Appendix I: Stormwater Management Standards

I-1: Intent and Purpose

This appendix provides minimum standards, control and criteria for stormwater management. The principal design consideration in this appendix is to minimize the harmful physical and economic effects of erosion, sedimentation, and flooding from stormwater runoff. This is to be accomplished through the requirement of special measures to mitigate erosion both during and after construction, the detention and controlled discharge of the differential runoff from the development, and a well-designed stormwater conveyance system.

I-2: Definitions

For the purpose of this appendix, the following terms shall be deemed to have the meaning indicated below:

(a) *County Technician.* A person or firm that the County Commission authorizes by appointment or by contract to fulfill the responsibilities of reviewing plans, making recommendations, etc. as provided for in this appendix.

(b) *Design Storm Event*. A storm of a specific duration expected to occur with a frequency of once every ten years.

(c) *Detention Facility*. A surface water runoff storage facility that is normally dry but is designed to hold (detain) surface water temporarily during and immediately after a runoff event.

(d) *Differential Runoff.* The difference in peak flow rate of water anticipated to shed from a parcel of land between the existing and improved surface condition, for each rainfall event.

(e) *Freeboard*. The difference in elevation between the top of the detention basin dam and the design surface water elevation.

(f) *Major Storm Event*. The storm of a specific duration expected to occur with a frequency of once every one hundred years.

(g) *NRCS Urban Manual, NRCS Engineering Field Manual, and NRCS Field Office Technical Guide*. Guides and manuals used to supplement *TR-55*.

(h) *Retention Facility*. A surface water runoff storage facility always contains (retains) a substantial volume of water to serve recreational, aesthetic, water supply, or other functions. Surface water is temporarily stored above the normal stage during and immediately after runoff events.

(i) *Stormwater Management Plan*. The drawings, computations, data, proposed contours,

reports, etc. that identify how stormwater runoff is to be handled.

(j) *Stormwater Runoff*. Water that results from precipitation which is not absorbed by soil, evaporated into the atmosphere, or entrapped by ground surface depressions and vegetation.

(k) *Time of Concentration*. An estimate of the time of surface water flow from the hydraulically most remote part of the drainage area to the point in question.

(l) *Tributary Area*. All of the area that contributes stormwater runoff to a given point.

(m) *TR-55*. Technical Release 55 ■Urban Hydrology for Small Watersheds• as produced by the United States Department of Agriculture.

I-3: Sediment and Erosion Control Standards

(a) *General*. Sediment and erosion control will be accomplished by applying conservation practices that will reduce the potential for damage from these hazards. Control practices use trapping, filtering, or diversion techniques to protect adjacent properties from land disturbance activities.

(b) *NPDES Stormwater Permit*. Effective January 1, 1992 construction sites where the area to be disturbed is five acres or more, must apply for a stormwater discharge permit from the Missouri Department of Natural Resources. Permit requirements are set forth in 10 CSR 20-6.2000 of the Missouri Clean Water Laws.

(c) *When Controls are Required*. Standard vegetative and structural practices, as specified below, that filter, divert, or promote the settlement of sediment particles from storm runoff shall be provided in the following situations:

(1) to prevent sediment-laden runoff from leaving disturbed areas.

(2) to isolate disturbed areas from erosive surface runoff associated with significant undisturbed areas.

(3) to protect storm drainage conveyance systems at operable inlets.

(d) *Types of Controls*. Acceptable sediment and erosion controls shall be either vegetative, or structural as described below.

1. Vegetative Practices

a. *topsoiling* ●stockpiling of topsoil to enhance final site stabilization with vegetation shall be done in such a manner that natural drainage is not obstructed and no

off-site sediment damage results.

b. *seeding* ●of the rate and type to produce a dense vegetation.

c. *sodding*.

d. *mulching* ●is the application of grass, hay, wood chips, wood fibers, straw, gravel, or other suitable material to the soil surface. Seeded and planted areas where slopes are steeper than 2:1 shall be stabilized with mulch.

2. Structural Practices

a. *Construction entrance* ●is a rock stabilized pad located at points of vehicular ingress and egress on a construction site.

b. *Straw bale barrier* ●shall be placed on downslope areas to intercept sediment or to reduce flow velocity.; Straw bale barriers shall not be constructed in streams or swales where there is the possibility of washout.

c. *Silt fence* ●sediment shall be removed when it reaches one-third to one-half the height of the filter fence.

d. *Storm drain inlet protection* ●may consist of filter fabric, sand bags, excavated gravel, straw bale, block and grave, and any combination of the above.

e. *Diversion swale or dike* ●these may be used to intercept runoff and divert to a sediment control device around a disturbed areas, or to an area where it can be safely released.

f. *Sediment trap* ●is a small storage or detention area used to detain construction runoff long enough to allow the larger-sized sediment particles to settle out before the runoff is releases to downstream areas.

g. *Temporary sediment basin* ●performs the same function as a sediment trap, although it has a greater volume and is located below disturbed areas generally greater than five acres. They shall be sized to provide a minimum volume of three thousand six hundred cubic feet per disturbed acre draining to the facility.

h. *Temporary slope drain* ●may be plastic sheets, metal or flexible pipe, stone, gutter, fiber mats, concrete or asphalt ditches, or half round pipe to carry runoff from one elevation to a lower elevation without excessive erosion of the slope.

i. *Check dam* ●may be constructed of logs or stone across a swale or drainage

ditch to reduce the water•s velocity and to trap small amounts of sediment.

j. *Level spreader* •is an excavated depression to convert a concentrated flow to a sheet flow, allowing water to be released at less erosive levels.

k. *Erosion fabrics*

(e) *Construction plans*. A contoured development map must clearly indicate the pattern of surface water runoff, both upstream and downstream of the development. The type of sediment and erosion control to be utilized shall be clearly indicated. The county technician shall have authority to require proper controls, as specified herein.

I-4: Design Criteria

(a) *Purpose*. A development•s stormwater drainage system shall be designed to:

(1) Protect natural waterways.

(2) Convey upstream and on-site stormwater runoff to a natural watercourse or to a storm drainage facility.

(3) Provide protection from the design storm event and address the major storm so as to prevent major property damage and loss of life.

(b) *Rainfall frequency*. All facilities shall be designed to carry a twenty-five (25) year storm, 24 hour duration which produces the maximum peak flow rate of stormwater runoff, without inundation or surcharging. All hydraulic structures shall be designed to allow for a one hundred year storm, 24 hour duration to pass through the subdivision without destroying or damaging property or inundating dwellings. Design information which substantiates both conditions shall be provided. Cross-drainage shall carry a 25 year, 24 hour storm.

See TR-55 for rainfall curves.

(c) *Calculation of runoff*. The method for calculating stormwater runoff, differential runoff, and detention storage shall be TR-55. The drainage area shall consider all on and off-site lands contributing to the proposed development•s drainage system. Capacity for such faculties shall be based on the maximum potential watershed development permitted by the Unified Land Use Regulations.

The minimum percentage of imperviousness to be used in design shall be based on the zoning district.

District	Minimum Percentage Impervious

District	Minimum Percentage Impervious
SD	15
RD	30
RD-2	60
CD, CA, CA-3,	95
ID	95
AN	15
Parking, streets, roofs	100

Special circumstances may dictate that the developed impervious area may differ from that shown in the above table. An example may be single-family lots of larger than 1 acre. Calculations prepared by a registered professional engineer may be submitted to the county technician for his evaluation to determine if a minimum impervious area which differs from that shown in the above table may be utilized. Likewise, the county technician may determine that the percent of impervious area for a particular development differs from that shown in the above table.

(d) *Open channels*. Open channels consist of swales, ditches, or depressions, both natural and manmade, that convey water. Channels shall be protected from scour and erosion by providing a channel lining adequate to sustain the velocity of the 10 year design storm, 24 hour duration. If velocities in channels exceed five feet per second during ten year design storms, then erosion control other than vegetation shall be provided in channel construction. Channels shall have the hydraulic capacity to carry the 10 year design storm, 24 hour duration runoff within the channel bed and banks. Out of bank flow may be permitted on land slopes parallel to the channel where it can be shown that no erosion damage or serious property damage will result. Channels function as part of the major drainage system and shall be evaluated for the 100 year design storm, 24 hour duration to determine the impacts of runoff on adjacent property. The channel=s hydraulic capacity shall be increased where adjustments to channel geometry provide significant protection to adjacent properties during the 100 year event.

(e) *Closed conduit storm sewers*. Pipe sizes for closed conduit flow shall be based on the 10 year design storm runoff and minimum allowable velocities. The system shall provide for the cleaning of sediment and other deposits by maintaining a minimum velocity of two feet per second during the 10 year storm, 24 hour duration.

Manning=s Equation is the most common method of estimating the capacity and flow resistance in closed conduits, although the Kutter, Hazen-Williams, and Darcy Weisbach formulas are also acceptable.

Closed conduit storm sewer systems shall convey the 10 year design storm, 24 hour duration to a point of discharge by gravity or pressure flow. In pressure flow conditions, the hydraulic grade line shall be calculated to reflect losses in pipes and structures and shall not rise to an elevation greater than the sewer structure tops during the design storm.

Generally, gravity flow occurs where the capacity of pipe run exceeds the design flow and the outfall point does not control discharge. Storm sewer systems may be designed for pressure flow when the hydraulic grade line is above the crown of the pipe. The decision to design a pressure flow system may be based on aesthetics, the need to submerge outfalls, economics limitations associated with reduced pipe sizes, or grade constraints in outfalling the system.

(f) *Inlets*. Calculations shall be submitted to demonstrate the capacity of all inlets, such calculations must consider the cross-slope of the pavement, depth of water at the curb face, size of opening, and the longitudinal grade of street. Street inlets and inlets in parking areas shall reduce the spread and depth of flow to acceptable levels during the 10 year design storm, 24 hour duration. The acceptable level of flow for a minor access or local access street would maintain an 8 foot travel lane with a maximum 1 inch depth. One clear 10 foot travel lane must be maintained for a collector street. And two clear 10 foot travel lanes must be maintained for a major street. Any area inundated by water ponding at an inlet during the 10 year storm, 24 hour duration event shall also be analyzed to insure no property damage or dangerous conditions result. Inlets located on continuous grades may be designed to permit a portion of flow to bypass the structure; however, calculations for the downstream structure must consider the bypass.

(g) *Plans and calculations*. A drainage map shall be developed from a base reproduction of the site plan or grading plan. The existing and proposed contours shall be shown, normally at 2 foot intervals, for the subject property, extending off-site one hundred feet or less, as determined by the county technician for proper design of the proposed improvements. Contour intervals other than the above shall be used as determined by the site topography. Only USGS Datum shall be used.

The location of existing and proposed property lines, streets, sinkholes, railroads, areas within the tract subject to inundation by stormwater and other significant natural features, such as wooded areas and rock formations, etc., shall be included on the map. All existing and proposed stormwater facilities, such as inlets, manholes, pipes, culverts, bridges, channels, etc., and all existing and proposed improvements required for proper design review, such as pavement, buildings, etc., shall be included on the map.

The run-off details shall be required, showing individual flows for each existing and proposed structure and cumulative flows in pipes and gutters, including ■Q• (see Figure I-2) and area. The map shall show all bodies of water, such as ponds or lakes (including surface area and elevation), and all waterways (including their names or the names of creeks or rivers they flow into).

Lots shall be laid out so as to provide positive drainage away from all buildings. Individual lot

drainage shall be shown and coordinated with the drainage pattern for the area and designed so that run-off from one lot will not adversely affect an adjoining lot. All necessary grading to direct stormwater run-off shall be located within a drainage easement.

All computations, plans, and specifications, related to the implementation of this appendix must be prepared and sealed by a professional engineer, registered in the State of Missouri.

I-5: Detention and Retention Facilities

(a) *Maintenance*. Each owner of the property being developed has the responsibility and duty to properly operate and maintain any stormwater management system which has not been accepted for maintenance by the county. The responsibility of maintenance of the system in subdivision developments shall remain with the developer until such time as the stormwater management system escrow for such development has been released. Upon release of escrow, the maintenance responsibility shall be vested in the trustees of the subdivision, by virtue of a trust indenture. The indenture of trust shall clearly indicate resident responsibility for maintenance. The responsibility for maintenance in single-lot development shall remain with the general contractor and owner until final inspection of the development is approved, and an occupancy permit is issued. After occupancy, the maintenance of the management system shall be vested in the owner of the project. All such privately owned and maintained systems shall be subject to periodic inspection by the county, as needed.

(b) *Storage Capacity*.

(1) The rates (pre-developed and post-developed) of run-off shall be determined for the 2, 5, 10, 25, 50, and 100-year rainfall frequencies. The minimum storm duration shall be twenty-four (24) hours.

(2) Stormwater shall be detained on site or adjacent property under agreement and metered out at the rate of an undeveloped site for the above frequencies and minimum duration to prevent possible flooding and erosion downstream. Design criteria to establish this differential runoff rate shall be as provided in Section I-4, ▪Design Criteria•. Use of emergency spillway to change part of flow may be incorporated unless floodrouting calculations are presented to verify that a smaller pipe size will be adequate due to temporary storage. Note that stormwater pipes shall be sized to carry the total developed tributary upstream watershed. No reduction in pipe size shall be permitted because of detention.

(3) Detention basin volume will be based on routing each post-developed run-off hydrograph through the detention facility while satisfying the appropriate allowable release rate. The routing computation shall be based on an application of the continuity principle. The discharge rate shall be based on the maximum head conditions in the detention facility.

(c) *When Required*. The county retains the right to require detention storage in all cases in which

the proposed development will generate excess runoff that adversely affects the carrying capacity of the receiving watercourse, and/or adversely affects adjoining property owners. Therefore, every development shall have stormwater detention, except as specified herein.

(1) Off-site facility, two or more developments: If two or more developments including that of the applicant, have provided for a common system.

(2) Off-site facility by county: If an off-site stormwater management system has been either constructed or programmed or identified for construction by the county, and the applicant has agreed to contribute to or participate in the construction thereof.

(3) It is determined that no immediate adverse effects will result to adjacent property, and a contribution is made to the Stormwater Management Improvements Fund (as described in Subsection (e) of I-5 this appendix.

If immediate on-site or off-site detention is not required, as specified in the above paragraph, the applicant must contribute to the Stormwater Management Improvements Fund. The contribution shall be an amount equal to two hundred dollars ($200) for every cubic foot per second of differential run-off generated during the 100-year design storm, 24 hour duration event.

Other management techniques: Management techniques other than detention facilities may be utilized by the development provided the techniques proposed meet the intent of this appendix and provide a benefit to the watershed that equals or exceeds the benefit that a detention facility would provide.

(d) *General Design Features*

(1) Dry bottom basins. May be constructed to temporarily detain the stormwater runoff so that the rate at which it is released is the same rate as before development. The following features shall be incorporated into the design of any detention basin.

(i) Freeboard. Detention storage areas shall have adequate capacity to contain the storage volume of tributary stormwater runoff with at least two feet of freeboard above the water surface.

(ii) Outlet control works.

1) Outlet works shall be designed to limit peak outflow rates from detention storage areas to or below peak flow rates that would have occurred prior to the proposed development.

2) Outlet works shall not include any mechanical components or devices and shall function without requiring attendance or control during operation, unless

specifically approved by the county technician .

(iii) Emergency overflow/spillway. Emergency structure shall be provided to permit the safe passage of runoff generated in excess of the design storm event. Antivortex measures shall be provided.

(iv) Maximum depth. The maximum planned depth of stormwaters storage shall not normally exceed five feet.

(v) Side slopes. The maximum side slopes for grassed basins shall not normally exceed one foot vertical for three feet horizontal.

(vi) Limits of ponding. In no case shall the limits of maximum ponding be closer than thirty feet horizontally from any building and less than two feet vertically below the lowest sill elevation.

(vii) Interior drainage. The basin bottom should be designed to drain expeditiously. Flows through the detention basin should be handled by paved ditch from inflow structure to outflow structure to minimize erosion.

(viii) Multipurpose basins. If the detention basis is to have other uses, the design of the basin bottom should include underdrains to expedite drying of the bottom between runoff events.

(ix) Aesthetics. Designs should result in aesthetically pleasing configurations which will enhance public acceptability.

(2) *Wet bottom basins*. Wet bottom basins may also be used to temporarily detain the differential runoff from the development. In addition to the general design features enumerated above for dry bottom basins, the following features should also be incorporated into the design of any wet bottom basin:

(i) Normal pool depth. In order to minimize weed growth, the normal pool depth should be four feet minimum.

(ii) Depth for fish. If fish are to be kept in the pond, at least one-quarter of the area of the permanent pool should have a minimum depth of ten feet.

(iii) Facilities for emptying. In order to ease cleaning of the pond or shoreline maintenance, the pond design should include provisions for emptying the pond.

(iv) Low flow by-pass. The design of any pond may include a low flow by-pass channel or pipeline to divert runoff that can be accommodated by downstream drainage ways.

(v) Side slopes below normal pool. The side slopes below the normal pool elevation may exceed the maximum side slope permitted above normal pool (3:1 slope). The design shall, however, include provisions for a safety ledge having a depth of water not greater than three feet immediately adjacent to the shoreline.

(vi) Forbay. In order to minimize siltation of the pond, a forbay should be included in the design.

(3) *Parking lot storage*. Paved parking lots may be designed to provide temporary detention storage of stormwater on all or a portion of their surfaces. Outlets will be designed so as to slowly empty the stored waters and depths of storage must be limited so as to prevent damage to parked vehicles.

(4) *Other detention methods*. All or a portion of the detention storage may also be provided in underground or surface detention facilities, to include basins, tanks, or swales, etc. Emergency overflow conditions shall be considered in all methods.

(e) *Stormwater Management Improvements Fund*. A Stormwater Management Improvements Fund shall be and is hereby created. Said fund shall be reserved for funding improvements to stormwater systems owned and maintained by the county, and for no other purposes unless authorized in this appendix. All contributions made by parties developing in the county in accordance with I-5, Subsection (c) of this appendix shall be deposited to said fund. Said fund shall be deposited in an interest bearing account by the Franklin County Treasurer.

(f) *Plans and Calculations*

(1) Topographic map outlining the limits of the contributing watershed, and site plan of suitable scale and 2 foot contour interval, showing the land to be developed and such adjoining land whose topography may affect the layout or drainage patterns for the site.

(2) The location of streams and other floodwater runoff channels, calculations supporting the method and capacity needed for the safe and temporary storage of increased runoff resulting from the proposed development, if temporary storage is needed.

(3) Basic information regarding the receiving watercourse into which the proposed stormwater system will discharge. This information should include a general cross section, and existing downstream culverts, bridges, and other waterway openings.

(4) A layout of the proposed stormwater management system including the location and size of all drainage structures, storm sewers, channels, channel sections, detention basins, and analysis regarding the effect said improvements will have upon the receiving channel and its high water elevation.

(5) All computations, plans and specifications related to the implementation of this appendix must be prepared and sealed by a professional engineer, registered in the State of Missouri.

I-6: Material and Construction Standards

(a) Storm pipes shall be protected from excessive bearing pressures by placing them outside the forty-five degree influence zone of building structures unless an engineering calculation shows the pipe material or soil condition to be adequate for the subjected load.

(b) Pipes on twenty percent slopes or greater shall be anchored securely with concrete anchors or equal to prevent the pipe from creeping downhill.

(c) Pipes or structures constructed on fill shall be stable and protected against settlement by compacting fill material to ninety-five percent of the modified proctor maximum dry density.

(d) Pipes thirty-six inches or larger may be placed on a curved alignment utilizing alignment radii established by the pipe manufacturer.

(e) The receiving surface where pipes discharge shall be protected from erosion by evaluating the discharge velocity for the 10-year design storm, 24 hour duration. The use of energy dissipating devices may be necessary to reduce the velocity to acceptable levels for the receiving surface. Grouted revetment used shall be a minimum length of ten times the diameter of the discharge pipe.

(f) A manhole, inlet, or junction box shall be located at changes in pipe size, grade, alignment, or material.

(g) The angle between influent and effluent pipes shall be not less than ninety degrees, and the drop between inverts shall be not less than 0.1 foot.

(h) Manhole and inlet castings located in travelways shall be capable of withstanding traffic loads, and shall be constructed flush with the finished surface.

(i) All materials and appurtenances for stormwater management systems shall conform to current standards of the American Society for Testing and Materials (ASTM).

(j) Manholes shall be precast or cast-in-place concrete, brick, concrete block, with concrete or brick risers and approved manhole covers.

(k) A new drainage channel or pipe shall intersect an existing drainage channel at a maximum angle of sixty degrees.

(l) All trenches under roadway pavement shall be backfilled with MoDOT Type In aggregate in six inch layers and compacted to ninety-five percent of the modified proctor maximum dry density.

(m) All piping shall be bedded per the manufacturer•s requirements.

(n) Grated inlets will not be allowed without special approval by the county technician .

(o) All materials used in the construction of storm sewers shall be subject to inspection and approval of the county technician .

(p) Acceptable pipe material shall be reinforced concrete pipe, corrugated metal pipe, and corrugated polyethylene pipe. Reinforced concrete pipe shall conform to the requirements of the Specifications for Reinforced Concrete Culvert, Storm Drain and Sewer Pipe, ASTM C76. Strength class or classes shall be required per design specifications of the latest edition of the Concrete Pipe Handbook, as published by the American Pipe Association.

(q) Reinforced concrete pipe shall be required under road pavement.

(r) All construction details pertaining to stormwater drainage shall be in accordance with the Appendix C of these regulations. Metropolitan St. Louis Sewer District requirements may supplement these regulations for additional guidance and direction.