any water storage area (in the detention basin) which is normally dry between rainfall events must have a minimum slope of 2%. No area in the detention basin shall be deliberately constructed as wetland except where there is an existing wetland, which must be preserved, or where suitable hydrologic soil groups exist for creation of a stormwater infiltration area.

Berm Construction: Berms, which will impound storm water, must be constructed of sound clay compacted to 95% of modified proctor. Any pervious material located under the area proposed for the berm must be removed prior to the start of construction. A minimum of 2 soil borings per stormwater detention basin site with at least one boring per 2 acres of detention storage area is required. Soil borings are required to the greater of a depth 5 feet below the maximum pond excavation or 2 feet below any pervious material layer to determine the suitability of the subsoil for siting a detention basin. Unsuitable material at any depth below the proposed berm location will require an 8 foot wide cutoff wall of compacted clay, centered on the berm, to be placed to a 1 foot depth below the unsuitable material. Pipes passing through a berm shall be bedded and backfilled up to the top of pipe with crushed limestone conforming to the gradation no. 3 in section 304.2.6 of The State of Wisconsin Department of Transportation Standard Specifications for Highway and Structure Construction. The remainder of the trench shall be clay compacted to 95% of modified proctor. An anti-seep collar extending twice the pipe diameter in all directions, but not exceeding 5 feet horizontally or 3 feet vertically, and being a minimum of 18 inches thick shall be constructed of poured concrete at the berm midpoint.

Pipes Entering and Exiting Basins: All pipes entering and exiting the stormwater detention basin shall be reinforced concrete. Where a swale would discharge to the basin, terminate it approximately 20 feet in back of the top of the interior slope of the basin and replace it with an appropriately sized inlet and pipe with a flared end section discharging at the permanent water level.

Access Easement: All stormwater detention basins not adjacent to a public street shall have a minimum 10 foot wide easement to provide access to the basin parcel. Adequate room to turn around a pickup truck must be provided at the basin end of the easement. The easement may be maintained as grass but must have adequate drainage.

Outlet Structures: Outlet structures for the stormwater detention basin shall conform to the detention basin slope and have a minimum trash grate open area of 4 times the orifice protected or 4 square feet whichever is greater. Bars on the trash grate shall be of smooth, stainless steel, have a minimum size opening approximately two-thirds the diameter of the orifice protected, and be able to support a 250 pound point load without permanent deflection. Bars in two directions shall be required except for inlets discharging to pipes 48 inches in diameter or greater. Maximum grate openings shall be 5 inches for bars in one direction and 6 inches by 6 inches for bars in two directions. Grates with openings over 3 inches shall have a protective decorative fence such as post and chain around the sides.

Aesthetics: Aesthetics shall be taken into consideration in the design of stormwater detention basins. Curvilinear rather than rectangular shaped ponds shall be used wherever possible. Exposed rip-rap shall be kept to a minimum. More extensive areas of rip-rap should be covered with a thin layer of topsoil, turf reinforcement, and sod or be covered by water. Fieldstone shall be used for rip-rap wherever possible to provide a more natural appearance. Structures shall be flush with the ground surface whenever possible. A landscaping plan with a minimum of one tree or substantial bush cluster per detention basin side or per 100 feet of the perimeter,

	<p>whichever provides more plantings, is required. A minimum of 10 feet of level surface between the top of the detention basin slope and adjacent properties is required.</p> <p><u>Safety Shelves:</u> Underwater safety shelves are not permitted in stormwater detention basins. (The shallow water results in an increase in the water temperature. There is an increase in the amount of cattail and rush growth around the perimeter of the permanent pond resulting in stagnant water conditions. This encourages mosquito breeding. The drop-off at the edge of the shelf creates a drowning hazard for children.)</p> <p><u>Formulas for Outlet Capacity:</u> Calculation of orifice capacity shall be done using the formula $Q = 0.6 A (2gh)^{1/2}$. The Calculation for the capacity of a broad-crested weir shall be done using the formula $Q = 3 L H^{3/2}$</p>
<p>Design of Storm Sewers and Open Channels</p>	<p><u>Capacity:</u> Storm sewers shall be sized for the largest peak flow produced by the 10 year rational method design storm. The hydraulics of the storm sewer shall be designed to operate under full or partially full conditions for the 10 year storm. A design that would cause the storm sewer to surcharge during the 10 year storm is not acceptable. Where a storm sewer discharges into a storm water detention basin the pipe sizing must take into account the loss of hydraulic gradient due to rising water levels in the basin. Design calculations must show actual storm water taken in by each inlet draining to the proposed storm sewer and the amount of storm water by-passing the inlet.</p> <p><u>Inlet Time of Concentration:</u> The maximum initial inlet time for storm sewer design shall be 15 minutes for single family and duplex residential development, 10 minutes for multifamily residential development, and 5 minutes for commercial and industrial development.</p> <p><u>Inlet Spacing:</u> Inlet spacing in street pavement shall be governed by the following requirements: the spacing between inlets or from a high point to an inlet shall be a maximum of 400 feet, the storm water flow in gutters shall leave 7 feet of the adjacent traffic lane free of water, and 7 feet of the traffic lane adjacent to an inlet in a sump shall not be under water.</p> <p><u>Construction Methods:</u> Storm sewers shall be constructed according to the City of Kenosha's Standard Specifications for the Construction of Sewers. Copies of this specification can be obtained from the City of Kenosha Public Works Department or can be viewed at www.kenosha.org.</p> <p><u>Design of Open Channels:</u> The design of open channels shall be based on the TR-55 100 year 24 hour storm for all drainage areas equal to or greater than 2 acres in size. For drainage areas less than 2 acres in size the 10 year rational method design storm may be used. Appropriate means shall be used to avoid erosion of the channel during peak flow. Velocities shall not exceed 3 feet per second for grass lined channels, 6 feet per second for channels lined with coarse gravel or with turf reinforcement, and 8 feet per second for channels lined with rip-rap. Side slopes of channels shall not be greater than 4 to 1. A minimum of 6 inches</p>

of freeboard must exist between the design water surface and any building or electrical enclosure.

Excessive Stormwater Flow: An overflow path shall be provided for all sumps in the streets and any sumps in the interior of developments to protect against property damage in case of plugged inlets or runoff in excess of the storm sewer capacity. The required capacity of this overflow route shall be equal to that required for a TR-55 100 year 24 hour runoff under a plugged inlet condition. A minimum of 6 inches of freeboard must exist between the design water surface and any building or electrical enclosure. Sumps around yard inlets must only be in the immediate area of the inlet with no electrical transformer or telephone enclosure in the area subject to flooding if the inlet plugs.

Sumps in Manholes or inlets: All manholes and inlets shall be designed and constructed to drain dry. No amount of a sump in these structures is acceptable. (Standing water in these structures lead to mosquito and odor problems and any trapped pollutants are flushed out with the next rainstorm.)

Pipe Material: All storm sewer mains and inlet leads that will be maintained by the City of Kenosha shall be reinforced concrete pipe with O-ring gaskets. The minimum size pipe shall be 12 inches in diameter.

Yard Inlets: Backyard swales shall be intercepted by inlets spaced no more than 400 feet apart. No more than 200 feet of swale may discharge over a sidewalk without an inlet being required in back of the sidewalk. All yard inlets shall have flat grates, be located in a minimum 0.3 foot deep sump, and have adequate capacity for the 10 year rational method design storm with no more than 0.75 feet of head over the grate. Capacity for the inlet grates shall be rated using the water depth at which bypass flow will occur.

Long-Term Flows in Swales: Swales are acceptable only for intermittent storm water flows. Where long term flows are to be expected, such as from an extensive drainage area, a storm water detention basin, or a storm sewer connected to sump pumps, a storm sewer sized for the 10 year rational method design storm should be installed. With permission from the Director of the Stormwater Utility a low flow pipe may be substituted with the swale sized to take flows in excess of the pipe capacity. The minimum size for a low flow pipe shall be a diameter that will accommodate a 2 year rational method design storm. Pipe material shall be reinforced concrete with O-ring gaskets.

Sump Pump Connections: Sump pumps shall be connected to storm sewers with a 4 inch diameter SDR 26 solid wall PVC pipe having a minimum slope of 1% and either 3 feet or more of cover or a minimum of 2 ft. of cover if protected from frost with 2 inch thick, 24 inch wide closed cell extruded polystyrene boards.

Connections to Existing Culverts: Where flow from an existing culvert or storm sewer is to be picked up by a new storm sewer or a new storm sewer discharges to such an existing culvert or storm sewer, a direct connection to the existing pipe shall be made instead of leaving an intervening swale or ditch. (This is to avoid problems

	<p>with plugged grates on inlets and culverts and to improve the capacity of the system by reducing head loss.)</p> <p><i>Design for Off-Site Flows:</i> All storm sewers must be designed to pick up either the existing condition runoff from the TR55 100 year 24 hour storm or the 10 year rational method design storm for the developed condition of any off-site contributing drainage area (whichever is greater). Any proposed upstream detention that will not be constructed at the same time as the proposed development shall not be taken into consideration.</p>
Prepackaged Stormwater Treatment Structures	<p>Proprietary stormwater treatment devices may be used with the permission of the Director of the Stormwater Utility under certain circumstances. These circumstances include where control of the stormwater quality is the only issue. Generally the devices must utilize settling as their means of TSS reduction although advanced design filtration units may be submitted for consideration. A design must be accompanied by data showing that it will achieve the required total suspended solids (TSS) and petroleum products removal and that the removed sediment and petroleum product will be retained during storms exceeding the devices rated capacity. An analysis using the WinSLAMM methodology must be provided with the plan submittal. All proprietary settling devices shall be designed in accordance with the Wisconsin Department of Natural Resources Conservation Practice Standard 1006 (Method for Predicting the Efficiency of Proprietary Storm Water Sedimentation Devices). Settling facilities that require the addition of oil absorbent to achieve petroleum product removal are not acceptable.</p>
Infiltration Requirements	<p>Any development in an area with hydrologic soil group A or B soils must provide infiltration capacity as outlined in the performance standards. If the development fits the criteria for a claim for an exemption or exception the developer must submit a detailed explanation supporting the claim. A site evaluation in accordance with the Wisconsin Department of Natural Resources Conservation Practice Standard 1002 (Site Evaluation for Stormwater Infiltration) must be conducted to prove eligibility for any claimed exemption or exception. Soil testing will be required. Infiltration capacity must be designed, constructed and maintained according to the Wisconsin Department of Natural Resources Conservation Practice Standards 1003 (Infiltration Basins) and 1004 (Bioretention). An analysis of the infiltration capacity must be submitted using the RECARGA model. If a vegetated infiltration swale is to be used it must be designed in accordance with Wisconsin Department of Natural Resources Conservation Practice Standard 1005 (Vegetated Infiltration Swale). For all infiltration devices an analysis using the WinSLAMM methodology must be provided with the plan submittal.</p>
Protective Areas	<p>All developments must adhere to the standards of DNR regulation NR 151.12 regarding protective areas adjacent to wetlands, streams, rivers, lakes and ponds.</p>