

CITY OF OZARK DESIGN STANDARDS FOR PUBLIC IMPROVEMENTS



2021 EDITION
CITY OF OZARK, MISSOURI

- **Changes from the previous edition are noted in red.**

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DEFINITION OF ABBREVIATIONS, TERMS, PHRASES, AND WORDS

1. **AASHTO.** American Association of State Highway and Transportation Officials.
2. **ADA.** American with Disabilities Act.
3. **ANSI.** American National Standards Institute.
4. **ASTM.** American Society of the International Association for Testing and Materials.
5. **ASCE.** American Society of Civil Engineers.
6. **AWWA.** American Water Works Association.
7. **Bench Mark.** A permanent object of known elevation and location that is in an area where disturbance is unlikely.
8. **BMP'S.** Best Management Practices.
9. **Board of Aldermen.** The governing body of the City of Ozark.
10. **BOC.** Back of Curb.
11. **City.** City of Ozark.
12. **Construction Specifications.** The official City of Ozark's General Conditions and Technical Specifications used on public improvements within the City of Ozark, Missouri and such other areas outside the corporate boundaries which may contract with the City for the provision of services. This document contains data for public improvements from the beginning stage of a project through the actual construction and acceptance of the project.
13. **Cul-de-sac or Dead-end Street.** A minor street with only one outlet.
14. **Curb Return.** The curved portion of curb at the beginning of a driveway approach, which serves as a transition from the height of the curb to the level of the approach or connecting a curb on one street to another curb on the intersection street.
15. **Design Standards.** The official City of Ozark's design standards used for public improvements within the City of Ozark, Missouri and such other areas outside the corporate boundaries which may contract with the City for the provision of services. This document contains minimum design data for public improvements to be complied with in the design of public improvements.
16. **Driveway.** An area intended for the operation of automobiles and other vehicles from the street right-of-way line to a garage, parking area, building entrance, structure, or approved use located on the property. Unless otherwise indicated, any dimensions relating to the width of a driveway or driveway surface shall be measured at the right-of-way line.
17. **Driveway Approach.** An area intended for the operation of automobiles and other vehicles giving access between a roadway and abutting property. The driveway approach includes the sum of the curb returns on each side of the driving surface, plus the driving surface.

- 18. Easement.** A grant by the property owner to the public, a corporation, or persons of the use of land for specific purposes.
- 19. FEMA.** Federal Emergency Management Agency.
- 20. Final Plat.** The final map, drawing, or chart indicating the final approved layout of the subdivision. Approval shall be obtained from the City's Planning and Zoning Commission and Board of Aldermen.
- 21. Gutter.** That portion of the driving surface of a street, driveway, approach, or other public way, which abuts the curb and provides for the runoff of surface drainage.
- 22. Intersection.** The general area where two or more roadways meet, join, or cross at a common point establishing an area within which vehicles traveling different roadways may come in conflict.
- 23. Lot.** An undivided tract or parcel of land under one ownership, whether occupied or to be occupied by a building or building group together with accessory buildings, which parcel of land is designated as a separate and distinct tract, and is identified by a tract or lot number or symbol in a duly approved subdivision plat filed of record.
- 24. MoDNR.** Missouri Department of Natural Resources.
- 25. MoDOT.** Missouri Department of Transportation.
- 26. NPDES.** National Pollutant Discharge Elimination System.
- 27. Ordinance.** A regulation, order or rule passed by the City's Board of Aldermen.
- 28. P.C.,** Point of Curve. The point at which a straight line begins to curve.
- 29. P.C.C.,** Point of Compound Curve. The point where curves of different radii meet.
- 30. P.I.,** Point of Intersection.
- 31. P.T.,** Point of Tangency. The point at which a curve ends and a straight survey line begins.
- 32. PVC.** Point of Vertical Curve.
- 33. PVI.** Point of Vertical Intersection.
- 34. PVT.** Point of Vertical Tangency.
- 35. Planning and Development Department.** The City Department that administers the subdivision regulations, zoning regulations, growth management plan, and directs the development and plan review process. In addition, the department oversees code compliance and building inspections.
- 36. Planning and Development Director.** The Director of the City's Planning and Development Department.
- 37. Planning and Zoning Commission.** The City board that makes recommendations to the Board of Aldermen for a variety of development applications such as; rezoning, plats, permits and etc.

- 38. Preliminary Plat.** The preliminary map, drawing, or chart indicating the proposed layout of the subdivision initially required in the subdivision process.
- 39. Public Improvements.** Those infrastructures that are constructed, installed, or performed on public land, or on land that is to become public in the subdivision process, including but not limited to pavement, curbs, sidewalks, etc., including the grading of such land.
- 40. Public Works Department.** The City department that is responsible for maintaining and improving the city's infrastructure such as stormwater, streets, sanitary sewer, and water systems.
- 41. Public Works Director.** The Director of the City's Public Works Department.
- 42. PVC.** Polyvinyl Chloride.
- 43. Record Drawings.** Revised set of drawings submitted by the design engineer upon completion of a project. They shall reflect all changes made in the specifications and working drawings during the construction process. They shall show the exact dimensions, geometry, and locations of all elements of the work completed during the project. They are also known as as-built drawings.
- 44. Right-of-Way.** A general term denoting public ownership or interest in land, usually in a strip, which has been acquired for or devoted to the use of a street.
- 45. Right-of-Way Line or Street Right-of-Way Line.** The boundary between any street and one or more parcels of private property.
- 46. Shall, May.** The word "Shall" shall be deemed as mandatory. The word "May" shall be deemed as permissive.
- 47. Sight Distance.** The near worst-case distance a vehicle driver needs to be able to see in order to have room to stop before colliding with something in the roadway.
- 48. Storm Water Detention Facility.** A drainage facility designed and constructed for the purpose of detaining storm water runoff to reduce downstream flows and/or reduce storm water pollutant levels.
- 49. Standard Drawing Details.** The official City of Ozark's standard drawing details used on public improvements within the City of Ozark, Missouri and such other areas outside the corporate boundaries which may contract with the City for the provision of services. This document contains drawing details for public improvements to be followed and included in design drawings.
- 50. Subgrade.** The surface of a street on which a base course or riding surface is to be placed.
- 51. Subdivision.** The division of land into two (2) or more lots, tracts, or parcels for the purpose of transfer of ownership or building development, or, if a new street or easement of access is involved, any division of a parcel of land.
- 52. Tan.** Tangent distance between PC and PI, PI to PT.
- 53. USGS.** United States Geological Survey.

ARTICLE I

GENERAL REQUIREMENTS

Section 1.1 Short Title

1.1.1. This Ordinance shall be known and may be cited as the City of Ozark Design Standards for Public Improvements.

Section 1.2 Purposes

1.2.1. The regulations and provisions contained in the Design Standards are adopted for the following purposes:

- A. To protect and provide for the public health, safety and general welfare of the City.
- B. To provide for adequate transportation and circulation throughout the City and to ensure the adequate provision of water, sewer and other public utilities and services.
- C. To prevent the pollution of water resources, to protect from flooding and other dangers and to ensure the adequacy of drainage facilities.
- D. To preserve and protect the value of land and buildings through minimizing land development conflicts and encouraging reasonable standards of subdivision design and the provision of public improvements.

Section 1.3 Jurisdiction

1.3.1. This Ordinance shall apply to all land and infrastructure improvements within the corporate boundaries of the City of Ozark, Missouri and such other areas outside the corporate boundaries, which may contract with the City for the provision of services.

Section 1.4 Effective Date

1.4.1. This Ordinance shall be in full force and effect from and after passage.

Section 1.5 Interpretations, Conflict and Separability

1.5.1. The provisions of this Ordinance shall be considered to be the minimum requirements for the protection of the public health, safety, and general welfare. Where conditions imposed by any provision of this Ordinance are either more restrictive or less restrictive than conditions imposed by any other provision of this Ordinance or other applicable law, ordinance, rule or regulation, the regulations which are more restrictive and which impose a higher standard shall govern.

1.5.2. The provisions of this Ordinance are separable. If any section, sentence, clause or phrase of this Ordinance is for any reason held to be invalid by a court of competent jurisdiction, the decision shall not affect the remaining portions of this Ordinance. If any court of competent jurisdiction shall adjudge invalid the application of any provision of this Ordinance to a particular property, such judgment shall not affect the application of said provision to any other property.

1.5.3. Where any of the provisions contained herein may be unclear or ambiguous as they pertain to a particular site or situation, interpretations of the policies, criteria, and standards set forth herein shall be made in writing by the Public Works Director. Such written interpretations shall be kept on file for future reference for use in similar situations, and shall be incorporated in subsequent revisions of this Ordinance, if deemed necessary.

1.5.4. In the event it is determined by the City that the policies, criteria and standards set forth in this Ordinance for the design and installation of required infrastructure improvements would result in practical difficulties or undue hardship for the developer on account of the particular facts and circumstances of the property, and that alternative measures cannot be proposed or effected, then the most stringent requirements of any other applicable City ordinance or State of Missouri Department or Agency in effect at the time shall take precedence and shall be applicable as if set forth herein.

1.5.5. The developer/owner/engineer has full responsibility for ensuring that all requirements of these Regulations are met.

Section 1.6 Appeals

1.6.1. Where disagreements may arise over the interpretation of the requirements set forth herein by the applicant for subdivision plat approval, (or other improvement projects that includes public infrastructure), appeals may be made to the Board of Aldermen with a written request.

Section 1.7 Variances

1.7.1. In the event that compliance with the standards and criteria set forth herein is not practical or feasible, and that reasonable alternative measures can be proposed, application for a variance can be made. Requests for variances shall be made in writing to the Public Works Director.

Section 1.8 Required Engineering Reports

1.8.1. When required, two (2) paper copies and one Adobe pdf digital file of a report signed and sealed by an engineer registered in the state of Missouri shall be submitted with the preliminary plat, (or any other improvement projects that includes public infrastructure), that shall provide a study of the following items as pertaining to the proposed subdivision or improvement:

A. Storm Water Drainage

1. Drainage area map showing flow lines for onsite and offsite water.
2. Location of detention basins with estimated volumes required.
3. A field study of the downstream capacity of all drainage facilities and the effect of additional flow from the area to be improved shall be submitted. If the effect is to endanger property or life, the problem must be solved prior to plan approval.

1.8.2. Sanitary Sewer and Water; A report on water and sewer capacity and needs to include all applicable information as specified in the Design Standards, Article III and Article IV.

1.8.3. Ground Stability; If the proposed subdivision is in a mined area or other suspect area, a ground stability report shall be provided.

1.8.4. Traffic Analysis and Street Capacity; The Public Works Director **shall** require a Traffic Impact Analysis at the time of a site plan request **and** preliminary plat, **and may also require a Traffic Impact Analysis for** rezoning request, construction plan submittals or etc. In certain cases, the traffic analysis may also require evaluation of requirements for pedestrian ways through the development. See the latest addition of the **OTO's Technical Memorandum on Traffic Impact Study Guidelines** for detailed requirements for a traffic analysis. **The City of Ozark will review each Traffic Impact Study with its third party engineers and make a determination if transportation improvements are warranted due to the proposed development. If improvements are warranted, the City shall coordinate with the developer on the scope of work for said transportation improvements.**

Section 1.9 General Plan Requirements for Public Improvement Projects

1.9.1. The following criterion is established to provide a uniform system of plan preparation for submittal to the City. Applications and material submitted for processing under the provisions of this ordinance shall conform to the specifications prescribed in this Section. The Planning and Development Department and/or the Public Works Department shall make determinations regarding the completeness of applications. All documentation associated with plats, subdivision and building projects shall be submitted to the Planning and Development Department. Other documentation associated only with public infrastructure improvement projects, (water, sewer, streets and storm), shall be submitted to the Public Works Department.

1.9.2. All plans and reports submitted shall be prepared by, or under the direction of, a Professional Engineer, licensed in the State of Missouri, and shall be reviewed by the City for compliance with the minimum design requirements as established in the Design Standards and with all other applicable City's codes and standards.

1.9.3. Assumed elevations are not permitted. All benchmark references shall be noted on drawings. All surveys shall be accomplished in accordance with Missouri Minimum Standards for property boundary surveys. All survey data shall be vertically and horizontally tied to a minimum of two City's Geographic Reference System (GRS) Geodetic Control Points established by the MoDNR Land Survey Program and shall be shown on submitted digital and paper copies. Coordinates shall be provided for all exterior property corners on surveys and plats. Legal descriptions shall be written by a Registered Land Surveyor or an attorney, licensed to practice in the State of Missouri, and shall comply with the minimum standards as provided for in the Missouri State Statutes for such descriptions.

1.9.4. Attention is directed to the design engineer that whenever extraordinary or unusual problems are encountered in conjunction with a proposed project, additional information and analysis beyond the minimum requirements of these standards and criteria may be required.

1.9.5. The City is not responsible for the accuracy and the adequacy of the design or dimensions and elevations as depicted on the plans (which shall be confirmed and correlated at the site of the work).

1.9.6. Review and approval of drawings and calculations by City is conceptual in nature only and does not imply detailed approval to any particular design item or data shown on the drawings, nor does it give implied approval for any variance from any City regulations or design standards. The design professional whose seal appears on the plans is responsible for all lines and grades, field data, and constructability of the design in compliance with the City's standards and regulations.

1.9.7. Prior to approval of a Preliminary Plat, it will be the individual developer's/owner's/engineer's responsibility to acquire all required off-site water, sewer, drainage, access and other utility easements required to serve the proposed development. All required off-site easements shall be recorded with copies provided to the Planning and Development Department prior to approval of the preliminary plat. Easements dedicated to the City shall be provided to the City as an original copy.

1.10 Construction Drawings:

1.10.1 The owner of the tract proposed for subdivision or public infrastructure improvements shall have an engineer licensed in the State of Missouri, prepare and submit construction drawings to the City.

1.10.2. All plans and specifications for public improvement construction within the city limits of the City and such other areas outside the corporate boundaries which may contract with the City for the provision of services shall be prepared by a professional engineer licensed in the State of Missouri. The registration seal of the responsible engineer shall be placed in a convenient place on each sheet of the plans.

1.10.3. Construction drawings shall clearly show the location and extent of proposed construction in relation to existing and proposed property lines, physical features, and utilities. They shall include all details necessary to properly construct the proposed improvements. Line-work and lettering shall be neat and clear. Copies shall be free from smudges, tears, folds, and other imperfections which affect the legibility of the drawings.

1.10.4. When necessary, the construction drawings may be on several sheets accompanied by an index sheet showing the entire subdivision or project. For large subdivisions, the construction drawings may be submitted for approval progressively in phases satisfactory to the Planning and Development Department and Public Works Department.

A. Submittal of construction drawings shall comply with the following;

1. Two (2) paper copies and one (1) Adobe pdf digital copy and one AutoCAD dwg. file shall be submitted to the City for review and approval. Additional paper copies may be required if traffic and stormwater reviews by 3rd party consultants are necessary. Incomplete submittals will be returned without review.
2. All design changes that occur during the review process shall be incorporated into the bound construction drawing set as revised redrafted full size sheets. Addendums and loose unbound sheets are not acceptable. Addendums will only be acceptable for field changes after final approval of the construction drawings. A response letter shall be provided by the design professional indicating the response to each review comment. If the response letter is not included in the resubmittal, no action will be taken until the response letter is received by the City.
3. After approval and required revision, three (3) paper copies and one (1) Adobe pdf digital copy and one AutoCAD dwg. file shall be submitted to the City. One signed approved paper copy will be returned to the Engineer, which shall be utilized in bid documents distributed for proposals. In addition, one set of approved plans shall be provided by the owner/design professional to each utility company providing service in the proposed construction area.
4. The digital copies may be submitted on a CD or e-mailed to engtech@ozarkmissouri.org. The digital copies and the paper copies shall be to standards acceptable to the Directors of Planning and Development and Public Works.
5. The digital copy provided as an AutoCAD dwg. file shall comply with the following; Missouri Coordinate System of 1983, Central Zone, (in U.S. feet). The AutoCAD dwg. file shall include all external referenced files and appropriate layers and shall be on state plane. The Adobe pdf digital copy shall include a copy of each individual drawing sheet.

B. Drafting of construction drawings shall comply with the following;

1. General.

a. The construction drawings shall be drawn upon 24" x 36" sheets with a one-half inch ($\frac{1}{2}$ ") clear border on the top, bottom, and right sides of the drawing, and a one and one-half inch ($1\frac{1}{2}$ ") clear border on the left side of the drawing. When feasible, each section shall have the related infrastructure and notes darkened with all other unrelated information and background shaded to provide clarity. The background and other unrelated information shall not interfere with the legibility of the pertinent data. The lot dimensions/bearings and other unnecessary information shall be turned off on the water and sewer sheets for clarity. Lettering shall be in a size large enough to allow reproduction of legible half-size drawings for use in the field. Appropriate lot numbers shall be shown on all plan views. Plan and profile views shall be drawn on double or single plan and profile sheets to minimum scales of one (1) inch equals fifty (50) feet horizontal by one (1) inch equals ten (10) feet vertical, unless otherwise approved by the City for special cases.

b. When more than one drawing sheet is involved in a plan view or profile, an overlap of not less than one hundred (100) feet should be provided. Each project shall show at least fifty (50) feet of topography on each side. All existing topography and any proposed changes, including all utilities, and so forth shall be shown on the plans and profile.

c. Revisions to drawings shall be indicated above the title block and shall show the nature of the revision and the date made.

d. Plans shall make consistent use of standard symbols throughout the plan set. The cover sheet shall include a legend of all symbols used. Symbols shall not be duplicated and shall be clear on their indication. Topography for which symbols are not standardized shall be indicated and named on plans and profiles. In utilizing symbols for engineering design plans, all existing utilities, telephone installations, storm sewers, pavements, curbs, inlets and culverts and so forth shall be shown with a broken line; proposed facilities with a solid line; land, lot, and property lines to be shown with a slightly lighter solid line. For improvement projects without final plats, all required easements shall be recorded with copies provided to the City prior to approval of construction drawings. Easements dedicated to the City shall be provided to the City as an original copy. These easements shall be indicated on the construction drawings by property ownership name plus book and page for each property.

e. The plans shall consist of:

- (1). Title Sheet, (Cover Sheet)
- (2). General Layout Sheet, (Overall main plan, for street, storm, water and sewer)
- (3). Sediment & Erosion Control Plan (SECP)
- (4). Drainage Area Maps
- (5). Grading Plan (Street and/or storm drainage improvement plans only unless otherwise required by the City)
- (6). Plan and Profile Sheets
- (7). Cross-Section Sheets, when required by the City
- (8). Standard and Special Detail Sheets
- (9). Other sheets as required

f. Each sheet should contain a sheet number, including the individual sheet number and total number of sheets, the engineer's seal, name, phone number and fax number, revision block, proper project identification and date. The Missouri One-Call utility locate symbol shall be shown on all drawings involving earthwork. The top of each plan shall be either north or east and a north arrow shall be provided. The stationing on street plans and profiles may be from either direction. On drainage plans stationing shall always begin from the low point.

g. Each respective type of development/improvement project (i.e. sanitary sewer, streets, water mains, etc.) shall be submitted and bound as a separate set of plans unless otherwise allowed by the City. Each set shall contain consecutively numbered sheets.

h. Where feasible, sediment and erosion control plan and storm sewer construction details may be incorporated into grading plans or street construction drawings, if the combined total does not exceed 20 drawing sheets.

i. Additional information beyond what is indicated in the following paragraphs may be required on some projects.

2. Title Sheet.

a. The following items shall be included on the title sheet.

- (1). Name of project
- (2). Index of sheets included in plans
- (3). A location map adequately showing project location in relation to primary streets (minimum scale of 1" = 2000')
- (4). General description of project area (by Township, Range, and Section)
- (5). A summary of plan quantities of principal items, such as:
 - (a). Pipe size and material, lengths, number of manholes, etc... (sanitary sewers)
 - (b). Length of street center-line, square yardage of asphaltic concrete pavement, etc... (streets)
 - (c). Pipe sizes and material, lengths, number of inlets by size and type, flared end sections, etc... (storm sewers)
 - (d). Pipe sizes and material, lengths, number of valves, (by size), hydrants, etc... (water lines)
- (6). Additionally, a separate column shall be provided for listing of "as-built" quantities once the project has been completed and accepted by the City.
- (7). The project control bench mark shall be identified as to location and elevation; USGS datum.
- (8). Name, address, telephone number and fax number of consulting engineer and owner/developer.

(9). List containing name and telephone number of each utility company and public agency listed below;

- Electric Power
- Telephone
- Cable Television
- Gas
- Highway Department (Local Office)
- City of Ozark for Water & Sewer

(10). Project engineer's name and seal.

(11). Revision schedule.

(12). legend for all symbols.

3. General Layout Sheet.

a. The following items shall be included on the general layout sheet for all improvement projects.

(1). A legend of applicable symbols and abbreviations shall be shown.

(2). North arrow and graphic scale. Scale of the general layout map shall be one inch equals one hundred (100) feet, unless otherwise approved.

(3). Layout shall include names of subdivision, block designation, if any; lot designation, or proposed block and lots, all street names, and an accurate tie to at least one quarter section corner.

(4). Boundary line of project area.

(5). In addition, the following items shall be included on the general layout sheet for the particular type of improvement stated below.

(a). Streets

- Location of all existing and proposed streets and roadways within and adjacent to the project area.
- Location of all existing and proposed drainage system improvements.

(b). Storm Drainage

- Drainage calculation summary table containing the following information.
 - Pipe size and slope
 - Pipe capacity
 - Velocity (design and at capacity)
 - Time of concentration
 - Runoff coefficient
 - "K" factor (antecedent precipitation)
 - Design storm (return frequency)
 - Incremental tributary acreage
 - Accumulative acreage
 - Rainfall intensity
 - Rainfall runoff

4. Sediment & Erosion Control Plan, (SECP)

- a. An overall plan of the site showing proposed sediment and erosion control measures shall be included in the construction drawings. The sediment and erosion control plan may be superimposed upon the site dimension plan, grading plan or storm drainage facilities plan if legible. The sediment and erosion control plan shall also show the following:
- b. General limits of the area to be stripped of vegetation or disturbed by construction activities shall be shaded or otherwise clearly delineated.
- c. A summary table showing the total site area and the total area estimated to be disturbed.
- d. Proposed location(s) of temporary construction entrance(s) and concrete washout area.
- e. Proposed sediment containment measures: vegetative filter areas, straw bale dikes, silt fences, temporary containment berms, diversion berms, inlet protection, etc. Adequate details and notes for each containment measure shall be included.
- f. Site stabilization measures, showing the type of surface stabilization to be provided in various areas of the site, whether sod, erosion control blanket, mulch, concrete, etc. If more than one (1) type of erosion control blanket or mulch is specified, the different areas should be distinguished by use of varying shading or symbols.
- g. Seeding and mulching specifications, and allowable seasons for temporary and permanent seeding.
- h. Temporary and permanent erosion control measures, such as outlet protection, channel linings, or paved chutes, etc.

5. Drainage Area Maps

- a. Drainage area maps shall be provided for both on-site areas and off-site areas. Due to the difference in area, it will typically be necessary to provide a larger scale map for on-site drainage areas, and a smaller scale map for off-site drainage areas.
- b. Off-site drainage areas shall be shown as a minimum scale of 1"= 2000' (one inch equals two thousand feet).
- c. On-site drainage area maps shall be shown superimposed upon the site plan, with existing and proposed topographic contours shown.
- d. Drainage areas shall be clearly outlined on the map, and the identifying designation clearly shown.
- e. Drainage areas shall be given the same designation as the inlet or reference point to which they are tributary (i.e., drainage area 1-A is tributary to inlet 1-A, and etc.).

- f. The schematic plan of the proposed storm drainage improvements shall be shown on the drainage area map.
- g. Both pre- and post-development drainage areas must be shown for each primary outfall from the site.
- h. Include the flow path used for the development of the time of concentration used in detention basin calculations.

6. Site Grading Plans

- a. The following items shall be included on the general layout sheet for all streets and/or drainage improvement projects.
 - (1). Property lines identified as to existing or proposed lot and block number.
 - (2). Elevation and location of nearest bench mark (U.S.G.S. datum).
 - (3). One-hundred year flood plain line.
 - (4). Existing streets, transportation facilities, utilities, and storm drainage facilities.
 - (5). Existing physical features including waterbodies and watercourses, sinkholes, springs, caves, faults, fracture trends, and photolineaments.
 - (6). Existing structures, pavements, sidewalks, tree masses, pavements, and fences.
 - (7). Proposed streets, transportation facilities, utilities, and storm drainage facilities.
 - (8). Proposed structures, sidewalks, and pavements.
 - (9). Proposed topographic contours.
 - (10). Existing and final grading contours drawn at intervals not to exceed five feet. Each fifth contour shall be drawn as an index contour by using a heavier line weight. Index contours must be labeled. Intervals of less than five (5) feet may be required by the City dependent on the character of the topography

7. Storm Drainage

- a. Detailed alignment of the storm sewer along with all appurtenances, sizes of lines, conduit material and wall thickness, and other details relating to the storm drainage system including inlet and junction box (manhole) stations and top and invert elevations.
- b. All existing drainage facilities and structures such as, but not limited to, irrigation ditches, roadside ditches, improved or unimproved drainage channels, gutter flow directions, culverts, etc. All pertinent information such as size, shape, slope, location, etc. of such facilities shall be included to facilitate review and approval of the plans.
- c. Roadway section and grade including type of curb and gutter and gutter flow directions.
- d. Erosion control and energy dissipation devices.
- e. Proposed outfall point for runoff from the project area along with required easement information.

- f. Routing and cumulative flows at various critical points along storm runoff.
- g. Critical minimum finished floor elevations of all buildings adjacent to the project for protection from major storm runoff.
- h. Distances between storm sewer system components and other existing or proposed utilities within the right-of-way or drainage easement.
- i. Supporting calculations for storm drainage facilities must be included within the plan submittal. Supporting calculations shall include the following:
 - Drainage area map.
 - Summary table for inlet calculations.
 - Summary table for storm sewer and channel design.
 - Backwater computations for culverts and bridges.
 - Hydraulic data for drainage channels with uniform flow.
 - Water surface profile computations for drainage channels with gradually or rapidly varied flow.
 - Calculations for detention facilities.
 - Calculations for sediment basins and other sediment and erosion control facilities specified on the Sediment & Erosion Control Plan.
 - Where required, calculations for directly connected impervious area, water quality capture volume, and stormwater quality BMPs.
 - Flow path for time of concentration calculations.
 - Detailed time of concentration calculations.
 - USGS soil map showing breakdown of soil types.
 - Curve number calculations.
 - Rational method runoff coefficient calculations.

8. Sanitary Sewers/Water Lines

- a. Existing water distribution facilities including, but not limited to, pipe size and location, valves, fire hydrants, blow-offs, etc.
- b. Existing sanitary sewer facilities including, but not limited to size, slope, location, hydraulic capacity, and all pertinent information regarding which trunk line will ultimately receive the wastewater collected by the proposed system.
- c. Proposed piping with all appurtenances plainly labeled. Proposed piping shall be a heavier line-work.
- d. Existing or proposed easements and/or tracts through offsite areas.
- e. Estimated average quantity of wastewater generated offsite that would be tributary to the proposed development/improvement project, naturally as developed. The "Land Use Plan", which is a part of the City's Comprehensive Plan shall be the basis for determining the future use of offsite undeveloped land.
- f. All design elevations shall be invert of pipe. Top of pipe is acceptable for existing utilities.

- g. Existing utilities, particularly where crossed, with "as-built" elevations and stations.
- h. Stationing for the entire length of the utility beginning at the downstream end of the project. Stationing shall be provided for all manholes, fire hydrants, valves, **water service meters**, elbows, tees, service laterals, dead-end assemblies and all other related items.
- i. A uniform system of line and manhole designation shall be used subject to the approval of the Public Work Director.
- j. Detailed alignment of the proposed sewer with the manhole designation, station and angle shown at each manhole to provide unquestionable locations of the sewer within street right-of-way or on private property.
- k. All manholes shall be shown with manhole designation station, deflections, rim elevations and invert elevations. Drop manholes shall be designated as such. Bolt-down covers shall be designated as such. Invert elevations shown shall be the invert of the pipe in and out of the manhole. Proposed finish grade elevation of top of manhole shall be shown. Distance between manholes shall be shown as well as the gradient, pipe size, and type of material.
- l. The channel center line of waterways within fifty (50) feet either side of center line of sewer shall be shown.
- m. Results of all rock borings shall be shown at the proper locations.
- n. Accurate elevations of either the first-floor surface or the basement floor surface shall be shown, and identified, for all existing and/or proposed structures for all building sites to be served by the proposed sewer system.
- o. Station, length, and size of each service lateral.
- p. Profile view shall show existing grade at the center line as a dashed line, proposed finish grades or established street grades by solid lines. Each line shall be properly identified. The proposed sewer shall be shown as double solid lines properly showing the height of the pipe.
- q. Alignment of the proposed water line dimensioned from curb lines or right-of-way lines.

9. Plan and Profile Sheets

- a. The following items shall be included on the plan and profile sheets for all improvement projects.
 - (1). North arrows and graphic scale.
 - (2). Elevation and location of all applicable bench marks (USGS datum).
 - (3). Existing and proposed streets with names and widths.
 - (4). Property lines properly identified as to existing or proposed lot, block and subdivision.

- (5). All existing and proposed utilities such as power, gas, oil, water, telephone, sewer, cable television, and other items shall be properly located in conformance with the best information available (from the records of the owner of such facilities or field location) and identified as to size, material, and type of construction.
- (6). All existing and known proposed improvements within fifty feet each side of center line shall be shown at their proper locations. This shall include such existing items as paved streets, curbs and gutters, driveways, culverts, fire hydrants, utility poles, trees, shrubs, fences, walls, houses, and other such items, and shall be identified as to type, size, material, etc., as may be applicable. In case of new developments, some irrelevant items may be omitted.
- (7). All existing easements and right-of-way information recorded with the county.
- (8). All proposed easements and right-of-way information.
- (9). Minor construction notes shall appear on the proper plan and profile sheets.
- (10). Locations and widths of existing and proposed sidewalks.
- (11). In addition, the following items shall be included on the plan and profile sheets for the particular type of improvement stated below.

(a). Streets

- Width of right-of-way and width of pavement, (BOC to BOC), on all plan sheets.
- Typical cross-section for roadway(s).
- Station and critical elevation (flowline, invert of pipe, etc.) of all utility or drainage appurtenances, both existing and proposed.
- Indicate vertical and horizontal locations of all existing and proposed utility crossings on street profiles, including curb inlets.
- Flow direction arrows, particularly at intersections.
- Match lines and consecutive sheet number, beginning with cover sheet.
- Station and elevation of all curb returns (at 1/5 points); horizontal P.C.'s, P.T.'s, etc.; high or low point of all vertical curves; existing and proposed.
- Curb return radii, existing and proposed.
- Complete horizontal curve data for curbs and right-of-way, (R, L, Tan)
- Centerline stations and widths of all non-single family residential driveways and all intersecting roadways.
- Basis of plan view and profile elevations shall be the same, i.e., flowline and flowline, top of curb and top of curb, etc.
- Existing grades or established street grades shown as a solid line.
- All design elevations shall be centerline, top of curb, lip of gutter, or flowline (preferred) for 6" vertical curb and gutter; or lip of gutter, or flowline (preferred) for combination curb and gutter. The basis for as-built information shall be the same as the design (both flowline or both top of curb, etc.).

- Stationing continuous for the entire portion of the roadway shown in the plan view (100 feet minimum stationing), with the centerline station of all non-single family residential driveways and all intersecting roadways clearly labeled.
- Location of any pavement expansion joints in the plan view.
- All existing curbs, gutters, sidewalks, and pavement adjacent to the proposed design (minimum distance of 100 feet). Basis for existing grades shall be "as-built" or field verified elevations at intervals not to exceed fifty (50) feet. Previously approved designs are not an acceptable means of establishing existing grades.
- Station and elevation of all horizontal P.C.'s, P.C.C.'s and etc.; existing and proposed.
- Station and elevation of all vertical grade breaks, existing (as-built) and proposed.
- Distance and grade or slope between grade breaks.
- Vertical curves, where necessary, with PVI, PVC, and PVT, high or low point (if applicable) stations and elevations. All vertical curves shall be labeled with length of curve (L) and K ($=L/A$). All vertical curves shall be symmetrical.
- Design speeds and stopping sight distances for all vertical and horizontal curves.
- Existing and proposed utilities, (location, type and size). Field verified elevations and locations are required to be indicated on the plans for all utilities (existing or proposed) which will potentially affect the design and construction of the improvement.

10. Cross Section Sheets

a. The following items shall be included on the cross-section sheets.

- (1). Typical roadway cross-section for all roadways, existing or proposed, within and adjacent to the proposed development. These cross sections shall appear on the detail sheet. They shall indicate type of roadway(s), profile grade design point (centerline, flowline, top curb, lip of gutter, etc.), roadway width, right-of-way, type of curb, gutter, and walk, pavement cross slope, etc... Cross-sections shall show existing grade lines a minimum of ten (10) feet beyond right-of-way lines.
- (2). Cross-sections shall be shown at all intersecting streets and driveways.
- (3). Channel cross-sections shall be shown for all drainage channel improvements.
- (4). Additional cross-sections shall be shown as required by the City to clearly describe the extent of the grading operations.

11. Standard and Special Detail Sheets

a. Detail sheets shall be included to show all details of appurtenances, material, and construction whether or not covered by the Standards Drawing Details. When available, details shall conform to the Standard Drawing Details, labeled with the City's detail identification and are to be drawn clearly and neatly with proper identifications, dimensions, materials, and other information necessary to insure the desired construction.

12. Private Improvements.

- a. Private improvements, if any, shown on public improvement plans, shall be clearly defined and marked as such. These improvements will not be maintained by the City and, as such, an appropriate note shall be included on the drawings.

13. Required Notes

- a. The following general notes will be required as a minimum on all plan submittals for public improvement projects. These notes are not meant to be all-inclusive, and in certain situations the City may require the use of additional notes.

(1). Water

- Development plans are approved initially for one (1) year after which they automatically become void and must be updated and re-approved by the City before any construction will be permitted.
- The City's plan review is only for general conformance with City Design Criteria and the City Code. The City is not responsible for the accuracy and adequacy of the design, or dimensions and elevations that shall be confirmed and correlated at the job site. The City through approval of this document assumes no responsibility other than that as stated above for the completeness and/or accuracy of this document.
- The contractor shall have one (1) signed copy of the plans (approved by the City) and one (1) copy of the Construction Specifications at the job site at all times.
- Construction of the improvements shown or implied by this set of drawings shall not be initiated or any part thereof undertaken until the City is notified of such intent, and all required and properly executed bonds and permit fees are received and approved by the City.
- The Construction Specifications, latest edition, shall govern construction of this project.
- All existing utilities indicated on the drawings are according to the best information available to the Engineer; however, all utilities actually existing may not be shown. Utilities damaged through the negligence of the contractor to obtain the location of same shall be repaired or replaced by the contractor at his expense.
- All backfill shall be compacted.
- Contractor shall not be allowed to work on Sundays. Holiday or Saturday work shall be as approved in advance by the City.
- All materials and workmanship associated with this project shall be subject to inspection by the City. The City reserves the right to accept or reject any such materials and workmanship that does not conform to the Construction Specifications.
- The contractor shall notify the Public Work's Department twenty-four (24) hours prior to the beginning of construction. In addition, a minimum of twenty-four (24) hours notice shall be provided for any required inspections.

- City required inspections shall include but not be limited to; all water and sewer crossings, all encasements, all water lines, all service lines and all thrust blocks prior to backfilling. All water lines will be pressured tested and bacteria tested after backfilling. All testing after backfilling except bacteria testing, will be conducted by the contractor under the observation of the City's representative. After final grading is complete, the City's representative will verify proper final grade at all meter lids, valve boxes and fire hydrant. In addition, all tracer wire installation shall be located using typical low frequency (512Hz) line tracing equipment, and witnessed by the City's representative prior to acceptance.
- Relocation of any water line, sewer line, service line or any other utility thereof required for the construction of this project shall be the responsibility of the contractor at his expense.
- The proposed water line improvements shown by this set of drawings have been designed to provide the following fire flow requirements as determined by the City: _____ GPM (Note to be placed on development drawings that contain areas zoned for higher densities than R-2).
- Contractor shall provide two operating keys (T-bars) for operation of the wrench nuts for the water valves.

(2). Sanitary Sewer

- Development plans are approved initially for one (1) year, after which they automatically become void and must be updated and re-approved by the City before any construction will be permitted.
- The City's plan review is only for general conformance with City Design Criteria and the City Code. The City is not responsible for the accuracy and adequacy of the design, or dimensions and elevations that shall be confirmed and correlated at the job site. The City through approval of this document assumes no responsibility other than as stated above for the completeness and/or accuracy of this document.
- The contractor shall have one (1) signed copy of the plans (approved by the City) and one (1) copy of the Construction Specifications at the job site at all times.
- Construction of the improvements shown or implied by this set of drawings shall not be initiated or any part thereof undertaken until the City is notified of such intent and all required and properly executed bonds and permit fees are received and approved by the City.
- The Construction Specifications, latest edition, shall govern construction of this project.
- All existing utilities indicated on the drawings are according to the best information available to the Engineer; however, all utilities actually existing may not be shown. Utilities damaged through the negligence of the contractor to obtain the location of same shall be repaired or replaced by the contractor at his expense.
- All backfill shall be compacted.
- All stublines shall be laid on 1.00% minimum grade unless approved otherwise.
- _____ denotes Minimum Basement Floor Elevation.

- All materials and workmanship associated with this project shall be subject to inspection by the City. The City reserves the right to accept or reject any such materials and workmanship that does not conform to the Construction Specifications.
- The contractor shall notify the Public Work's Department a minimum of twenty-four (24) hours prior to the beginning of construction. In addition, a minimum of twenty-four (24) hours notice shall be provided for any required inspections.
- City required inspections shall include but not be limited to; all water and sewer crossings, all encasements, sewer lines, all service lines and all manholes prior to backfilling. All sewer lines will be air tested and also pulled with a mandrel after backfilling. All manholes will be vacuum tested after backfilling. All testing after backfilling will be conducted by the contractor under the observation of the City's representative. In addition, all tracer wire installation shall be located using typical low frequency (512Hz) line tracing equipment, and witnessed by the City's representative prior to acceptance. After final grading is completed, the City's representative will verify proper final grade at all manhole rims. In addition, the City may elect to camera test all sewer mains for defects, irregularities and compliance with design profile and specifications. The City may also elect to smoke test the entire sewer system.
- Contractor shall not be allowed to work Sunday. Holiday or Saturday work shall be as approved in advance by the City.
- Relocation of any water line, sewer line, service line or other utility thereof required for the construction of this project shall be the responsibility of the contractor and shall be at his expense.
- The Contractor shall install and properly maintain a mechanical plug at all connection points with existing lines until such time that the new line is tested and approved.

(3). Streets and Storm Drainage

- Development plans and drainage reports are approved initially for one (1) year, after which they automatically become void and must be updated and re-approved by the City before any construction will be permitted.
- The City's plan review is only for general conformance with City Design Criteria and the City Code. The City is not responsible for the accuracy and adequacy of the design, or dimensions and elevations that shall be confirmed and correlated at the job site. The City through approval of this document assumes no responsibility other than as stated above for the completeness and/or accuracy of this document.
- The contractor shall have one (1) signed copy of the plans (approved by the City) and one (1) copy of the Construction Specifications at the job site at all times.
- Construction of the improvements shown or implied by this set of drawings shall not be initiated or any part thereof undertaken until the City is notified of such intent, and all required and properly executed bonds and permit fees are received and approved by the City.
- The Construction Specifications, latest edition, shall govern construction of this project.

- All existing utilities indicated on the drawings are according to the best information available to the Engineer; however, all utilities actually existing may not be shown. Utilities damaged through negligence of the contractor to obtain the location of same shall be repaired or replaced by the contractor at his expense.
- All backfill shall be compacted.
- A minimum of one (1) compaction test and a maximum of two (2) compaction tests shall be performed by a qualified testing laboratory for every 1,000 feet of street construction. Soil samples for such tests shall be collected by laboratory technicians. All testing laboratory expenses shall be paid for by the contractor.
- All materials and workmanship associated with this project shall be subject to inspection by the City. The City reserves the right to accept or reject any such materials and workmanship that does not conform to the Construction Specifications.
- The Contractor shall notify the Public Work's Department a minimum of twenty-four (24) hours prior to the beginning of construction. In addition, a minimum of twenty-four (24) hours notice shall be provided for any required inspections.
- City required inspections shall include but not be limited to; subgrade prior to base course application, base course prior to sidewalk, curb or asphalt/concrete application and the final sidewalk, curb and asphalt/concrete application. Black base shall be inspected prior to application of asphalt surface course. All storm pipes and boxes shall be inspected by the City's representative prior to any backfilling. Nuclear density tests or proof rolling shall be provided by the contractor upon demand by the City. In addition, the City may elect to camera test all storm sewer mains.
- Contractor shall not be allowed to work Sundays. Holiday or Saturday work shall be as approved in advance by the City.
- Relocation of any water line, sewer line, service line or other utility thereof required for the construction of this project shall be the responsibility of the contractor and shall be at his expense.

(4). Sediment and Erosion Control Plan

- This plan shows the location and details for primary sediment controls to be constructed. The contractor is responsible for controlling erosion and discharge of sediment from the site at all times during construction. The contractor shall provide necessary measures during all phases of his operations regardless of whether they are specifically noted on this plan and shall maintain and replace controls as necessary during the course of his operations.
- Temporary construction entrance(s) and silt fences, fiber rolls or other initial sediment controls shown on this plan must be installed prior to any land disturbance.
- Sediment basins and detention facilities shown on this plan shall be installed prior to any other land disturbance.
- The contractor shall clean streets both interior and adjacent to the site, as needed, after each rainfall, and at the end of construction.

- The contractor is responsible for controlling dust during construction and shall water the construction areas whenever conditions warrant.
- The contractor is responsible for cleaning accumulated sediment from storm drains prior to approval of construction.
- All disturbed areas not receiving other permanent stabilization such as pavement, roofs, sod, etc., shall be seeded and mulched, as specified. Vegetation shall be established before temporary sediment controls can be removed and prior to final approval of construction.
- The contractor is responsible for inspecting the BMPs, weekly and after it rains in accordance with the MoDNR erosion control permit.
- The contractor is responsible for maintaining copies of the Sediment and Erosion Control Plan, the Stormwater Pollution Prevention Plan, (SWPPP), and the weekly inspection reports on site at all time.
- The City's approval of these erosion control plans in no way releases the developer/contractor from the responsibility for all sediment/erosion control methods to be in compliance with the City's Standards and Codes. This includes, but is not limited to; proper maintenance of all controls in place and providing additional control as required for both sheet flow and concentrated flow areas.

14. Approval Block. A signature block shall be required on the cover sheet of all plans and reports submitted for review and approval. All plans and reports require the signature of the Public Works Director and the date of such signing for formal approval by the City. After one year, the plans and reports shall become null and void and shall be resubmitted prior to approval of construction of that project. The general form of the approval block for construction drawings shall be as follows:

APPROVED FOR ONE YEAR FROM THIS DATE

City of Ozark Public Works Director

Date

The City's approval of these improvement plans in no way releases the developer/contractor from the responsibility to be in compliance with the City's Standards and Codes.

1.11 Record, (as-builts) Drawings;

A. The owner of the tract proposed for subdivision shall submit record, (as-built), drawings to the Planning and Development Department for approval. Record, (as-builts), drawings shall be provided to the Public Works Department prior to acceptance for any other improvement projects that includes public infrastructure. The drafting of the record, (as-built), drawings shall comply with all of the same criteria as the construction drawings and shall be corrected to show the project as constructed. The drawings shall accurately and completely denote all changes made during the course of the work. Each sheet within the plans shall be clearly marked as "Conforming to construction Records" and shall include the date of revision and certifications by the engineer. All manhole depths shall be measured and noted. The Developer's Engineer shall gather field notes and shall conduct field surveys of all items, (fire hydrants, valves, **water meters**, manholes, storm boxes, exposed storm pipe ends, storm water detention basins etc.) to ensure the accuracy of the record, (as-built) drawings. Where changes occur, the Developer's Engineer shall verify and certify in writing that all design criteria are still met. The record, (as-built) drawings shall comply with the following:

1. As-built information shall be clouded and noted with a symbol showing the revision number.
2. The record, (as-built) drawings shall be sealed by an engineer registered in the State of Missouri.
3. In addition, when construction of the improvements is completed, the Developer's Engineer shall perform surveys to determine that the location, dimension, and grade of the drainage improvements is in substantial conformance with the approved plans. Location of improvements shall be checked by field survey to ensure that the improvements are completely located within the easements or rights-of-way which have been provided. The location of improvements which vary more than six inches (6") from the location shown on the approved plans must be approved in writing by the City.
4. Elevations and grades shall be verified at the following locations:
 - Center of access manhole or grate for junction structures and inlets.
 - Inlet entry for side opening inlets (except curb opening inlets).
 - Pipe and culvert inverts. For box culverts greater than five feet (5') wide, invert elevation shall be checked at each side of the inlet and outlet.
 - Detention basin and sediment basin outlet structures.
 - Maximum intervals of one hundred feet (100') and at grade changes in drainage channels (excluding road side borrow ditches).
 - Detention and sediment basins.
5. Elevations differing by more than one-tenth of a foot (0.1') from plan grades or five-hundredths of a foot (0.05') for detention basin outlet structures must be approved in writing by the City prior to final approval.
6. Dimensions must be verified for the following:
 - Pipe diameter for circular pipe.
 - Height and width for elliptical or arch pipe, or box culverts.
 - Drainage channel cross-sections at maximum intervals of two hundred feet (200').
 - Erosion protection at pipe outlets.
 - Overflow spillways and outlet structures for detention and sediment basins.
 - Detention and sediment basin volume.

B. Submittal of Record Drawings.

1. After approval and any required revision, one (1) paper copy and one (1) Adobe pdf digital copy and one AutoCAD dwg. file shall be submitted to the City. The digital copies may be submitted on a CD or e-mailed to engtech@ozarkmissouri.org. The paper copies shall be separately bound on 24" x 36" sheets. Each sheet within the plans shall be clearly marked as "Record Drawings" and shall include the date of revision and certifications by the Engineer. The digital copies and the paper copy shall be to standards acceptable to the Director of the Public Works Department.
2. The AutoCAD dwg. file shall comply with the following; Missouri Coordinate System of 1983, Central Zone, (in U.S. feet). The AutoCAD dwg. file shall include all external referenced files and appropriate layers and shall be on state plane. In addition, a digital copy shall be provided as an Adobe pdf format with a copy of each individual drawing sheet.

Section 1.12 Pre-Construction Conference

1.12.1. Prior to the commencement of any construction or installation of any infrastructure improvements, a pre-construction conference shall be held with the developer/owner or his representative, the contractor(s) responsible for installation of the infrastructure improvement, the Public Works Director or his representative, and Public Works staff. The pre-construction conference shall be held to ensure that all applicable provisions of this Ordinance or other applicable law, rule, or regulation have or will be met, that all applicable permits have been obtained, and that any questions regarding the scheduling of construction and installation of improvements are resolved. The developer/owner or his representative shall be responsible for contacting the Public Works Department to schedule the pre-construction conference. Public Works Department will then notify the parties of the date and time of the pre-construction conference.

Section 1.13 Inspection Requirements

1.13.1. Periodic inspections shall be required during construction work. These inspection requirements are outlined in the individual standards for streets, sidewalks, drainage or other public improvements.

1.13.2. The developer shall provide inspection services for all improvements that will be dedicated to the City of Ozark and all stormwater facilities improvements. These inspections shall be performed by or under the direct supervision of the developer's engineer who shall be registered in the State of Missouri. Inspections shall be of sufficient frequency to enable the developer's engineer to provide to the City a sealed certification that the improvements were constructed in accordance with the approved engineering design plans, or in accordance with approved record (As-Built) plans.

1.13.3. The developer shall also submit copies of field inspection reports and testing results in sufficient detail to record the history of the entire installation, testing and deviations from the approved engineering design plans. These reports shall bear the seal of an engineer registered in the State of Missouri.

1.13.4. These inspections, reports and certifications shall be the financial responsibility of the developer. In no case shall the presence of City personnel during any part of the construction and testing constitute acceptance by the City or a substitute for on-site observation by the developer's engineer.

1.13.5. Unless otherwise specified in any of the regulations contained in this Ordinance, the developer shall notify the City a minimum of twenty-four (24) hours prior to any testing of public improvements. If the City requests to be present during any phase of construction and testing and is not notified by the developer, the developer shall uncover concealed work or retest any materials or systems for the City's personnel to observe.

ARTICLE II

STREETS, SIDEWALKS AND OFF-STREET PARKING STANDARDS

Section 2.1 Street-General Requirements

2.1.1. The classifications, extent, width, grade and location of all streets shall conform to the City's Comprehensive Plan and Major Thoroughfare Plan in addition to the Ozark Transportation Organization's Long Range Transportation Plan.

2.1.2 In any case where additional street right-of-way is required, the additional right-of-way shall be split evenly on both sides of the existing right-of-way unless otherwise approved by the Board of Aldermen.

2.1.3. Where not shown, the arrangement and design standards of streets shall conform to the provisions herein or the Missouri Department of Transportation or Ozark Special Road District or Christian County where applicable. Streets which have an entry onto a state highway will require approval from the Missouri Department of Transportation. Streets which have an entry onto a Christian County or Ozark Special Road District roadway will require Christian County or Ozark Special Road District approval.

2.1.4. The arrangement of streets in new subdivisions shall be coordinated with existing, proposed and anticipated streets outside of the subdivision. Provision shall be made for the continuation of existing streets in adjoining areas.

2.1.5. When a new subdivision adjoins a tract susceptible to being subdivided, new streets shall be extended to the boundaries of such tract.

2.1.6. Streets shall be related appropriately to the topography and street grades shall conform as closely as practical to the original topography. Street grades shall be in accordance with the requirements of this Design Standards.

2.1.7. Local streets shall be designed so as to discourage through traffic. However, provisions must be made for the extension of arterial and collector streets into and from adjoining areas.

2.1.8. Every lot shall have access to a road that provides reasonable ingress and egress for emergency and non-emergency vehicles as well as for the intended use of the lot. Commercial or industrial lots shall have access to a collector street, but shall not have direct access to any residential street or residential collector street, except in the case of appropriately separated planned retail center.

2.1.9. When a subdivision abuts or contains an arterial street, the Planning and Zoning Commission may require marginal access streets, reverse frontage lots, or other such treatment as may be necessary for adequate protection of abutting properties and to provide separation of through and local traffic.

2.1.10. Half-streets shall be prohibited except where such streets, when combined with a similar street (developed previously or simultaneously) on property adjacent to the subdivision, create a street that meets the right-of-way and pavement requirements and this Ordinance. In such case, the developer shall dedicate that portion of land in the proposed subdivision that will complete the street right-of-way to the minimum standards.

2.1.11. Blocks shall have sufficient width to provide for two (2) tiers of lots of appropriate depth, except in the case of reversed frontages. The lengths of blocks shall be appropriate in the opinion of the Planning and Zoning Commission for the locality and the type of development contemplated and shall comply with the provisions of Chapter 410, Subdivision Regulations and Requirements of the City's Municipal Code.

Section 2.2 Street-Design Guidelines

2.2.1. **General.** Proposed street improvements within the City shall conform to the pattern established in the Major Thoroughfare Plan as adopted by the City. Street improvements shall be designed to conform to applicable codes, regulations, ordinances, and the provisions set forth in these criteria as established by the City. **All proposed streets and parking lots shall be surfaced with either asphalt or concrete. Gravel surfacing is not permitted without approval by the Public Works Director or his designee.** Plans for said improvements shall be submitted to the Public Works Director for approval and shall include all information as may be required or described hereinafter.

2.2.2. **Functional Classification of Streets.** The classification of streets shall be generally defined as follows:

A. Primary Arterial Streets. Primary streets provide for high to moderate-volume, moderate-speed traffic movement between and through major activity centers. Access to abutting property is subordinate to traffic flow and is subject to necessary control of entrances and exits.

B. Secondary Arterial Streets. Secondary arterial streets augment and feed the primary arterial system and are intended for moderate-volume, moderate-speed traffic movement. Access to abutting property is partially controlled.

C. Primary Collector/Commercial Streets. Primary collector streets collect and distribute traffic between arterial streets and residential collector or residential/local streets and are intended for short length trips while also providing access to abutting properties. Commercial streets serve areas predominately zoned for commercial or industrial uses. The City may require additional lanes as required to serve intended or future developments.

D. Residential Collector. Residential collector streets are designed to collect and distribute traffic from between residential streets and collector or arterial streets. Residential collector streets are intended for low-speed low-volume traffic movement and for short length trips. Design of residential collector streets will vary depending on the character and intensity of traffic generated by adjacent land development. Parking may be allowed on the street and bicycle lanes may be required. Any proposed design for residential collector streets shall be submitted to the City for review and approval.

E. Residential/Local Streets. Residential/Local streets are designed to provide direct access to abutting property. Residential/Local streets are intended for low-speed low-volume traffic movement and for short length trips.

F. Downtown Local, Provides direct access to abutting property. Downtown local streets are intended for low-speed, low-volume traffic movement and for short length trips. Design of downtown local streets varies depending on the character and intensity of traffic generated by adjacent land development as well as the existing right of way and significant buildings and the Design Standards. Design of downtown local streets will vary depending on the character and intensity of traffic generated by adjacent land development. Any proposed design shall be submitted to the City for review and approval.

2.2.3. Street Design Standards, (Refer to Ozark Transportation Organization standards for additional details.)

	PRIMARY ARTERIAL	SECONDARY ARTERIAL	PRIMARY COLLECTOR*	RESIDENTIAL COLLECTOR	RESIDENTIAL / LOCAL
Minimum Right-of-way Width (ft)	110	80	65	55 or 60**	50
Street Width (BOC-BOC in ft)	29 Ea Side	41 or 46**	29 or 35**	29 or 35**	29
Median Width (ft)	18'	NA	NA	NA	NA
Minimum Pavement Depth (Asphaltic Concrete) inches	***	***	See standard details	See standard details	See standard details
Design Volume (VPD) Range	10,000-30,000	6,000-20,000	1,500-8,000	800-1,500	Less than 800
***Design Speed (MPH)	35-45	30-35	30	25	25
Maximum Grade	6%	6%	8%	10%	12%
Minimum Grade	0.5%	0.5%	0.5%	0.5%	0.5%
Curb Return Radius	***	50'	30'	25'	25'
Minimum Radii, Horizontal Curves	***	600'	400'	300'	175'
Max. Superelevation*****	***	0.04	0.03	0.02	0.02
Vertical Curves, K Values; Crest	***	80	60	40	20
***** Sag	***	70	60	50	30
Min. Safe Stopping Sight Distance (ft)	***	325	250	200	150
Min. Safe Stopping Distance At Intersection (ft)	***	500	450	300	250
Minimum Spacing for Non-Signalized Intersections, Centerline to Centerline	1/4 Mile	660 feet	660 feet	300 feet	300 feet
Minimum Distance Private Driveway Curb Cut Spacing, Centerline to Centerline in feet	330 Right in & Right Out Commercial Only	210 Commercial Only	160 Commercial Only	Ref. Paragraph 2.2.22.A.2	Ref. Paragraph 2.2.22.A.2
Minimum Distance from Intersection of cross street ROW to edge of driveway curb cut in feet	250	200	150	25	25
***** Sidewalk width (ft)	5' Min.	5' Min.	5' Min.	5' Min.	5' Min.
Parking Permitted	No	No	No	One Side	One Side
Storm Sewers	Yes	Yes	Yes	Yes	Yes
Curb & Gutter	Barrier	Barrier	Barrier	Barrier	Barrier
Number of lanes	4 to 6	2 to 3	2	2	2

- * Also applicable to commercial streets. Commercial streets may require additional width for on-street parking.
- ** Increased width if bicycle route is included.
- *** To be individually designed and approved.
- **** Design Speed criteria for horizontal and vertical alignment should meet the requirements of the current edition of "A Policy on Geometric Design of Highways and Streets, AASHTO".
- ***** Minimum length of superelevation runoff = 100'.
- ***** Length of vertical curves, (L) = KA with K from table above and A = algebraic difference in grades.
- ***** Installed as per the requirements indicated in the latest version of the Code of Ordinances of the City.

2.2.4. Off-Center Street Intersections. Off-center street intersections shall be separated by a minimum centerline to centerline dimension of three hundred feet.

2.2.5. Intersection Vertical Alignment. In all cases where a higher functional street intersects with a lower functional street, normal street crown shall be maintained on the higher functional street. Where streets of equal function intersect, street grades shall coincide in the center of the intersection with reduced rideability for both streets, or a warping of the cross slope for both streets

2.2.6. Right-of-Way Triangle Requirements

Intersection of with	Primary Arterial	Secondary Arterial	Primary Collector	Residential Collector	Residential/Local
Primary Arterial	A	A	B	B	C
Secondary Arterial	A	B	B	C	D
Primary Collector	B	B	C	C	D
Residential Collector	B	C	C	C	D
Residential/Local	C	D	D	D	E

A – 100' X 100' ROW triangle w/separate right-turn lanes

B– 30' X 30' ROW triangle w/50' corner radii

C– 10' X 10' ROW triangle, (or 15' ROW radius) w/30' corner radii

D– 10' X 10' ROW triangle, (or 15' ROW radius) w/20' corner radii

E – No ROW triangle w/15' corner radii

2.2.7. Leveling Areas of Intersection. Any approach leg of an intersection that is subject to either stop control or a signalized intersection where vehicles may be stored while waiting to enter an intersection shall be designed with a maximum grade on the approach legs of three (3) percent within a minimum length of 100 feet. The 100 foot shall be measured from the intersection of the edge of gutter flag or edge of pavement, with a maximum cross-fall of 6" at the throat of the radius returns of the intersection street.

2.2.8. Street Intersections. Intersections involving the junction of more than two (2) streets shall be prohibited. See chart above for intersection spacing requirements.

2.2.9. Sight Distances at Intersections. Sight distance is a function of the intersection control and vehicle speed. See appropriate AASHTO standards in the latest edition of Geometric Design of Highway and Streets.

2.2.10. Minimum Angle of Intersection. It is desirable for all intersections to meet at approximately a 90 degree angle. Skewed intersections should be avoided, and in no case should the angle be less than 60 degrees. When local streets intersect collector or arterial streets, the angle shall not be less than 75 degrees.

2.2.11. Maximum Gradient. The maximum gradient for streets as noted in Section 2.2.3 may be exceeded only upon written approval of the Director of Public Works. Such approval will only be granted in unusual cases where grades within the acceptable limits cannot be obtained.

2.2.12. Grading Gradients. Except for the sidewalk surface, the finished grade within the limits of the right-of-way shall slope from one-quarter (1/4) inch vertical to one (1) foot horizontal minimum; to one-half (1/2) inch vertical to one (1) foot horizontal maximum measured above the back of the curb. The grading gradients may be varied only upon written approval of the Director of Public Works. See details in the Standard drawing details.

2.2.13. Grade Breaks. Grade breaks will be permitted up to 1% street center-line profile grade differential. A vertical curve will be required for all street center-line profile grade differentials exceeding 1%.

2.2.14. Connections to Existing Pavements. Where a new street is to connect to an existing street, all deteriorated or cracked asphalt within five (5) feet of the connection point shall be removed to a point where sound material is found. If full-depth pavement removal is required, the subgrade will be recompacted to 95% of standard density.

2.2.15. Storm Drainage. All storm drainage works constructed in connection with street improvements shall be designed in accordance with the Design Standards.

2.2.16. Cul-De-Sacs. Permanent dead-end streets or cul-de-sac shall be no longer than 750 feet and shall provide at the closed end a paved turn-around having a minimum diameter of one hundred (100) feet to the back of the outside curb and one hundred twenty (120) feet to the street right-of-way line. See details in the Standard Drawing Details.

2.2.17. Temporary Turn-Arounds. At locations where streets are to be temporarily terminated which will be extended at a later date, and said street extends beyond the intersection of an adjacent street more than 150 feet, a temporary cul-de-sac or “hammerhead” turnaround shall be constructed. This requirement may be omitted only upon written approval of the Director of Public Works. See details in the Standard Drawing Details.

2.2.18. Other Design Criteria. All other street design elements not contained within these criteria shall be in accordance with the most current edition of "A Policy on Geometric Design of Highways and Streets" authored by the American Association of State Highway and Transportation Officials (AASHTO) or other applicable AASHTO design guides.

2.2.19. Driveway Elevations. Driveways shall attain top of curb elevation within the right-of-way. Break-over grades for crest drives shall be 8% maximum and sag drives shall be 12% maximum. Driveway elevation shall allow for a smooth sidewalk profile and appropriate ADA cross-slopes. See details in the Standard Drawing Details.

2.2.20. Curb and Gutters. All streets shall be constructed with concrete curb and gutter. Curb and gutter shall be installed in conformance with details in the Standard Drawing Details.

2.2.21. Cut and Fill Slopes. Slope adjoining right-of-ways shall be sloped no steeper than a 3:1 grade. 4:1 grades are preferred where possible.

2.2.22. Driveway Approaches

A. All driveway entrances and other openings onto streets within the City of Ozark's planning jurisdiction shall be constructed so that:

1. Vehicles can enter and exit from the lot in question without posing any substantial danger to themselves, pedestrians or vehicles traveling on abutting streets. Interference with the free and convenient flow of traffic on abutting or surrounding streets is minimized.
2. For residential streets, only one driveway approach shall be permitted abutting any frontage of less than eighty (80) feet. The number of driveways abutting any frontage of eighty (80) to one hundred fifty (150) feet shall not exceed two (2). The number of driveways for frontages of more than one hundred fifty (150) feet and less than one thousand eight hundred (1800) feet shall not exceed three (3). The number of driveways for frontages of more than one thousand eight hundred (1800) feet shall not exceed one (1) driveway per two hundred (200) feet of frontage. A minimum distance of forty (40) feet shall exist between the interior lines of adjacent driveways serving one lot.
3. No driveway approach shall be permitted which will interfere with any traffic control devices or public utilities including curb inlets and fire hydrants. The direction of any garage opening shall not align with an existing fire hydrant or curb inlet location. No driveway pavement shall be installed over manholes, valves boxes, water meters and etc.

4. All driveway approaches shall be located a minimum of 5' from edge of driveway to property line. Radius or sloped edge of the driveway approach shall not extend beyond the projection of the adjacent property line, extended perpendicularly to the right-of-way line. See details in the Standard Drawing Details.

B. Where drainage culverts are required, all driveway entrances and other openings onto streets shall be constructed so that:

1. The culvert is at least fifteen (15) inches in diameter, with a minimum of twelve (12) inches of surface cover over the culvert or as determined by the Public Works Director. Larger sizes may be required as determined by the Public Works Director.

C. The size of culverts under City streets shall be approved by the City Public Works Director. The minimum allowable pipe size for storm sewers is dependent upon a diameter practical from a maintenance standpoint. For storm sewers in public right-of-way or public drainage easement less than fifty feet (50') in length, the minimum allowable diameter is fifteen (15) inches. All pipe over fifty feet (50') in length shall have a minimum diameter of eighteen (18) inches. The maximum allowable diameter is six feet (6') unless otherwise approved.

2.2.23. Sidewalks

A. Sidewalks shall be constructed on all new public streets as per the requirements indicated in the latest version of the Code of Ordinances of the City of Ozark. Sidewalks may also be required along existing public streets for the full length of all street frontages of any proposed development or structure. Sidewalks shall comply with all requirements of the latest edition of the ADA Standards for Accessible Design.

B. Public sidewalks shall be located within the street right-of-way but shall not be built longitudinally over sanitary sewer or water mains. Sidewalks shall be constructed of Portland concrete. Decorative brick walk ways may be permitted with approval by the Director of Public Works. Colored, stamped concrete resembling brick would be preferred over decorative brick.

C. Maximum longitudinal grade for sidewalks shall either be 5% maximum running grade or matching the profile grade established for the adjacent roadway. Cross slopes of sidewalks shall not exceed 2% maximum. Minimum cross-slope of sidewalks shall be 0.5%.

D. Sidewalks shall be a minimum of 5 feet wide. A grass planting strip shall normally be provided between the curb and the sidewalk. Sidewalks adjacent to the back of curb shall be a minimum of 6 feet wide. Public sidewalks located adjacent to multi-store front commercial buildings shall be a minimum of eight (8) feet wide. Clear width shall not be less than 48" at any point location while not exceeding 36" in length.

E. Whenever the City of Ozark finds that a means of pedestrian access is necessary from the subdivision to schools, parks, playgrounds, or other roads or facilities and that such access is not conveniently provided by sidewalks adjacent to the streets, the developer may be required to construct other walkway improvements to provide such access.

F. All sidewalks shall be constructed up to each intersecting street and curb ramps shall be provided for intersections at the curb return and other major points of pedestrian flow. A curb ramp shall be provided across from the curb ramp at the opposite curb return where sidewalks exist or are proposed. Cross slopes for accessible crosswalks on street crossings shall not exceed 2% maximum. Curb ramps and the flared sides of curb ramps shall be located so that they do not project into vehicular traffic lanes, parking spaces or parking access aisles. Curb ramps at marked crossings shall be wholly contained within the markings excluding any flared sides. Diagonal curb ramps with flared sides shall have a segment of curb 24" long located on each side of the curb ramp within the marked crossing. Curb ramps, street crossings and depressed curbs shall be constructed in accordance with the latest edition of the ADA standards in effect at the time of construction. See details in the Standard Drawing Details.

G. Raised islands in crossings shall be either cut through level with the street or have curb ramps at both sides. The cuts shall be a minimum width of 36". Each curb ramp shall have a level area of 48" at the top of the curb ramps with the 48" dimension oriented in the direction of the running slope of the curb ramp that it serves. Level cuts may have asphalt surface. Curb ramps and landing areas shall be concrete surfaced.

2.2.24. Accessible Parking Space and Access Aisle Dimensions

A. The minimum number of accessible parking spaces as well as parking space and access aisle dimensions shall be in conformance with the latest edition of the ADA standards in effect at the time of construction.

ARTICLE III

SANITARY SEWERS

Section 3.1 General Requirements

3.1.1. All developments/public improvements shall be provided with an approved system for wastewater disposal in accordance with this Article and subsequent sections of this Design Standard.

3.1.2. All sanitary sewer main extensions, pump stations, appurtenances, and all collection and treatment systems shall be designed and constructed in accordance with the most current regulation of the MoDNR's rules, regulations, and Statutes of the State of Missouri. Any proposed extensions or modifications to the City's sanitary sewer system shall in general, comply with the City's Sanitary Sewer Master Plan. Any deviations shall require approval by the Director of Public Works.

3.1.3. All sanitary sewer improvements plans including all gravity and pressure systems within the City, shall be submitted to the Department of Public Works, for review and approval by the Public Works Director and/or a representative designated by the City. The developer/applicant shall be responsible for all costs associated with the required review and approval of submitted plans.

3.1.4. Any review by the City, or approval of construction shall not relieve the developer or the developer's engineer from complying with all rules, regulations, ordinances, laws or statutes that are in effect at the time of design or construction.

3.1.5. In addition to the rules, regulations and state statutes specified in Section 3.1.2, the City will require conformance with the following design guidelines and with the Standard Drawing Details and Constructions Specifications.

3.1.6 Construction of new sewer septic systems are not permitted within the city limits of Ozark. Only replacements of existing septic systems are permitted when no other option is feasible. **Replacement and construction of new holding tanks are allowed on a case-by-case basis upon the property owner(s) demonstrating an environmental need for said holding tank to the Director of Public Works, or his designee, or if the City determines it is not economically feasible for the City to extend the municipal public sanitary sewer system within a reasonable distance to the property.**

Section 3.2 Design Guidelines

3.2.1. Sanitary Sewers shall be designed for the ultimate tributary population. Due consideration shall be given to current zoning regulations and approved planning and zoning reports where applicable. The most current City of Ozark Land Use Plan shall be consulted when determining proposed land uses within the ultimate tributary area for calculation of the required size of the proposed sewer collection system for areas that have not been developed. In the absence of a proposed and/or up to date Land Use Plan for the ultimate tributary area, the design engineer shall use sound professional judgment to establish proposed land uses in order to calculate anticipated flow rates. All planning interpretations and/or predictions shall be subject to the approval of the City. Whenever possible, actual platted land uses shall be used for calculations of ultimate tributary population flow rates. Sewer capacities shall be adequate to handle the anticipated maximum hourly quantities of sewerage and industrial waste together with reasonable consideration given to infiltration/inflow.

A. Sewers shall be designed for the total tributary areas using the following minimum criteria:

Using these criteria all pipes are to be sized flowing full.

1. Interceptors and trunk lines 0.015 CFS/Acre
2. Laterals and sub-mains 0.03 CFS/Acre

3. Lift Station Pumping Rates: The capacity of proposed lift stations or modifications/upgrades to existing lift stations shall be calculated per the MoDNR Design Guide. In the absence of measured and accurate flow or data, the following shall be used, for the land uses indicated, for sizing calculations:

- a. Single Family Residential: 3.7 persons/lot
- b. Multi-Family (Duplex & Townhomes): 3.7 persons/unit
- c. Multi-Family (Apartments, Condos): 3.0 persons/unit
- d. Commercial/Industrial: Unit flow rates shall be established by the design engineer for the proposed facility to be constructed, and shall be approved by the City.

B. The diameter of proposed sewers shall not exceed the diameter of the existing or proposed outlet, whichever is applicable, unless otherwise approved by the Public Works Director. No public sewer shall be less than eight (8) inches in diameter.

C. Stublines for service connections shall not be less than four (4) inches in diameter for residential lots. Tees shall be SDR -26 for SDR-35 mains and SDR-21 for SDR-21 mains. Sewer services shall be Schedule 40 PVC. No split services, (except for multi-family), or 90° turns are permitted. Service connections on the mains shall have a minimum of five (5) feet of separation and shall be located a minimum of five (5) feet from the exterior wall of a manhole. Service connections shall be provided for every lot and every structure and shall be centered in the lot frontage where feasible. Tracer wire and indicator tape shall be provided for all service connections as per Details in the Standard Drawing Details.

D. Clean outs shall be located not more than 100 feet apart measured from the upstream entrance of the cleanout. See the International Plumbing Code for services 8" in diameter and larger. No clean outs shall be located within public right-of-way except those required for the termination of the tracer wire.

E. Sanitary sewers shall be constructed of pipe material resistant to or protected from bacterial degradation, acid and alkaline solutions, normal sewer temperature variation, abrasion, and industrial wastes or other material which may be transmitted by the collection system.

1. The following types of commercial pipe are approved for gravity sanitary sewer systems constructed in the City. All PVC sewers over 10' deep shall be SDR-21, Class 200 pipe. SDR 35 may be used for depths less than 10 feet. Vitrified Clay sewer pipe is not permitted.

Ductile Iron Pipe	ANSI A21.51, AWWA C151, ASTM A536, Grade 60-42-10; thickness Class 50, ASTM A746, Pressure Class 350, with 1.5-2.5 mils of coal tar Paint, MIL-C-18480, or Bituminous Coating per Manufacturer's Standard unless otherwise required by the Public Works Director. Mechanical joints shall comply with ANSI A21.11 and AWWA C111, except gaskets shall be synthetic rubber. Natural rubber will not be acceptable. Fittings shall
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comply with ANSI A21.10 and AWWA C110. Polywrap all pipe and fittings in accordance with AWWA C-105 and install per AWWA C-600.

PVC Pipe

ASTM D3034, Type PSM Polyvinyl (Chloride), SDR 35 and SDR-21; PVC Material shall conform to ASTM D3034 and shall have a cell classification of 12454-B, as defined in ASTM D1784. 18" or larger diameter pipe shall comply with ASTM F679 and shall have a cell classification of 12364-C or 12454-C. Minimum pipe stiffness (F/Y) at 5ø deflection shall be 46 for all sizes when tested in accordance with ASTM D2412. All joints of PVC pipe and fittings shall conform to ASTM D3212 with elastomeric seals conforming to ASTM F477.

F. All sewers shall be designed to give mean velocities when flowing full of not less than 2.0 feet per second. All velocity and flow calculations shall be based on Manning's formula using an "n" value of 0.013.

G. The velocity of flow in sewers shall not exceed 12 feet per second.

H. Sewers mains shall be laid with uniform slope and straight alignment between manholes. Curvilinear alignment of sewers larger than 24" may be considered on a case-by-case basis provided compression joints are specified and the pipe manufacturer's maximum allowable pipe joint deflection limits are not exceeded. Curvilinear sewers are limited to starting and ending at manholes. When curvilinear sewers are proposed, the recommended minimum slopes shall be increased accordingly to provide a minimum velocity of two feet per second when flowing full.

I. Steep slope protection. Sanitary sewers on twenty percent (20%) slope or greater shall be anchored securely with concrete slope anchors or equal, spaced as follows:

1. Not over thirty-six feet (36') center-to center on grades twenty percent (20%) and up to thirty-five percent (35%);
2. Not over twenty-four feet (24') center-to center on grades thirty-five percent (35%) and up to fifty percent (50%);
3. Slopes shall not exceed fifty percent (50%).

J. The following shall be minimum slopes for the size indicated.

Sewer Size	Minimum Slope In Feet per 100 feet
8"	0.40
10"	0.28
12"	0.22
14"	0.17
15"	0.15
16"	0.14
18"	0.12
21"	0.10
24"	0.08

K. Exceptions to these minimum slopes shall be made at the upper end of the lateral sewers serving fewer than thirty houses. Said sewers shall have a minimum slope of 0.76%.

L. Where lateral sewers serve less than ten (10) houses; the minimum slope shall not be less than 1% unless otherwise approved by the Public Works Director.

M. When a sewer joins a larger one, the invert of the larger sewer should be lowered sufficiently to maintain a continuous energy gradient.

N. In situations where flow is continuous and grit is a problem, and where velocities greater than 10 feet per second are possible, special provisions shall be made to protect against abrasion damage to the pipe. Such protection may be attained utilizing ductile iron pipe.

O. The flow-line angle for manholes shall not be less than 90 degrees.

P. Manholes shall be installed at the end of each line; at all changes in grade, size, or alignment; at all intersections; and at a distance not greater than four hundred (400) feet for sewers fifteen (15) inches or less in diameter and not greater than five hundred (500) feet for larger sewers.

Q. The construction of all manholes and castings shall conform to the specifications and details shown in the Construction Specifications and Standard Drawing Details. Where corrosive conditions due to septicity or other causes are anticipated, corrosion protection on the interior of the manholes shall be provided. Corrosive conditions are considered to be present where sewer mains are 12" or larger in size or where discharge is occurring from a force main. Where discharge is from a force main an additional two manholes downstream shall be lined. The lining shall be an epoxy with a minimum of 90% solids by volume. A concrete admixture of "Con-Shield" or equivalent may be substituted for epoxy lining.

R. The minimum horizontal clear distance within the barrel of standard manholes shall not be less than four (4) feet. Manholes with connecting pipe diameters greater than eighteen, (18) inches shall have a minimum inside clear dimension of five (5) feet and manholes with connecting pipe diameters greater than 30 inches shall have a minimum inside clear dimension of six (6) feet.

S. Drop manholes should be avoided as much as possible. However, an outside or inside drop pipe shall be provided for a sewer entering a manhole at an elevation of twenty-four (24) inches or more above the manhole invert. The outside drop pipe shall be protected against breaking or settling by the use of concrete encasement. The drop pipe shall have the same nominal diameter as that of the incoming sewer. The minimum diameter of an in-side drop type manhole shall be increased to five (5) feet.

T. Without utilizing drop manholes, the difference in elevation between the invert of any incoming sewer and the invert of the outgoing sewer should not exceed twenty-four (24) inches except where required to match crowns. When a sewer joins a larger one, the crown of the smaller sewer shall not be lower than the crown of the larger one. The minimum drop through manholes shall be 0.2 feet.

U. Where manholes are to be built in close proximity to streets, the top of manhole elevation shall be set within the following limits:

- | | |
|----------------------|---|
| 1. Minimum Elevation | 1/4" per foot rise above top back of curb |
| 2. Maximum Elevation | 1/2" per foot rise above top back of curb |

- V. All other sanitary sewer lines (sewer lines across unplatted land, etc.) shall have the tops of manholes set 2" above the existing ground elevation
- W. Any variation from the above top of manhole criteria will require a letter of explanation to be submitted with the drawings and be subject to approval by the Public Works Director.
- X. Sanitary sewers mains shall be located within right-of-ways and easements to provide the least interference with the location of other utility lines unless topography dictates otherwise. A 15' minimum easement width, (unless combined with right-of-way), shall be provided for all sanitary sewer mains and normally shall be centered on the main. Additional width may be required as determined by the Public Works Director. This determination will be based on depth, location or presence of adjacent utilities. The planting of trees in sanitary sewer easements is not permitted. Temporary construction easements shall also be provided as necessary. Sanitary sewer lines shall be constructed on the opposite sides of streets from water lines. Construction of sidewalks longitudinally above sanitary sewers is not permitted. No sanitary sewer main shall be constructed under storm boxes.
- Y. A tracer wire and indicator tape shall be provided for all sewer mains and services per details in Standard Drawing Details. Access boxes for tracer wire splices not corresponding to a manhole or other structure shall be provided.
- Z. End lines with easements shall be extended to provide access from street rights-of-way where possible.
- AA. Not less than 42" of cover shall be provided over top of pipe in all areas unless otherwise approved by the Public Works Director.
- BB. Open cutting of streets shall be permitted only where approved by the Public Works Director or the local agency responsible for the roadway. At locations where open cutting is not permitted, the crossing shall be made by boring or tunneling. Crossings made by boring or tunneling shall require a casing pipe unless otherwise approved by the Public Works Director. All work and materials shall be in conformity with all requirements of the Construction Specifications. The diameter and length of the casing pipe to be used shall be in accordance with details in the Standard Drawing Details.
- CC. Cleanouts and lampholes are not permitted on sanitary sewer mains.
- DD. Manhole Frames and Lids:
1. Type A frames and lids shall be provided for traffic areas.
 2. Type B frames and lids shall be provided for non-traffic areas and shall be installed in areas where type A and C frames and lids are not specified.
 3. Type C frame and lid shall be bolt-down type. Type C lids shall be installed in all areas subject to flooding and as required by the Public Works Director.
- EE. There shall be no physical connection between a public or private potable water supply system and a sewer, or appurtenance thereto, which would permit the passage of any wastewater or polluted water into the potable water supply.

1. Horizontal Separation:

a. All sanitary sewers, storm sewers, or manholes shall be laid at least 10 feet, horizontally, from a water main. The distance shall be measured from edge to edge of pipes. In cases where it is not practical to maintain a ten-foot separation, deviation may be allowed on a case-by-case basis, if supported by data from the design engineer. Such a deviation may allow installation of the sewer closer to a water main, provided that the water main is in a separate trench or on an undisturbed earth shelf located on one side of the sewer and at an elevation so the bottom of the water main is at least 18" above the top of the sewer. A request for variance shall be submitted to the MoDNR Public Drinking Water Branch and the Public Works Director for approval. This request shall include proposed alternate installation configuration.

2. Vertical Separation:

a. Water mains crossing sanitary sewers, house sewers, or storm sewers shall be constructed to provide a minimum clear distance of 18 inches between the outside of the water main and the outside of the sewer. This clearance is required whether the water main is above or below sewer pipes. The designer shall make every effort to install proposed water lines at sanitary sewer crossing above the sanitary sewer pipe, whenever practical. At crossings, the full length of water pipe shall be located so that both joints will be as far from the sewer as possible but in no case less than 10 feet. Special structural support for the upper pipe may be required. In areas where the proper separation cannot be maintained as stipulated above, either the water main or sewer line must be constructed of mechanical joint pipe or cased in a continuous casing.

FF. Adequate support shall be provided at all joints in pipes utilized for aerial crossings. Precautions against freezing, such as insulation and increased slope, shall be provided. Expansion jointing shall be provided between above-ground and below-ground sewers. Where buried sewers change to aerial sewers, special construction techniques shall be used to minimize frost heaving. For aerial stream crossings, the impact of flood waters and debris shall be considered. The bottom of the pipe shall be placed no lower than the elevation of the fifty-year flood. Only ductile-iron pipe with restrained joints shall be used. Otherwise, they shall be constructed so that they will remain watertight and free from changes in alignment of grade.

GG. Appropriate sewer mains easements shall be extended to the property line for potential future extension. Manholes shall be placed at the ends of these dead end lines with an invert formed for future connection. There shall also be a formed opening, gasket, 5' pipe stub and a pipe plug placed at the manhole invert for future connection.

HH. Where a sewer must be constructed on fill, a profile of the original undisturbed ground line along sewer centerline shall be shown. All sewers to be constructed on fill shall be a special design approved by the Public Works Director.

II. Sewer systems shall be designed to minimize the number of stream crossings. Sewer crossings shall be designed to cross a stream as nearly perpendicular as possible and shall be free from change in grade. All structures, such as manholes and etc. shall be located so they do not interfere with the free discharge of flood flows of the stream. Sewers entering or crossing streams shall be constructed of ductile-iron pipe with mechanical joints; otherwise, they shall be constructed so they will remain watertight and free from changes in alignment or grade. Material used to backfill the trench shall be stone, coarse aggregate, washed gravel, or other materials which will not readily erode, cause siltation, damage pipe during placement, or corrode the pipe. The design engineer shall include in the project specifications the method(s) to be employed in the construction of sewers in or near streams. Such methods shall provide adequate control of siltation and erosion by limiting unnecessary excavation, disturbing or uprooting trees and vegetation, dumping of soil or debris, or pumping silt-laden water into the stream.

Section 3.3 Lift Stations

3.3.1. In the design of sanitary sewer systems, it is the policy of the City that lift stations will not be acceptable when gravity flow is reasonably available, or when overflows of raw sewage would flow into spring recharge areas, public water supplies, sinkholes and streams, except where the developer provides additional design and construction features sufficient to overcome environmental concerns to the satisfaction of the City.

Construction of a proposed lift station with force main will normally only be permitted within the city limits of Ozark in those cases where the proposed lift station is replacing the use of an existing lift station. Advance coordination with the Public Work Director is required prior to proceeding with any lift station plans. Design details, criteria and capacities for any sanitary sewer lift station shall be determined during that coordination. Individual lift stations and locations would require site-specific conditions and or equipment to ensure proper construction, performance and operation.

3.3.2. Developers or property owners who desire to utilize a lift station and force main for the development of property within the city limits of Ozark, shall submit to the City of Ozark, through the normal processes of subdivision plat or development plan approval, a plan for the lift station and force main. This plan shall include the following:

A. A certification by an engineer registered in the state of Missouri that a gravity flow connection to the sewer system is not reasonably available to service the subject property, with the reasons that gravity flow is unavailable stated with particularity and to include calculation of costs for installation of gravity flow sewer for the proposed development, prepared by the developer's engineer.

B. A certification by an engineer registered in the state of Missouri that the lift station, as proposed, is sufficient to perform the desired functions for the entire proposed development and that the force main and wetwell are sufficient to service the entire drainage area.

C. A certification by an engineer registered in the state of Missouri what the costs of construction of the proposed lift station and force main will be.

3.3.3. Upon review of the developer's plan and recommendation of the Public Works Director, the City of Ozark shall make a determination if the lift station and force main may be utilized for the development.

3.3.4. A request by a developer or property owner to connect a new development to a sewer system served by an existing lift station will be reviewed on a case-by-case basis by the City of Ozark. The request will be accompanied by a certification with sufficient justifying calculations by an engineer registered in the state of Missouri that the existing lift station and force main are sufficient in capacity to serve the properties proposed to hook onto the existing lift station and force main. In the case where an existing lift station is found to have insufficient capacity for a proposed development, the Developer may propose potential upgrade to the existing lift station and force main to provide sufficient capacity. The Developer's engineer shall provide calculations and plans for the proposed improvements. All proposals, calculations, and plans are subject to approval by the Public Works Director. The City may reject existing lift station upgrades that are not part of the City of Ozark Sewer Master Plan.

3.3.5 Developers or property owners who have received approval from the City of Ozark to utilize a lift station and force main shall be responsible for complying with all applicable requirements of the City of Ozark.

Section 3.4 Force Mains

3.4.1. At design average flow, a cleansing velocity of at least four (4) feet per second shall be maintained.

3.4.2. The force main shall connect at an angle to the gravity sewer main at a point not less than five (5) feet downstream from a manhole.

3.4.3. The force main pipe and fittings shall be designed to withstand normal pressure and pressure surges. Force main pipe shall be designed and so constructed to provide a minimum cover of forty-two (42) inches and a maximum cover of sixty (60) inches over the top of the pipe. Justification shall be provided where additional depth is required. Concrete thrust blocking shall be provided at all bends 11-1/4 degrees or greater. Force mains designed to cross public streets shall be encased with steel casing of adequate size to allow for future removal of the force main pipe.

3.4.4. Include on the plans that testing of the force main shall be in accordance with the requirements of AWWA C-600. Testing pressure shall be: Total Design Head x 0.433 x 1.5

3.4.5. A Valmatic Model 801A air release valve, or approved equal, shall be placed at high points in the force main to prevent air locking. The air release valve shall be equipped with shutoff valve, blowoff valve and backflushing attachments. A standard four-foot diameter shallow manhole with standard frame and cover shall be installed around the force main relief valve for maintenance access to valve. The cover shall be labeled "City of Ozark" and "Sanitary Sewer". See details in the Standard Drawing Details.

3.4.6. Provide tracer wire and indicator tape at force mains as per details in Standard Drawing Details. Use access boxes for tracer wire splices when an air release valve is not available.

Section 3.5 Grinder Pumps

3.5.1, Any grinder pumps proposed in a submitted plan shall remain in private ownership. Any service lines or force mains included for these grinder pumps shall also remain in private ownership. The city shall not be responsible for any maintenance of said grinder pumps or service lines or force mains.

Section 3.6 Grease, Oil and Sand Interceptors

3.6.1. General Provisions. Grease, oil, and sand interceptors shall be provided at the developer's or user's expense when the Public Works Director determines that they are necessary for the proper handling of wastewater containing grease or any flammable wastes, sand, and other harmful ingredients, except that such interceptors shall not be required for private living quarters or dwelling units. All interceptors shall be of a type and capacity approved by the Public Works Director and shall be so located as to be readily accessible for cleaning and inspection. Grease and oil interceptors shall be constructed of impervious materials capable of withstanding abrupt and extreme changes in temperature. They shall be of substantial construction, watertight, and equipped with easily removable covers which when butted in place shall be gas tight and water tight. When installed, all grease, oil and sand interceptors shall be maintained by the user, at his/her expense, in continuously efficient operation.

3.6.2. Grease Interceptor Standards

A. Grease interceptors shall be provided on kitchen drain lines from institutions, hotels, restaurants, school lunch rooms, nursing homes and facilities, and other establishments from which significant amounts of grease may be discharged to the public sewer collection and treatment system.

B. Grease interceptors should be located on the exterior of the facility but as close to the fixtures being served as possible and should receive only the waste streams from grease-producing fixtures. Sanitary waste streams, garbage grinder waste streams and other waste streams which do not include grease should be excluded from passing through the grease interceptors. This separation is mandatory for new construction or replacement facilities. Grease interceptors must be cleaned on a regular basis and must be readily accessible for this purpose.

C. Sizing of grease interceptors is based on wastewater flow and can be calculated from the number and kind of sinks and fixtures discharging to the interceptor. The following two (2) equations shall be used to determine the capacity of grease interceptors for restaurants and other types of commercial facilities: (Water use data and the number of meals served at similar facilities may be used to determine the gallons of wastewater per meal.) Grease interceptors should not be less than 1,000 gallons' capacity without submittal of proper justification based on formulas below and with approval by the Director of Public Works.

1. Restaurants

$D \times GI \times Sc \times (Hr/2) \times Lf = \text{Size of grease interceptor in gallons, where:}$

D = Number of seats in dining area;

GI = Gallons of wastewater per meal, normally 5 gallons;

Sc = Storage capacity factor, minimum of 1.7;

Hr = Number of hours open; and

Lf Loading factor,

1.25 interstate highways

1.0 other freeways

1.0 recreational areas

0.8 main highways

0.5 other highways.

2. Hospitals, nursing homes, other type commercial kitchens with varied seating capacity.

$M \times GI \times Sc \times 2.5 \times Lf$ = Size of grease interceptor in gallons, where:

M = Meals per day;

GI = Gallons of wastewater per meal, normally 4.5;

Sc = Storage capacity factor, minimum of 1.7; and

Lf= Loading factor,

1.25 garbage disposal and dishwashing

1.0 without garbage disposal

0.75 without dishwashing

0.5 without dishwashing and garbage disposal

D. Grease interceptors shall be provided with a manhole or opening of sufficient size to permit inspection and cleaning. When the grease interceptor is located below ground, the access opening shall be extended to grade. The opening shall be fitted with a tight fitting cover which will prevent the entrance of insects and vermin. Sampling manholes shall be provided at the outlet of all grease interceptors as per details in the Standard Drawing Details.

E. The grease interceptor should be constructed of materials similar to septic tanks and be properly baffled on both the inlet and outlet.

F. Grease interceptors shall not discharge prohibited substances as defined in the City of Ozark Sewer Use and Sewer Rate Ordinance in any single event as determined by a grab sample.

G. The City shall have the right to inspect facilities from time to time, during regular business hours, to determine if the facility is in compliance with this provision. The City shall have the right to require regular sampling, to be conducted at the Owner's expense, should the City deem sampling activities necessary for compliance by the subject industry.

3.6.3. Variances to Grease Interceptor Requirement. Under certain conditions, as indicated in this Subsection, a variance from the requirement of a grease interceptor of 1,000 gallon or more may be given after following the procedure set out for obtaining a variance.

A. Variance may be granted to a temporary food preparation and clean-up facility when:

1. Food preparation and clean-up will be limited to a specific event or time, and

2. It can be shown that only minor levels or incidental quantities of fats, oils and grease would be released into the sewer collection system.

ARTICLE IV

WATER SYSTEMS

Section 4.1 General Requirements

4.1.1. All development shall be provided with an approved system for water service in accordance with this Article and subsequent sections of this Design Standards.

4.1.2. All water wells, well houses, water storage tanks, water pumping facilities and related systems shall be designed and constructed in accordance with the latest edition of the MoDNR's "Minimum Design Standards for Missouri Community Water Systems".

4.1.3. All water main extensions and appurtenances shall be designed and constructed in accordance with the Design Standards, Construction Specifications and the most current regulation of the MoDNR's rules, regulations, and Statutes of the State of Missouri.

4.1.4. All water improvements plans, including all systems within the City of Ozark, shall be submitted to the Public Works Department, for review and approval by the Public Works Director and/or a representative designated by the City. The Developer/Applicant shall pay for costs associated with the required review and approval of submitted plans.

4.1.5. Submittal of all engineering reports, plans and specifications to MoDNR shall comply with the requirements of the latest edition of the MoDNR's "Minimum Design Standards for Missouri Community Water Systems".

4.1.6. Any review by the City, or approval of construction shall not relieve the developer or the developer's engineer from complying with all rules, regulations, ordinances, laws or statutes that are in effect at the time of design or construction.

Section 4.2 Design Guidelines

4.2.1. In addition to the rules, regulations and state statutes specified in Section 4.1.3, the City will require conformance with the following design guidelines and with the Constructions Specifications and Standard Drawing Details.

A. All water systems shall be designed to provide adequate fire flow in accordance with the requirements of MoDNR. The plans for the water system must be submitted to the Ozark Fire District for review and the Fire District's recommendation must be provided to the City. Copies of any fire flow tests or calculations must be sent to the City. All fire hydrants installed by the contractor shall be flow tested following pressure testing and disinfection of the mains. This testing shall be done by the developer in the presence of the Ozark Fire District and the Public Works Representative with the results forwarded to the City.

B. No public water line shall be constructed less than eight (8) inches in diameter.

- C. Appropriate water mains easements shall be extended to the property line for potential future extension. A gate valve the same size as the extended main shall be placed at the end of the line with a dead end assembly and a fire hydrant for flushing the main.
- D. Construction of sidewalks above water mains shall not be permitted, except for main crossings.
- E. All water mains shall have a minimum cover of forty-two (42) inches and a maximum cover of sixty (60) inches. Justification shall be provided where additional depth is required.
- F. Open cutting of streets shall be allowed only where permitted by the Public Works Director or the local agency responsible for the roadway. At locations where open cutting is not permitted, the crossing shall be made by boring or tunneling. Crossings made by boring or tunneling shall require a casing pipe unless otherwise approved by the Public Works Director. All work and materials shall be in conformity with all requirements of the Construction Specifications. The diameter and length of the casing pipe to be used shall be in accordance with details in the Standard Drawing Details.
- G. The design of all water systems shall provide for a complete loop-type water distribution system adequate to service the area with a connection, meter and meter setter for each lot.
- H. Water pressures in distribution systems below 20 PSIG are a violation of Missouri Safe Drinking Water Regulation 10 CSR 60-4.080 (9). All water mains shall be sized in accordance with a hydraulic analysis based on flow demands and pressure requirements. Distribution systems shall be designed to maintain at least 35 PSIG normal working pressure at ground level at all points in the distribution system under all conditions of design flow not including fire flow.
- I. Proposed water mains shall be so located within right-of-ways and easements to provide the least interference with the location of other utility lines. A 15' minimum easement width, (unless combined with right-of-way), shall be provided for all water mains and normally shall be centered on the main. Additional width may be required as determined by the Public Works Director. This determination will be based on depth, location or presence of adjacent utilities. Planting of trees within water main easements is not permitted. Temporary construction easements shall also be provided as necessary. Water lines shall be constructed on the opposite sides of streets from sewer lines. Construction of sidewalks longitudinally above water mains is not permitted. No water main shall be constructed under storm boxes. Street grades and elevations of proposed main shall be taken into consideration so that once constructed they will not require regrading or relocation. In areas where grading activities will take place, the water main shall not be installed until final grade has been achieved in the location of the proposed water main. The City shall not be responsible for required relocating or lowering of installed water lines due to insufficient pre-construction grading activities. See details for utilities in the Standard Drawing Details.
- J. A tracer wire and indicator tape shall be provided for all water mains and services per details in Standard Drawing Details. Access boxes for tracer wire splices not corresponding to a valve or other structure shall be provided.
- K. At the termination of all water mains or at locations as specified by the Public Works Director, a dead end assembly with a fire hydrant in accordance with the Construction Specifications shall be provided to allow for future water main extensions.
- L. Fire hydrants shall be provided at locations as required to provide for thorough flushing of all water mains in the project area. Whenever practical, water mains five hundred (500) feet and longer shall be provided with a fire hydrant for flushing.

M. Reaction blocking of adequate size shall be provided at all tees, elbows and bends to resist all resultant thrusts due to hydrostatic pressure. Horizontal and vertical alignment shall be achieved by appropriate elbows and bends with adequate blocking. Alignment by deflection will not be permitted. All blocking shall conform to the Construction Specifications and Standard Drawing Details.

N. Ductile iron pipes or PVC shall be used for all water mains constructed in the City.

1. The ductile iron pipe shall conform to ANSI A21.51, AWWA C151, ASTM A536 and Grade 60-42-10. The minimum nominal thickness class for 8" and larger ductile iron pipe shall be Class 50 unless otherwise designated by the Public Works Director.

2. Ductile-iron pipe joints, unless otherwise specified, shall be of the push-on type conforming to ANSI A21.11/AWWA C111, except gaskets shall be synthetic rubber. Natural rubber will not be acceptable. The pipe shall be cement mortar lined, conforming to ANSI A21.4/AWWA C104 and shall be coated inside and out with a bituminous coating.

3. Ductile-iron fittings shall be complete with all accessories and shall be ASTM A536, Grade 70-50-05, conforming to ANSI A21.10/AWWA C110, 350 PSI pressure rating. Joints shall be of the standard mechanical joint type conforming to ANSI A21.10/AWWA C111. All fittings shall be cement mortar lined conforming to ANSI A21.4/AWWA C104 and shall be coated inside and out with a bituminous coating.

4. PVC pressure pipe shall be designed to carry potable water at pressures (including surge) up to the maximum class rating. Materials from which the pipe, couplings, and fittings are manufactured shall conform to ASTM D1784, Type 1, Grade 1, 200 psi design stress. The minimum wall thickness for the pipe shall be SDR 21 (Class 200 as defined in AWWA C900).

5. All PVC pipe shall conform to the latest revisions of ASTM D 2241, Department of Commerce PS22-70 (SDR-PR) pressure rated pipe, and National Sanitation Foundation Testing Laboratories (NSF). Pipe ends shall be tapered to accept gasketed coupling. Flexible elastomeric gaskets, meeting the requirements of ASTM F477, shall be synthetic rubber. Natural rubber will not be acceptable.

6. The couplings and fittings shall accommodate the pipe for which they are used. The minimum pressure ratings shall be 235 psi for couplings and 250 psi for the fittings but shall be no less than the pressure rating of the associated pipe. Pipes, fittings, and appurtenances containing more than 0.25 percent lead calculated by weighted average shall not be permitted. Used pipes, fittings, and appurtenances shall not be permitted. Packing and jointing materials used in the pipe joints shall conform to the latest edition of the AWWA standards.

7. In areas that are contaminated with organic chemicals, permeation of organic chemicals into the water system shall be prevented by using non-permeable materials for all portions of the water system including pipe, fittings, service connections, and hydrant leads.

O. Fire hydrants shall conform to AWWA C502, and shall be either Mueller "~~Modern~~ Centurion" or Clow "Medallion" models.

1. Hydrants shall be traffic models with breakaway flanges and shall have one 4 1/2 inch pumper nozzle and two 2 1/2 inch nozzles. All hydrants shall be furnished with auxiliary gates valves.
2. Hydrants should be placed at or near each street intersection and at intermediate points when block lengths become long. Hydrants shall be provided within 50' of any lift station, but not within the fenced area. Under no circumstances shall the spacing of fire hydrants exceed five hundred (500) feet in residential areas nor three hundred (300) feet in commercial areas, (measured in street driving distance).
3. Fire Hydrant installations shall conform to the Standard Drawing Details and Construction Specifications. As a rule, hydrants shall be oriented with the pumper outlet perpendicular to the curb which faces the street. Hydrants shall be protected if subject to mechanical damage. The means of protection shall be arranged in a manner that will not interfere with the connection to, or operation of, hydrants. In poor load-bearing soil, special construction such as support collars may be required.
4. Systems that cannot provide a minimum fire flow of 250 GPM for a duration of two hours are not designed to provide any fire protection. Water mains that are not designed to provide fire protection shall not have fire hydrants connected to them.
5. The hydrant lead line (the line from the main to the hydrant) shall be designed to match the ability of the system to supply flows to the fire hydrant that will not reduce pressures anywhere in the system below 20 PSIG when the hydrant is fully opened. Alternatively, a throttling valve may be installed on the lead line to control the flow out of the hydrant. Provide the maximum allowable flow for each hydrant. Thrust restraint shall be provided for throttling valve so that the hydrant may be removed without shutting down the supply main. A concrete collar should be installed around the hydrant lower barrel to prevent damage to the main in the event that the hydrant is hit during a traffic accident.
6. All fire hydrants shall be flow tested to determine the maximum flow that each hydrant can produce without dropping the system pressures below 20 PSIG. If a throttling mechanism is used, it shall then be set at the maximum flow that will not drop system pressures below 20 PSIG. Depending upon the results of the flow test, the bonnet and nozzle caps of each hydrant should be color coded to indicate its flow class in accordance with local fire authority requirements or NFPA standards.

P. Proposed projects shall include supportive documentation that shows water lines can be adequately flushed while maintaining the minimum required pressures. Provide a hydraulic analysis that evaluates the proposed extension at average design flows and peak flows, including flushing requirements. This analysis needs to include existing lines back to the nearest storage tank or booster pump station. Flushing devices and valves shall be provided to allow every main in the distribution system to be flushed. Flushing devices should be sized to provide flows that will give a velocity of at least 2.5 ft./sec in the water main being flushed. In order to provide increased reliability of service and reduce head loss, dead ends shall be minimized by making appropriate tie-ins whenever practical. Where dead end mains occur, they shall be provided with an approved flushing device. No flushing device shall be directly connected to any sewer. Long runs of transmission mains shall have flushing devices appropriately located so that flushing velocities can be reached and contaminant removal can be achieved with minimal customer impact. Flushing devices shall be sized to provide a maximum flow that does not drop system pressures below 20 PSIG. Throttling valves shall be set on the leads to flushing devices to set the maximum flow of the device so that it will not drop system pressures below 20 PSIG. Flushing devices

should be installed at low points of the water main installation, depending on flow rate and pipe profile, where sediment may accumulate.

Q. Sufficient isolation valves shall be provided on water mains to allow a system to be adequately flushed and so that inconvenience and sanitary hazards to customers will be minimized during repairs. The following requirements shall be met when designing system valves. The weight of the valve shall not be carried by the pipe. Valves shall be provided with proper support, such as crushed stone, concrete pads or a well compacted trench bottom. Where new water mains connect to an existing main, a valve shall be installed on the new line. As a rule of thumb, no more than four valves should require closing to isolate a pipe. At a reducer, a valve should be placed in the smaller pipe within 20 feet of the reducer. In municipalities, valves should be located at not more than 300-foot intervals in commercial areas and at not more than one block or 500-foot intervals in residential or other areas.

R. Gate valves shall be of the resilient-seated configuration and shall conform to the applicable requirements of AWWA C515.

1. Acceptable manufacturers are Clow Corporation, Mueller and Keystone valve USA Inc.

2. Gate valves shall be used in all water mains.

3. Where two lines intersect, a valve should be placed in each pipe on each side of the intersection. Where two water lines intersect, and the use of a tee or cross is required, a flanged gate valve shall be installed on each leg and/or branch of the water line at the intersection. The valves shall be installed with flanged connections close to the tee or cross; however, valves shall not be located within the limits of the street pavement.

4. Extension stems shall be provided for buried valves when the operating nut is more than three feet below finished grade. Each extension stem for a buried valve shall extend to within three feet of the ground surface, shall be provided with spacers which will center the stem in the valve box, and shall be equipped with a wrench nut.

S. At high points in water mains where air can accumulate, provisions shall be made to remove the air by means of manually operated hydrants or air relief valves. Automatic air relief valves shall not be used. The discharge pipe from a manually operated valve shall be capped with a threaded removable cap or plug and should be extended to the top of the pit. Bypass lines shall be provided for Pressure Reducing Valves (PRV) on critical lines. Pressure gauges should be located upstream and downstream of PRVs to verify operation. Chambers, pits, or manholes containing valves, blow offs, meters, or other such appurtenances to a distribution system, shall not be connected directly to any storm drain or sanitary sewer, nor shall blow offs or air relief valves be connected directly to any sewer. Such chambers or pits shall be drained to the surface of the ground or provided with sump.

T. Tapping sleeves and valves shall be used where required to connect to existing in-service mains.

1. The tapping valves shall be 200 psi, resilient-seated, cast iron body, nonrising stem gate valves conforming to all applicable requirements of AWWA C515. Each tapping valve shall be provided with a flanged inlet end designed, faced and drilled for connection to the outlet end of the tapping sleeve. The outlet end of the tapping valve shall be provided with a tapping flange for attachment of a standard drilling machine and also with a mechanical joint-type bell end for connection of the branch main.

2. Tapping sleeves shall be of the flanged-outlet type designed for attachment to the flanged inlet end of the tapping valve, and shall be provided with mechanical joint ends at each end of the run and shall be Mueller "No. H-615" for ductile iron pipe or approved equal.
3. Connections to existing water mains shall be made in such a manner as to provide the least amount of interruption to water service. In the event closing of valves to make a connection will affect a customer who cannot be without service, provision shall be made on the plans for a temporary service at the expense of the developer/applicant.

U. There shall be no physical connection between a public or private potable water supply system and a sewer, or appurtenance thereto, which would permit the passage of any wastewater or polluted water into the potable water supply. No water main shall be located closer than 25 feet to any wastewater disposal facility, agricultural waste disposal facility, or landfill. Water mains shall be separated by a minimum of 25 feet from septic tanks and wastewater disposal areas such as cesspools, subsurface disposal fields, pit privies, land application fields, and seepage.

1. Horizontal Separation:

- a. All sanitary sewers, storm sewers, or manholes shall be laid at least 10 feet, horizontally, from a water main. The distance shall be measured from edge to edge of pipes. In cases where it is not practical to maintain a ten-foot separation, deviation may be allowed on a case-by-case basis, if supported by data from the design engineer. Such a deviation may allow installation of the sewer closer to a water main, provided that the water main is in a separate trench or on an undisturbed earth shelf located on one side of the sewer and at an elevation so the bottom of the water main is at least 18" above the top of the sewer. A request for variance shall be submitted to the MoDNR Public Drinking Water Branch for approval. This request shall include proposed alternate installation configuration.

2. Vertical Separation:

- a. Water mains crossing sanitary sewers, house sewers, or storm sewers shall be constructed to provide a minimum clear distance of 18 inches between the outside of the water main and the outside of the sewer. This clearance is required whether the water main is above or below sewer pipes. The designer shall make every effort to install proposed water lines at sanitary sewer crossing above the sanitary sewer pipe, whenever practical. At crossings, the full length of water pipe shall be located so that both joints will be as far from the sewer as possible but in no case less than 10 feet. Special structural support for the upper pipe may be required. In areas where the proper separation cannot be maintained as stipulated above, either the water main or sewer line must be constructed of mechanical joint pipe or cased in a continuous casing.

V. Surface water crossings present special problems, whether over or under water. Special detail drawings shall be submitted that are scaled and dimensioned to show the approximate bottom of the stream, the approximate elevation of the low and high-water levels, and other topographic features. Mechanical, restrained, or fusion welded joint pipe shall be required in waterways and wet weather streams.

1. Above water crossings

- a. The pipe shall be adequately supported and anchored, protected from damage and freezing and accessible for repair or replacement.

2. Underwater crossings

- a. Flowing streams and water body crossings five hundred feet or less in length shall have a minimum cover of four feet over the pipe. When crossing water courses greater than 15 feet in width, the following shall be provided:
 - (1). The pipe shall be of special construction, having flexible watertight joints. Steel or ductile iron ball-joint river pipe shall be used for open cut crossings. Mechanical or restrained joint or fusion welded pipe may be used for open cut crossings, provided it is encased in a welded steel casing. Mechanical or restrained joint or fusion weld pipe shall be used for bored crossings.
 - (2). Adequate support and anchorage shall be provided on both sides of the stream.
 - (3). Valves shall be provided at both ends of water crossings so that the section can be isolated for testing or repair; the valves shall be easily accessible and should not be subject to flooding.
 - (4). The valve closest to the supply source shall be in an accessible location and installed in a vault, manhole, or meter pit sized to allow the installation of leak detection equipment.
 - (5). Permanent taps shall be provided on each side of the valve within the manhole, vault, or meter pit to allow insertion of a small meter to determine leakage and for sampling purposes.
 - (6). Bank erosion is a major cause of stream crossing failures, and erosion protection measures such as rip rap have limited success. Stream movement and the history of bank erosion must be considered when choosing the length that the crossing pipe or casing shall extend beyond the upper edge of the stream channel. The stream crossing pipe or casing shall extend at least 15 feet beyond the upper edge of the stream channel on each side of the stream.
 - (7). Large river crossings require specialized design and shall be considered on a case-by-case basis.
- b. For lake, water body, and flood plain crossings greater than 500 feet in length, the design shall consider the ability to access and repair or replace the pipe in these crossings. Consideration shall also be given to the ability to continue service to areas served by the crossing in the event of a submerged leak or pipe break.
 - (1). Submerged portions of pipe crossing proposed lakes shall not be buried when the submerged pipe is greater than 500 feet in length except for the transition from water to land.
 - (2). Steel or ductile iron ball-joint river pipe or fusion welded pipe shall be used under water during normal flow conditions. Mechanical, restrained joint, or fusion welded pipe shall be used in flood plains.
 - (3). Underwater installations shall be tested for leaks prior to installation.
 - (4). Valves above the high water level shall be provided at both ends of water crossings so that the section can be isolated for testing or repair.
 - (5). The valve closest to the supply source shall be in an accessible location and installed in a vault, manhole, or meter pit sized to allow the installation of leak detection equipment.

(6). Permanent taps shall be provided on each side of the valve within the manhole, vault, or meter pit to allow insertion of a small meter to determine leakage and for sampling purposes.

c. Intermittent flowing streams

- (1). Restrained joint or thermal welded pipe shall be used for all stream crossings.
- (2). The pipe shall extend at least 15 feet beyond the upper edge of the stream channel on each side of the stream.
- (3). Adequate support and anchorage shall be provided on both sides of the waterway.

W. An approved backflow prevention device shall be installed on each service line to a consumer's water system serving premises where, in the judgment of the Director of Public Works, actual or potential hazards to the public potable water system exist. Use only double check valve assemblies or reduced pressure principle assemblies included on the current Missouri Department of Natural Resources approved assemblies list. Use on commercial or industrial applications. Backflow preventers and their installation shall conform to Missouri Department of Natural Resources Regulations 10 CSR 60-11.010. Backflow prevention devices for fire lines shall be located in an appropriate vault as close to the water main as is reasonably practical. Backflow prevention devices for domestic water services shall be located on the consumer's side of the water meter. In certain cases, the domestic water service may be supplied from the fire line with the approval of the Director of Public Works. The fire line would remain the responsibility of the property owner. The City of Ozark's Code book, section 720 shall be referenced for additional backflow prevention details.

X. Water services and plumbing shall conform to the applicable local plumbing codes. Pipes and pipe fittings containing more than a weighted average of 0.25 percent lead shall not be used. Solders and flux containing more than 0.2 percent lead shall not be used. Plumbing fittings and fixtures not in compliance with standards established in accordance with 42 U.S.C. 300g-6(e) shall not be used.

Y. A service connection shall be provided for each lot between the water main and the meter setter. The service line shall be a minimum 1-inch diameter, (single setter), and a minimum 2-inch diameter, (double setter), 200 PSI, SDR-9 PE 3408, ASTM-D2737, CTS-OD pipe. For new systems, each service connection shall be individually metered. For existing systems, each new service connection shall be individually metered.

Z. Single family units, each unit of a townhome, duplex, triplex and four-plex shall normally be provided with separate water meters for each living unit unless otherwise approved by the City. Multi-family apartment units shall be provided with one water meter for the entire facility. A separate commercial water meter shall be provided for each separate commercial unit unless otherwise approved by the City. Irrigation systems may be provided with separate water meters.

AA. The following requirements shall be met in the design of water loading stations.

1. An appropriate backflow prevention arrangement shall be incorporated in the piping so there is no backflow to the public water supply. A filling device shall be used so the hose does not extend into the water vessel to prevent contaminants being transferred from a hauling vessel to others subsequently using the station. Hoses shall be short enough that they do not contact the ground or any constructed platform. Hanging brackets or rope and pulley hoist is acceptable.

ARTICLE V

STORM WATER DESIGN STANDARDS

PART I – GENERAL PROVISIONS

Section 5.1 General Requirements

5.1.1. All development shall be provided with an approved system for stormwater in accordance with this Article and subsequent sections of this Ordinance.

5.1.2. All stormwater system and appurtenances shall be designed and constructed in accordance with the most current regulation of the MoDNR's rules, regulations, and Statutes of the State of Missouri.

5.1.3. All stormwater system plans, including all systems within the City, shall be submitted to the Director of Public Works, for approval.

5.1.4. Any review by the City, or approval of construction shall not relieve the developer or the developer's engineer from complying with all rules, regulations, ordinances, laws or statutes that are in effect at the time of design or construction.

5.1.5. In addition to the rules, regulations and state statutes specified in Section 4.1.2, the City will require conformance with the following design guidelines and with the Constructions Specifications.

Section 5.2 Approvals and Permits Required

5.2.1. National Pollutant Discharge Elimination System (NPDES) Storm Water Permit

A. Provisions of the 1987 Clean Water Act require that certain storm water discharges obtain an NPDES storm water permit. In Missouri, these permits are administered by MoDNR.

B. Federal rules for NPDES storm water discharges are contained in 40 CFR Parts 122, 123, and 124 of the Code of Federal Regulations.

C. State NPDES storm water regulations are contained in 10 CSR 20-6.200 of the Code of State Regulations.

D. Additional provisions for NPDES storm water permits for land disturbance activities and information are contained in Part VI of this Article.

E. Copies of any submittals and approvals of the NPDES Storm Water Permit shall be provided to the Director of Public Works.

5.2.2. "404" Permit

A. For certain activities that involve the discharge of dredged or fill materials into the waters of the United States, a Department of the Army permit may be required as set forth in Section 404 of the Clean Water Act. Rules for 404 permits are contained in 33 CFR Parts 320 through 330 of the Code of Federal Regulations.

B. The Kansas City or Little Rock District office of the Corps of Engineers generally makes determination of applicability for Section 404 requirements.

C. A brochure regarding the Corps of Engineers regulatory program may be obtained from the Corps offices.

D. Copies of any submittals and approvals of the “404” Storm Water Permit shall be provided to the Public Works Director.

5.2.3. City of Ozark Land Disturbance Permit

A. In the event a developer, land owner and/or land owner’s representative wishes to remove permanent land cover on an area of one (1) acre or more, one (1) of the above mentioned parties must obtain a land disturbance permit from the Public Works Department prior to commencing work.

Section 5.3 Coordination with Other Jurisdictions

5.3.1. Where proposed storm drainage facilities are located on property adjoining to other local government jurisdictions, the design of storm drainage facilities shall include provisions to receive or discharge storm water in accordance with the requirements of the adjoining jurisdiction, in addition to meeting City requirements. In these cases, two (2) additional sets of plans shall be submitted and will be forwarded to the adjoining jurisdiction for review and comment.

5.3.2. No grading or construction of storm drainage facilities may commence without prior notification of the Missouri One Call utility warning system at 1-800-DIG-RITE, as required by law.

Section 5.4 Ownership and Maintenance

5.4.1. Improvements on Public Road Right-of-Way

A. Storm drainage improvements on public right-of-way shall, upon acceptance of the constructed improvements by the Board of Aldermen, become the property of and shall be maintained by the City.

5.4.2. Improvements on Private Property

A. Storm drainage improvements on private property shall be maintained by the owner of the lot upon which the improvements are located or by the homeowners' association for improvements located in common areas. Maintenance of such improvements shall be identified on the final plat, in the subdivision covenants, and in the homeowner association’s bylaws.

B. All such improvements that serve a drainage area of five (5) acres or more shall be located in drainage easements as defined in Article V and the public shall have such rights of access to repair or maintain such facilities.

Section 5.5 Drainage Easements

5.5.1. All areas subject to inundation during a major storm must be included in drainage easements. Specific standards for drainage easements to be provided for storm sewers, open channels, and detention facilities are set forth in Article V.

Section 5.6 Design Guidelines

5.6.1. In addition to the rules, regulations and state statutes specified in Section 5.1.2, the City will require conformance with the following standards, specifications and design guidelines:

PART II - STORM WATER RUNOFF CALCULATIONS

Part II outlines acceptable methods of determining storm water runoff.

Section 5.7 Guidelines

5.7.1. For watersheds with a total tributary area less than 200 acres and a one percent annual probability (100-year) fully developed discharge less than 300 cfs, the design storm runoff may be analyzed using the rational formula.

5.7.2. For watersheds with a total tributary area greater than 200 acres or with a one percent annual probability (100-year) fully developed discharge greater than 300 cfs, the design storm runoff shall be analyzed using an approved hydrograph method.

Section 5.8 Rational Formula

5.8.1. The rational formula, when properly understood and applied, can produce satisfactory results for urban storm sewer design. The rational formula is as follows:

$$Q = CIA$$

Where: Q = Peak discharge in cubic feet per second.

C = Runoff coefficient which is the ratio of the maximum rate of runoff from the area to the average rate of rainfall intensity for the time of concentration.

I = Average rainfall intensity in inches per hour for a duration equal to the time of concentration.

A = Contributing watershed area in acres.

5.8.2. The basic assumptions made when applying the rational formula are:

A. The rainfall intensity is uniform over the basin during the entire storm duration.

B. The maximum runoff rate occurs when the rainfall lasts as long as or longer than the basin time of concentration.

C. Runoff response characteristics are relatively uniform over the entire basin.

D. The time of concentration is the time required for the runoff from the most hydraulically remote part of the basin to reach the point of interest.

5.8.3. The drainage basin should be divided into sub-basins of a size where all of the basic assumptions apply.

Section 5.9 Time of Concentration

5.9.1. Time of concentration, t_c , is calculated by:

$$t_c = t_i + t_t \text{ (5 minutes, minimum) where}$$

$$t_i = \text{initial, inlet or overland flow time in minutes,}$$

$$t_t = \text{shallow channel and open channel flow time in minutes.}$$

5.9.2. Overland flow (sheet flow) time shall be calculated as:

$$t_i = ((n \times L)^{0.8}) / (4.64 \times S^{0.4}) \text{ where (G.O. 021111, 11/11/02)}$$

$$t_i = \text{initial, inlet or overland flow time in minutes,}$$

$$n = \text{Manning's n for sheet flow (from the following table),}$$

$$L = \text{Overland flow length in feet, (maximum of 300 feet, pre-developed, ends where building grading begins*),}$$

$$S = \text{Slope in feet per foot.}$$

*40' past the front setback line

Roughness Coefficients (Manning's n) For Sheet Flow - Surface Description

Smooth surfaces (concrete, asphalt, gravel or bare soil)	0.011
Fallow (no residue)	0.050
Cultivated soils	
Residue cover less than or equal to 20 percent	0.060
Residue cover greater than or equal to 20 percent	0.170
Grass	
Short grass prairie	0.150
Dense grasses ¹	0.240
Bermuda grass	0.410
Range (natural)	0.130
Woods ²	
Light underbrush	0.400
Dense underbrush	0.800

¹ Includes species such as weeping lovegrass, bluegrass, buffalo grass, glue grama grass and native grass mixtures.

² When selecting n, consider cover to a height of about 0.1 feet. This is the only part of the plant cover that will obstruct sheet flow.

5.9.3. Shallow channel velocities may be estimated from Figure 3-1 in Reference 11 (see References List).

5.9.4. Open channel flow velocities may be estimated from Manning's equation. Open channel velocities are generally estimated under bank full conditions.

5.9.5. The basin time of concentration calculation techniques are described in detail in Reference 11, TR-55, Chapter 3.

Section 5.10 Hydrograph Methods

5.10.1. Methodologies

A. The Corps of Engineers HEC-1 Flood Hydrograph Package and Soil Conservation Service TR-55 computer models are the preferred runoff models. Other models may be used with approval from the Public Works Director.

B. The runoff model must include the entire drainage basin upstream of the proposed development. The model shall be prepared in sufficient detail to ensure that peak runoff rates are reasonably accurate.

C. The runoff model shall be developed for the following cases:

Case 1: Existing conditions in the drainage basin prior to development of the applicant's property.

Case 2: Existing conditions in the drainage basin with developed conditions on the applicant's property.

Case 3: Fully developed conditions in the entire drainage basin.

5.10.2. Rainfall

A. Rainfall depth-duration-frequency and intensity-duration-frequency curves for the City of Ozark area are shown on Drawing No. 1. Design rainfall intensities were developed from the U.S. Department of Commerce, National Weather Service, Technical Paper 40 (Reference 19) and the National Oceanic and Atmospheric Administration publication "HYDRO-35" (Reference 9).

B. Rainfall shall be distributed in time using the SCS Type II distribution (Reference 11), the Huff's Distribution or the Pilgrim-Cordery Distribution adapted to local rainfall data (References 20 and 21) as shown in the following table.

Huff's Median Time Distributions of Heavy Storm Rainfall at a Point

Cumulative percent of Storm time	First-quartile
5	16
10	33
15	43
20	52
25	60
30	66
35	71
40	75
45	79
50	82
55	84
60	86
65	88
70	90
75	92
80	94
85	96
90	97
95	98

Pilgrim-Cordery Method
Synthetic Rainfall Mass Curves

Cumulative Fraction of Storm Duration	Cumulative Fraction of Depth				
	1-Hour	2-Hour	3-Hour	4-Hour	6-Hour
.00	.00	.00	.00	.00	.00
.05	.03	.03	.03	.02	.05
.10	.07	.05	.05	.03	.09
.15	.11	.10	.06	.05	.14
.20	.14	.17	.09	.06	.20
.25	.17	.22	.11	.08	.28
.30	.23	.25	.13	.14	.35
.35	.29	.27	.19	.20	.41
.40	.35	.29	.31	.27	.43
.45	.41	.30	.39	.33	.46
.50	.47	.31	.44	.38	.49
.55	.56	.41	.47	.47	.60
.60	.65	.51	.54	.56	.70
.65	.73	.60	.64	.64	.80
.70	.82	.69	.70	.74	.86
.75	.91	.78	.73	.83	.89
.80	.93	.82	.81	.87	.93
.85	.95	.87	.89	.90	.96
.90	.97	.92	.94	.93	.97
.95	.99	.96	.98	.97	.98
1.00	1.00	1.00	1.00	1.00	1.00

PART III - STORM WATER DRAINAGE STRUCTURES

Section 5.11 Inlets

5.11.1. Inlet Locations

A. Inlets shall be provided at locations and intervals, and shall have a minimum inflow capacity such that maximum flooding depths set below are not exceeded for the specified storm; at all sump locations where ponding of water is not desired, and where drainage cannot be released at the ground surface. It is recommended that inlets be provided at street intersections upstream of pedestrian cross-walks

5.11.2. Inlet Interception Capacities

A. Inlet capacities shall be determined in accordance with the Federal Highway Administration HEC-12 Manual (Reference 5) or HEC-22, (See standard curb opening inlet – Definition Sketch in attachments).

B. Nomographs and methods presented in the Neenah Inlet Grate Capacities report (Reference 12) may also be used where applicable.

C. The use of commercial software utilizing the methods of HEC-12 or HEC-22 is acceptable. Software used shall be pre-approved by the Public Works Director.

D. Clogging Factors

1. The inlet capacities determined as required in this section must be reduced as follows, in order to account for partial blockage of the inlet with debris:

<u>Inlet Type & Location</u>	<u>Clogging Factor</u>
Curb Opening Inlets on grades and in sumps	0.8
Open-side Drop Inlets in sumps	0.9
Grated Inlets	
on grades	0.6
in sumps	0.5

2. Inlet lengths or areas shall be increased as required to account for clogging.

5.11.3. Interception and Bypass Flow

A. It is generally not practical for inlets on slopes to intercept 100% of the flow in gutters. Inlets must intercept sufficient flow to comply with street flooding depth requirements. Bypass flows shall be considered at each downstream inlet, until all flow has entered approved storm sewers or drainage ways.

5.11.4. Allowable Street Depths

A. Urban streets are a necessary part of the City of Ozark drainage system. The design for the collection and conveyance of storm water runoff is based on a reasonable frequency and degree of traffic interference. Depending on the street classification, (i.e.: local, collector, etc.) portions of the street may

be inundated during storm events. Drainage of streets is controlled by both minor and major storm events. The minor system is provided to intercept and convey nuisance flow. Flow depths are limited for the major storm to provide for access by emergency vehicles during most flood events.

B. When the depths of flow exceed the criteria presented in this section a storm sewer or open channel system is required.

C. General Design Guidelines

1. Flow from new commercial developments shall not be discharged onto public streets.
2. Allowable Flow Depth for new subdivisions. Flow is permitted with allowable depths of flow as follows:
 - a. Local streets: no crown overtopping for a five (5) year rainfall, maximum of top of curb for a twenty-five (25) year event.
 - b. Collector streets: the equivalent of one ten-foot driving lane must remain clear of water for the five (5) year storm, maximum of top of curb for the twenty-five (25) year storm.
 - c. Arterials: two ten-foot lanes must remain clear of water, one in each direction for the five (5) year storm, maximum of top of curb for the twenty-five (25) year storm.
 - d. For all classifications, for on grade, one-hundred (100) year storms shall be limited to the right-of-way and twenty-five (25) year storms shall be limited to the top of curbs. For in sumps, twenty-five (25) year storms shall be limited to the right-of-way. For one-hundred (100) year storms, the maximum depth shall be 18" at the face of curb for both on grades and in sumps.
 - e. Parking Lots & Private Drives: No requirements for five (5) year storms. Depth shall be limited to 18" measured from the top of the grate or from the bottom of a vertical inlet opening for twenty-five (25) year storms.
 - f. Where allowable depths are exceeded a storm sewer system must remove the excess water.
3. Cross Flow for new subdivisions. Cross flow at intersections is permitted up to the depths in the following table:

Street Classification	5-Year Storm Allowable Depth	25-Year Storm Allowable Depth
Local	3" in cross pan	6" at gutter flow line
Collector	3" in cross pan	6" at gutter flow line
Arterial	No cross flow permitted	No cross flow permitted

D. Hydraulics

1. The allowable storm capacity of each street section with curb and gutter is calculated using the modified Manning's formula for both the 5-year and 25-year storm event (G.O. 021111, 11/11/02).

$$Q = 0.56(Z/n)S^{1/2}d^{8/3}$$

Where: Q = discharge in cubic feet per second
Z = cross slope of the street in feet per foot

d	=	depth of flow at the gutter in feet
S	=	longitudinal slope of the street in feet per foot
n	=	Manning's roughness coefficient

5.11.5. **Types of Inlets Allowed**

A. Public Streets

1. Curb Opening Inlets

a. Standard curb opening inlets as shown on details in the Standard Drawing Details shall be used for public streets with curb and gutter.

2. Grated Inlets

a. In general, the use of grated inlets in streets, which require adjustment when streets are repaved, will not be permitted.

b. Where conditions are such that curb inlets cannot intercept the required rate of flow, necessary to control street flooding depth or to provide diversion of flow to detention, sedimentation or infiltration basins, "trench inlets" with vaned grates may be specified with approval of the Public Works Director.

c. Other types of inlets will not be permitted unless approved by the Public Works Director

B. Outside of Public Right-of-Way

1. The type of inlets specified outside of public right-of-way is left to the discretion of the designer provided the following criteria are met:

a. Maximum flooding depths for the major or minor storm as set forth above are not exceeded.

b. General safety requirements as set forth below are met.

c. All inlets shall be depressed a minimum of two (2) inches below the surrounding grade to allow proper drainage to the inlet and prevent inadvertent ponding in the area around the inlet.

d. Inlets in pavements shall be provided with a concrete apron.

5.11.6. **General Safety Requirements**

A. All inlets openings shall:

1. Provide for the safety of the public from being swept into the storm drainage system; the maximum allowable opening shall not exceed six (6) inches in height. The maximum bar spacing for grated inlets shall be six (6) inches in any direction.

2. Be sufficiently small to prevent entry of debris that would clog the storm drainage system;

3. Be sized and oriented to provide for safety of pedestrians, bicyclists, etc.

Section 5.12 Storm Sewers

5.12.1. Design Criteria

A. Design Storm Frequency: The storm sewer system, beginning at the upstream end with inlets, is required when the 5-year peak flow in the street exceeds five (5) cfs or when allowable street depths are exceeded. Allowable street depths are specified above.

B. Construction Materials: Storm sewers in public right-of-way or public drainage easements shall be constructed using corrugate steel pipe, **corrugated polyethylene pipe** or reinforced concrete. **Corrugated polyethylene pipe surfaces and flared end sections shall not be left exposed to the elements after final installation.** Reinforced concrete shall be installed under traffic-ways. Corrugated polyethylene pipe (CPP) is not allowed in these locations. Cast-in-place concrete pipe, masonry, vitrified clay, or other pipe not shown below is not allowed unless specifically approved. The concrete pipe material and appurtenances shall meet one or more of the following standards:

<u>Material</u>	<u>Symbol</u>	<u>Standard</u>
Reinforced concrete round pipe	RCP	ASTM C76, Class III
Reinforced concrete elliptical pipe	RCEP	ASTM C507
Reinforced concrete pipe-arch	RCPA	ASTM C506
Joints for concrete pipe		ASTM C443
Precast concrete flared end sections	FES	ASTM C76
Corrugated, steel round pipe	CMP	AASHTO M274, Aluminum-Coated
Corrugated, steel pipe-arch	CMPA	AASHTO M274 Aluminum-Coated
Steel flared end sections	FES	AASHTO M274 Aluminum-Coated
Corrugated polyethylene pipe	CPP	AASHTO M294 & M252
Cast-in-place reinforced concrete box culverts	RCB	MoDOT Specification
Precast concrete box culvert	RCB	ASTM C1433

Detailed information on structural and hydraulic properties of the type of pipe referred to above can be found in the Concrete Pipe Design Manual, the Handbook of Steel Drainage & Highway Construction Products.

C. Vertical Alignment

1. The recommended minimum slope for storm drain piping is 0.5% (five-tenths percent). Pipe grades may not be less than the minimum friction slope required to convey the design flow, unless specifically approved. Maximum recommended grade is 10% (ten percent). Properly designed anchorage may be required for grades above 10% (ten percent) and will be required for grades above 20% (twenty percent).

2. When changing pipe diameters, the inside tops of the pipes shall be set at the same elevation. Pipe size shall never be reduced downstream even though pipe slope and theoretical capacity may increase. A minimum vertical drop of 0.2' (two-tenths feet) shall always be provided across a junction structure, unless otherwise approved.

3. Under or within two feet (2') of streets or paved areas, the top of the pipe shall be located a minimum of twelve inches (12") below the pavement or curb subgrade, or greater if required to meet minimum cover and strength requirements for the type of pipe specified to withstand an AASHTO HS-20 loading. Outside of paved areas, the top of the pipe shall be located a minimum of twelve inches (12") below finished earth grade. Box culverts or other relatively wide and flat conveyance structures may be required to have additional cover if deemed necessary to support grass or other vegetative cover.

4. Siphons or inverted siphons are not allowed in the storm sewer system.

D. Horizontal Alignment:

1. Storm sewer alignment between manholes shall be straight except when approved by the Public Works Director. Curved alignments are not allowed.

2. Storm sewer crossings shall be perpendicular to the street.

3. The permitted locations for storm sewer within a street right-of-way are behind the curb. The outside edge of the pipe shall be located a minimum of 6" behind the back edge of curb. Except for crossings, storm sewers shall not be located under streets.

4. Storm sewers located on private property shall be located within drainage easements and shall be aligned parallel with property lines unless otherwise approved. Where storm drains exit the street right-of-way between residential lots, the pipe shall be extended a minimum of forty feet (40') past the front yard setback line, or to the estimated location of the rear of the dwellings, whichever is more. The outside edge of the pipe shall be located a minimum of five feet (5') from the easement line.

E. Bends and Junctions:

1. A manhole or junction structure must be provided at each change in direction or grade of the piping, except that bends may be located at junction structures in order to provide a perpendicular connection. Bends must be provided at junction structures if the angle of entry is less than sixty (60) degrees. Pipes shall be aligned such that the direction of flow of any incoming pipe is not less than perpendicular to the direction of flow of the outflow pipe (i.e. flow "against the grain" shall be avoided).

2. Access manholes for junction structures shall not be located within the pavement area for public streets. Junction structures shall be located such that the outside edge of the access manhole is twelve inches (12") minimum behind the curb or from the edge of a retaining wall or other obstruction.

3. Access manholes shall be provided at a maximum of five hundred feet (500') spacing along the pipe.

4. Precast circular manholes, square cast-in-place or precast junction boxes, or inlets may be used for junction structures.

F. Clearance from Other Utilities:

1. Horizontal Clearance:

Utility Minimum distance from outside edge of pipe to outside edge of pipe

Storm sewer Inside diameter of largest pipe*

Sanitary sewer and water Ten feet (10')

* or greater, if needed to allow proper placement and alignment of flared end sections

2. Vertical Clearance: A minimum clear distance of eighteen inches (18") from any other utility line shall be maintained above or below the storm drain pipe, unless otherwise approved by the Public Works Director.

G. Pipe Size: The minimum allowable pipe size for storm sewers is dependent upon a diameter practical from the maintenance standpoint. For storm sewers in public right-of-way or public drainage easement less than fifty feet (50') in length, the minimum allowable diameter is fifteen (15) inches. All pipe over fifty feet (50') shall have a minimum diameter of eighteen (18) inches. The maximum allowable diameter is six feet (6') unless otherwise approved.

H. Storm Sewer Capacity and Velocity

1. Storm sewers should be designed to convey the design storm (25-year) flood peaks without surcharging the storm sewer. The sewer may be surcharged during larger floods and under special conditions when approved by the City. However, new public improvements shall be designed to detain the 100-year storm in a detention basin. Therefore, the 100-year storm must be conveyed to the detention basin without bypass flow.

2. The capacity and velocity shall be based on the Manning's n-values presented in Table I. The maximum full flow velocity shall be less than fifteen (15) fps. The City may approve higher velocities if the design includes adequate provisions for uplift forces, dynamic impact forces and abrasion. The minimum velocity in a pipe based on full flow shall be 2.5 fps and the minimum slope shall be 0.50% to avoid excessive accumulations of sediment.

3. The energy grade line (EGL) for the design flow shall be no more than six (6) inches below the final grade at manholes, inlets, or other junctions. To insure that this objective is achieved, the hydraulic grade line (HGL) and the energy grade line (EGL) shall be calculated by accounting for pipe friction losses and pipe form losses. Total hydraulic losses will include friction, expansion, contraction, bend, manhole, and junction losses. The methods for estimating these losses are presented in the following sections.

I. Storm Sewer Outlets: All storm sewer outlets into open channels shall be constructed with a headwall and wingwalls or a flared-end-section. Flared end sections and headwalls shall have a toewall extending a minimum of eighteen inches (18") below grade at their downstream end to prevent undercutting.

Approved energy dissipation material shall be provided at all outlets.

J. Hydraulic Evaluation: Presented in this section are the general procedures for hydraulic design and evaluation of storm sewers.

K. Pipe Friction Losses: Pipe friction losses are estimated using Equation 1001 and Manning's formula (Equation 1002) which is expressed as follows:

$$\begin{aligned} H_f &= S_f \times L \quad (1001) \\ \text{Where } H_f &= \text{head loss due to friction (feet)} \\ S_f &= \text{friction slope from Manning's equation (feet per foot)} \\ L &= \text{length of pipe segment (feet)} \\ \text{and } V &= 1.49 \times R^{2/3} \times S_f^{1/2} / n \quad (1002) \\ \text{Where } V &= \text{velocity of flow (feet per second)} \\ R &= \text{hydraulic radius} = A/ WP \text{ (feet)} \\ S_f &= \text{friction slope (feet per foot)} \\ A &= \text{area of flow (square feet)} \\ WP &= \text{wetted perimeter (feet)} \\ n &= \text{Manning's roughness coefficient (Table I)} \end{aligned}$$

L. Pipe Form Losses: Generally, between the inlet and outlet, the flow encounters, in the flow passageway, a variety of configuration such as changes in pipe size, branches, bends, junctions, expansions and contractions. These shape variations impose losses in addition to those resulting from pipe friction. Form losses are the result of fully developed turbulence and can be expressed as follows:

$$\begin{aligned} HL &= K (V^2/2g) \quad (1003) \\ \text{Where } HL &= \text{head loss (feet)} \\ K &= \text{loss coefficient} \\ V^2/2g &= \text{velocity head (feet)} \\ g &= \text{gravitational acceleration (32.2 ft/sec}^2) \end{aligned}$$

The following is a discussion of a few of the common types of form losses encountered in storm design.

M. Expansion Losses: Expansion losses in a storm sewer will occur when the sewer outlets into a channel. The expansion will result in a shearing action between the incoming high velocity jet and the surrounding outlet boundary. As a result, much of the kinetic energy is dissipated by eddy currents and turbulence. The head loss can be expressed as:

$$\begin{aligned} HL &= K_x (V_1^2/2g) (1-(A_1/A_2))^2 \quad (1004) \\ \text{Where } A &= \text{cross section area in square feet} \\ V_1 &= \text{average upstream pipe flow velocity, feet per second} \\ K_x &= \text{expansion loss coefficient} \end{aligned}$$

Subscripts 1 and 2 denote the upstream and downstream sections respectively. The value of K_x is about 1.0 for a sudden expansion (such as an outlet to a channel) and about 0.2 for a well-designed expansion transition. Table II presents the expansion loss coefficient for various flow conditions.

N. Contraction Losses: The form loss due to contraction is:

$$\begin{array}{lcl} \text{HL} & = & K_c (V_2^2/2g) (1-(A_2/A_1)^2)^2 \quad (1005) \\ \text{Where } K_c & = & \text{Contraction loss coefficient} \end{array}$$

K_c is equal to 0.5 for a sudden contraction and about 0.1 for a well-designed transition.

Subscripts 1 and 2 denote the upstream and downstream sections respectively. Table II presents the contraction loss coefficient for various flow conditions.

O. Bend Losses: The head losses for bends, in excess of that caused by an equivalent length of straight pipe, may be expressed by the relation:

$$\begin{array}{lcl} \text{HL} & = & K_b (V_2^2/2g) \quad (1006) \\ \text{Where } K_b & = & \text{Bend coefficient} \end{array}$$

The bend coefficient has been found to be a function of: (a) the ratio of the radius of curvature of the bend to the width of the conduit, (b) deflection angle of the conduit, (c) geometry of the cross section of flow, and (d) the Reynolds Number and relative roughness. Recommended bend loss coefficients for standard bends, radius pipe, and bends through manholes are presented in Table II.

P. Junction and Manhole Losses: A junction occurs where one or more branch sewers enter a main sewer, usually at manholes. The hydraulic design of a junction is in effect the design of two or more transitions, one for each flow path. Allowances should be made for head loss due to the impact at junctions. The head loss at a junction for each pipe entering the junction can be calculated from:

$$\begin{array}{lcl} \text{HL} & = & (V_2^2/2g) = K_j (V_1^2/2g) \quad (1007) \\ \text{Where } V_2 & = & \text{the outfall flow velocity} \\ V_1 & = & \text{the inlet velocity} \\ K_j & = & \text{junction loss coefficient} \end{array}$$

Because of the difficulty in evaluating hydraulic losses at junctions (Reference 6) due to the many complex conditions involving pipe size, geometry of the junction and flow combinations, a simplified table of loss coefficients has been prepared. Table II presents the recommended energy loss coefficients for typical manhole or junction conditions encountered in the urban storm sewer system.

Q. Partially Full Pipe Flow: When a storm sewer is not flowing full, the sewer acts like an open channel and the hydraulic properties can be calculated using open channel flow.

R. Storm Sewer Outlets: When the storm sewer system discharges into an open channel, additional losses, in the form of expansions losses, occur at the outlet. For a headwall and no wingwalls, the loss coefficient K_e is 1.0. For a headwall with 45 degree wingwalls, the loss coefficient is about 1.14. For a flared-end-section (which has a D_2/D_1 ratio of 2 and a theta angle of around 30 degrees) the loss coefficient is approximately 0.5.

S. Connection Pipes: Connector pipes are used to convey runoff from an inlet to the storm sewer. If, however, the storm sewer runs through the inlet, then a connector pipe is not needed. Connector pipes can connect a single inlet to the storm sewer or they can be connected in a series.

These bends, turns, and flows through the connector pipe give rise to three hydraulic losses: a change from static to kinetic energy to get the water moving through the connector pipe, an entrance loss from the inlet to the connector pipe, and a friction loss along the length of the connector pipe. The total head loss in the connector pipe can be calculated from the following equation:

$$H_{cp} = H_v + K_e \times H_v + S_f \times L \quad (1009)$$

Where H_{cp} = head loss in the connector pipe (feet)
 K_e = Entrance loss coefficient.
 H_v = velocity head in the pipe, assuming full pipe flow (feet),

and the other variables are as previously defined. The value of the entrance loss coefficient is determined from Table II.

If the connector pipes are connected in series, the head loss in each pipe is calculated from Equation 1009 and the total head loss is the summation of the individual head losses.

5.12.2. Easements

A. Drainage easements shall be provided for all public drainage flowing across any proposed development. Generally, private, onsite drainage does not require a drainage easement. In some cases, additional drainage improvements and easements may be required upstream or downstream of a new development to address potential impacts of the development. The required easement widths are as follows, but shall not be less than 15' width. These requirements are assuming that the storm sewer is centered within the easement. Additional width may be required as determined by the Director of Public Works:

1. For pipes forty-two (42) inches or less in diameter or width, the required minimum easement width is fifteen (15) feet.
2. For pipes and boxes greater than forty-two (42) inches in width, the required minimum easement width is ten (10) feet plus the width of the proposed storm sewer, but shall not be less than 20' width.
3. Storm sewers greater than eight (8) feet in depth to the flow line may require additional easement width.
4. All easements required for construction of storm sewers, which are not included on the final plat, shall be recorded and a copy of such recorded easement filed with the City prior to approval of the engineering design plans.

Section 5.13 Design Standards for Culverts

5.13.1. **Horizontal Alignment.** Culverts shall be positioned to match the alignment of the existing watercourse to the greatest degree practical. Relocating existing stream channels to match the culvert alignment shall be avoided unless specifically approved.

5.13.2. Vertical Alignment. Culverts shall be placed such that the vertical alignment of the invert matches the slope of the existing water course to the greatest extent practical. The recommended minimum slope for culverts is 0.5% (five-tenths percent). Culvert grades may not be less than the minimum friction slope required to convey the design flow, unless specifically approved. Maximum recommended grade is 10% (ten percent). The top of the culvert pipe shall be located a minimum of twelve inches (12") below the pavement or curb subgrade, or greater if required to meet minimum cover and strength requirements to withstand an AASHTO HS-20 loading for the type of pipe specified. A reduction in minimum clearance may be allowed when necessary in order to minimize rock excavation or to provide clearance from existing utilities, with written approval by the Public Works Director and if located within public road right-of-way, written approval from the Highway Administrator is also required. Where necessary to minimize rock excavation, cast-in-place reinforced concrete box culverts may be designed such that the top slab serves as a bridge deck. In these cases, the top slab grade shall be designed to match the vertical alignment of the roadway. Top slab thickness shall be increased by two inches (2") to provide a wearing surface. If asphalt pavement is specified, top of the slab may be located two inches (2") below finished pavement grade to allow for placement of an asphalt wearing surface. Structural design of the culvert shall include allowance for the wearing surface weight.

5.13.3. Bends and Junctions. Changes in direction, grade, size or material are not allowed within the culvert barrel, unless approved in writing by the Public Works Director.

5.13.4. Clearance from Other Utilities. Clearance from other utilities shall be the same as specified for storm sewers.

5.13.5. Allowable Sizes. The minimum allowable inside diameter or least dimension for any culvert is fifteen inches (15").

5.13.6. Construction Materials. Culverts under public and private roads shall be constructed of any of the materials allowed for storm sewers.

5.13.7. Design Capacity. Culverts shall be designed to pass the 25-year storm with one (1) foot of freeboard prior to overtopping the road or driveway.

5.13.8. Headwater. The maximum headwater for the major storm design flow shall be 1.5 times the culvert diameter for round culverts or 1.5 times the culvert rise dimension for shapes other than round.

5.13.9. Inlet and Outlet Requirements. Culverts are to be designed with protection at the inlet and outlet areas as provided in Part VI of these criteria. A cast-in-place concrete headwall or a pre-fabricated flared end section of the same type of material as the culvert pipe shall be provided at the inlet and outlet ends of all culverts. Headwalls or end sections are to be located a sufficient distance from the edge of the shoulder or the back of walk to allow for a maximum slope of 3H:1V to the back of the structure. Flared end sections and headwalls shall have a toewall extending a minimum of eighteen inches (18") below grade at the downstream end to prevent undercutting. The type of outlet protection required is as follows:

$V < 7 \text{ FPS}$	$7 \text{ FPS} < V < 15 \text{ FPS}$	$V > 15 \text{ FPS}$
Minimum	Channel protection	Energy Dissipator
Channel protection	or Energy dissipator	

5.13.10. Velocity Limitations. The maximum allowable discharge velocity is fifteen (15) feet per second.

5.13.11. **Culvert Hydraulics.** It is recommended that the procedures outlined in the publication "Hydraulic Design of Highway Culverts" (Reference 4) be used for the hydraulic design of culverts. Backwater calculations demonstrating the backwater effects of the culvert may be required.

Section 5.14 Design Standards for Bridges

5.14.1. **Structural Design.** All bridges shall be designed to withstand an HS-20 loading in accordance with the design procedures of AASHTO "Standard Specifications for Highway Bridges" (Reference 13). The designer shall also check the construction loads and utilize the most severe loading condition.

5.14.2. **Design Capacity.** Bridges shall be designed to pass the major storm with one foot of freeboard between the 100-year water surface elevation and the bridge low chord.

5.14.3. **Backwater.** Backwater is defined as the rise in the water surface due to the constriction created by the bridge approach road fills. The maximum backwater for the major storm design flow shall be one (1) foot.

5.14.4. **Velocity Limitations.** Discharge velocities through bridge openings shall be limited to fifteen (15) feet per second. Abutment and channel scour protection shall be provided at all bridges.

5.14.5. **Bridge Hydraulics.** All bridge hydraulics shall be evaluated using the procedures presented in the publication "Hydraulics of Bridge Waterway" (Reference 14). Backwater calculations demonstrating the effects of the bridge and approach fills compared to the existing flood stages shall be submitted for all bridges.

Section 5.15 Design Standards for Open Channels

5.15.1. General Design Guidelines

A. Natural or Existing Manmade Channels;

1. The stream channel of perennially flowing streams or intermittent streams which are blue lined streams on the United States Department of the Interior Geological Ozark, Nixa or Selmore Quadrangles shall not be modified or channelized except where unavoidable to construct road crossings or to repair erosion and stabilize the stream channel. A 404 permit or determination is required to place any fill in a blue lined stream to construct a road crossing.

2. Trees and vegetation shall not be removed within twenty-five feet (25') of the stream bank of a blue lined stream. If the stream banks are not defined, then the twenty-five feet (25') shall be taken from the invert of the blue lined stream. Clearing of brush and undergrowth shall be minimal. It is preferred that existing vegetation remain within one hundred feet (100') of the stream bank.

3. Any work within a Federally designated floodplain requires a Floodplain Development Permit. A Conditional Letter of Map Revision (CLOMR) must be obtained for any filling within the floodway. Work within the stream channel may require a Department of the Army "404" permit.

4. Watercourses in which flow is broad and shallow, and which have no defined channel should not be modified or channelized. Removal of trees and vegetation within the watercourse should be avoided as much as practical.

5. The area inundated by the peak flow from the 100-year (1% AEP) storm is considered to be the flooding area for any watercourse, whether or not it is designated on the Flood Insurance Rate Maps. An implicit drainage easement is considered to exist along the area inundated by the peak flow from the 1% AEP (100-year) storm.
6. For the purpose of preliminary planning and design, the approximate limits of the floodplain can be determined using approximate methods.
7. In determining the capacity and depth of flow in watercourses, they shall be analyzed by selecting the most restrictive channel section for each reach and determining the normal depth by analyzing the channel as an irregular section using representative "n" values for each segment of the channel cross-section
8. Where the effects of increased frequency of flow or increased velocity may significantly effect the stability or the stream channel, measures such as grade checks, check dams or bank stabilization may be required.

B. Grass Lined Channels:

1. Grass lined channels are the most desirable of the artificial channels. The channel storage, lower velocities and the greenbelt multiple use benefits obtained create significant advantages over other artificial channels. Unless existing development restricts the availability of right of way, channels lined with grass should be given preference over other artificial types. The minimum slope in a grass-lined channel shall be 1.0% unless a concrete low flow channel is installed. Maximum side slopes shall be 3:1 with 4:1 preferred.

C. Low Flow (Trickle) Channels

1. Trickle channels shall be provided in constructed grass channels (not natural channels) where base flow or perennial flow prevents the establishment or re-establishment of a sod bottom. Types of trickle channels are as follows:

a. Concrete Trickle Channels

- (1). Trickle channel capacity shall be approximately five percent (5%) of the design flow rate.
- (2). Concrete trickle channels may be unreinforced up to a total width of (5') five feet. For total widths of (5') five feet to (10') ten feet the trickle channel shall be reinforced with 6 X 6-10-10 welded wire mesh. For widths greater than (10') ten feet see requirements for concrete channels.
- (3). Trickle channel alignment shall be the same as the overall channel alignment. Radii at changes in direction shall be the minimum radius required based upon the channel top width.
- (4). Capacity of grass channels with trickle channels may be determined as a composite cross-section, or the additional capacity of the trickle channel can be ignored.
- (5). Erosion potential at the grass/concrete interface should be checked. Shear stress or tractive force shall be determined and shall be limited to the maximum values set forth below:

Maximum Allowable Shear Stress for Various Lining Types

<u>Lining Type</u>	<u>Maximum Shear Stress</u>
Grass, sod	0.60 psf
Jute fiber net	0.40 psf
Straw erosion control blanket with attached netting	1.45 psf
Excelsior (wood fiber) erosion control blanket with netting	1.55 psf
Synthetic erosion control blanket	2.00 psf

Foregoing values were obtained from Table 9.5 of the ASCE Design Manual
Manufacturer's data shall be submitted for erosion control blankets specified.

b. Other Types of Trickle Channels

(1). Trickle channels of porous pavers, gravel filled Geoweb, submerged flow wetlands, natural stone and other materials can be specified, and are encouraged to improve aesthetics and water quality. However, assurance must be given that quality control will be maintained during construction and that adequate maintenance will be provided after construction.

D. Composite Channels

1. Many different channel shapes and lining types are possible. Different shapes and lining types can be combined in a composite design. In determining the capacity and depth of flow in composite channels, they shall be analyzed as an irregular section using representative "n" values for each segment of the channel cross-section

E. Concrete Channels

1. Concrete lined channels are sometimes required where right of way restrictions within existing development prohibit grass-lined channels. The lining must be designed to withstand the various forces and actions that tend to overtop the bank, deteriorate the lining, erode the soil beneath the lining and erode unlined areas. The minimum slope in a concrete lined channel shall be 0.50%.

F. Other Lining Types: The use of fabrics and other synthetic materials for channel linings has increased over the past several years. Proposed improvements of this type will be reviewed on an individual basis for applicability and performance.

5.15.2. Hydraulics

A. An open channel is a conduit in which water flows with a free surface. The calculations for uniform and gradually varied flow are relatively straight forward and are based upon similar assumptions (e.g. parallel streamlines). The basic equations and computational procedures are presented in this section.

B. Uniform Flow

1. Open channel flow is said to be uniform if the depth of flow is the same at every section of the channel. For a given channel geometry, roughness, discharge and slope, there is only one possible depth, the normal depth. For a channel of uniform cross section, the water surface will be parallel to the channel bottom for uniform flow.

2. The computation of normal depth for uniform flow shall be based upon Manning's formula as follows:

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

Where Q = Discharge in cubic feet per second (cfs)
n = Roughness coefficient (Table I)
A = Cross sectional flow area in square feet
R = Hydraulic radius, A/P, in feet
P = Wetted perimeter in feet
S = Slope of the energy grade line (EGL) in feet/foot

For channels with a uniform cross section the EGL slope and the bottom slope are assumed to be the same.

C. Critical Flow

1. The design of earth or rock channels in the critical flow regime (Froude numbers from 0.9 to 1.2) is not permitted. The Froude number is defined as follows:

$$F = V/(gD)^{0.5}$$

Where F = Froude number
V = Velocity in feet per second (fps)
g = Acceleration of gravity, 32.2 ft/sec²
D = Hydraulic depth in feet = A/T
A = Cross sectional flow area in square feet
T = Top width of flow area in feet

The Froude number shall be calculated for the design of all open channels.

D. Gradually Varied Flow

1. The most common occurrence of gradually varied flow in storm drainage is the backwater created by culverts, storm sewer inlets or channel constrictions. For these conditions the flow depth will be greater than normal depth in the channel and the water surface profile must be computed using backwater techniques.

2. Backwater computations can be made using the methods presented in Chow (Reference 1). Many computer programs are available for computation of backwater curves. The most widely used program is HEC-2, Water Surface Profiles, developed by the U.S. Army Corps of Engineers (Reference 2) and is the program recommended for backwater profile computations. Another program by the Federal Highway Administration is WSPRO and is acceptable for use in backwater computations.

5.15.3. Design Standards

A. Flow Velocity

1. Maximum flow velocities shall not exceed the following:

Channel Type	Maximum Velocity
Grass lined*	5 fps
Concrete	15 fps
*Refer to sub-section F below	

B. Maximum Depth

1. The maximum allowable channel depth of flow is three (3) feet for the design flow.

C. Freeboard requirements

1. Freeboard is defined as the vertical distance between the computed water surface elevation for the design flow and the minimum top of bank elevation for a given cross section.
2. For all channels, one-foot minimum of freeboard is required. Freeboard shall be in addition to super elevation.

D. Curvature

1. The minimum channel centerline radius shall be three (3) times the top width of the design flow.

E. Super Elevation

1. Super elevation shall be calculated for all curves. An approximation of the super elevation h may be calculated from the following formula:

$$h = \frac{V^2 T}{gr}$$

Where h = Super elevation in feet
 V = Velocity in fps
 T = Top width of flow area in feet
 g = Acceleration of gravity, 32.2 ft/sec²
 r = radius of curvature in feet

2. Freeboard shall be measured above the super elevated water surface.

F. Grass Channels

1. Side slopes shall be 3 (horizontal) to 1 (vertical) or flatter. Steeper slopes may be used subject to additional erosion protection and approval from the Public Works Director.
2. For design discharges greater than 50 cfs, grade checks shall be provided at a maximum of 200 feet horizontal spacing.

3. Channel drops shall be provided as necessary to control the design velocities within acceptable limits.
4. Vertical drops may be used up to three feet in height. Drops greater than three (3) feet shall be baffled chutes or similar structures.
5. Manning's roughness coefficient ("n", also known as the retardance coefficient) for grass channels shall be determined based upon the product of the velocity and the hydraulic radius ($V \times R$) using the chart shown in Mannings's n for grass-lined slopes. Retardance curve C shall be used to determine the channel capacity and Retardance curve D shall be used to determine the velocity.

5.15.4. Easements

- A. Easements shall be provided for all open channels constructed in the City that are not located within public rights-of-way. The minimum easement width for open channels is the flow width inundated by a 100-year event plus fifteen (15) feet. Additional width may be required as determined by the Director of Public Works.
- B. All easements required for construction of open channel drainageways, which are not included on the final plat, shall be recorded and a copy of such recorded easements filed with the City prior to approval of the engineering design plans.

PART IV - STORM WATER DETENTION DESIGN

Section 5.16 Purpose

5.16.1. Detention facilities are used to reduce storm water runoff rates by storing excess runoff. The usual function of a detention facility is to provide sufficient storage such that peak runoff rates are not increased when development occurs.

Section 5.17 Policy

5.17.1. The primary goal of the City's storm water management program is the prevention of flood damage to residential, commercial and public property.

5.17.2. In adopting this policy, the City recognizes that:

- A. There are many areas in the City where residential flooding occurs because of inadequately sized drainage ways,
- B. Flooding depths and frequency will increase as development occurs upstream of these areas,
- C. Detention basins are the only effective "on-site" means which can be used to control peak runoff storm water rates as areas develop.

5.17.3. The City further recognizes that:

- A. The best means to assure effective performance of a detention basin is to perform reservoir routing calculations using hydrographs, The Simplified Volume Formula shall not be allowed in the City.

Section 5.18 Methods of Analysis

5.18.1. A detailed analysis using the hydrographs provided in Section 5.10 is required. The director of Public Works (at his discretion) may permit detention volume calculations for small increases in impervious areas to be determined from the table provided in the "payment in Lieu of Constructing Stormwater Detention table".

5.18.2. Innovation in design

- A. It is the desire of the City that detention facilities be designed and constructed in a manner to enhance aesthetic and environmental quality of the City as much as possible. The City therefore encourages designs, which utilize and enhance natural settings, and minimize disturbance and destruction of wooded areas, natural channels, and wetlands.

5.18.3. Interpretation

- A. The Public Works Director will make interpretations of the detention policy. Appeals of the decisions of the Public Works Director may be made to the Board of Aldermen.

Section 5.19 Design Criteria

5.19.1. General

- A. Detention facilities shall discharge into a drainage easement or public right-of-way. The detention facility and all required energy dissipation at the discharge shall be located within the proposed development. The discharge point of the detention facility, including area for energy dissipation and erosion control shall not be located within 20' of the development's property line.
- B. One (1) foot of freeboard shall be provided between the maximum water surface elevation (maximum stage for a 1% annual probability event) and the minimum top of berm or wall elevation.
- C. Embankment slopes steeper than three horizontal to one vertical (3H:1V) are not permitted.
- D. Concrete walls shall not be substituted for earth berms unless otherwise approved by the Public Works Director.
- E. Dry detention basins shall maintain a minimum bottom slope of one foot per hundred feet (1%).
- F. Any detention basin or channel shall not be located closer than twenty (20) feet horizontally from any building and the maximum water surface elevation shall be at least three (3) feet below the lowest sill plate elevation of any building. For this application the horizontal limits of the detention basin shall be defined as the outside face of the crest of the berm.
- G. Trickle channels shall have a minimum slope of one foot per hundred feet (1.0%) for unpaved channels and one-half foot per hundred feet (0.5%) for paved channels.
- H. The maximum allowable depth of ponding for parking lot detention is eighteen (18) inches.
- I. Parking lot detention may not inundate more than ten (10) percent of the total parking area.
 - 1. All parking lot detention areas shall have a minimum of two (2) signs posted identifying the detention pond area. Any suitable materials and geometry of the sign are permissible, subject to approval by the Public Works Director. The signs shall have a minimum area of 1.5 square feet and contain the following message: "WARNING This area is a storm water detention pond and is subject to periodic flooding to a depth of 18 inches".

5.19.2. Detailed Analysis

- A. Detailed analysis shall be performed using hydrograph methodologies and reservoir routing techniques. The most common techniques are those developed by the Corps of Engineers and the Soil Conservation Service. These methods are preferred; however other proven techniques will be accepted.
- B. Detention basins designed by detailed methods shall be designed on the basis of multiple storm recurrence frequencies to ensure that they function properly for both frequent storms and large infrequent storms.
 - 1. A minimum of three (3) recurrence frequencies, the 50%, 10% and 1% annual probability storms (the "2-year, 10-year and 100-year" storms) must be considered.

C. The runoff model must include the entire drainage basin upstream of the proposed detention pond. The model shall be prepared in sufficient detail to ensure that peak runoff rates are reasonably accurate. The runoff model shall be developed for the following cases:

1. Case 1: Existing conditions in the drainage basin prior to development of the applicant's property.
2. Case 2: Existing conditions in the drainage basin with developed conditions on the applicant's property.
3. Case 3: Fully developed conditions in the entire drainage basin.
4. Cases 1 & 2 are utilized to determine the required detention volume and the type of outlet structure to be provided, and shall be analyzed for the three storm recurrence frequencies required above.
5. The detention facility shall be designed such that peak outflow rates from the facility for Case 2 are no greater than the rates determined in Case 1 for each of the three storm recurrence frequencies required.
6. The storage volume provided shall not be less than the difference in total runoff volume between Case 1 and Case 2.
7. Case 3 is used determine the size of the overflow spillway. Case 3 need only be analyzed for the 1% annual probability ("100-year"). The overflow spillway will, in most cases, be combined with the outlet structure.

5.19.3. Submittals

A. The following information must be submitted for detention ponds designed by detailed methods:

1. Information regarding analytical methods and software to be used, including:

- a. Name of software to be used.
- b. Type and distribution of precipitation input.
- c. Method for determining precipitation losses.
- d. Type of synthetic hydrograph.
- e. Method for routing hydrographs.
- f. Method used for reservoir routing.

B. Map(s) showing sub-basin delineation, topography, presumed flow routes, and pertinent points of interest; soil types; existing basin development conditions used in the model; fully developed conditions used in the model.

C. Routing diagram for the runoff model.

D. A summary of sub-basin characteristics used for program input.

E. Stage-area or stage-storage characteristics for the basin in tabular or graphic form.

F. Stage-discharge characteristics for the outlet structure and overflow spillway in tabular or graphic form; hydraulic data for weirs, orifices, and other components of the control structure.

G. A printout of the input data file.

H. A summary printout of program output, including plots of hydrographs (these are intended to be the printer plots generated by the software).

I. A computer generated soil survey should be provided from the USDA following site; (<http://websoilsurvey.sc.egov.usda.gov/App/HomePage.htm>). The soils data should be submitted as a Hydrologic Soil Group report. Submitting data from the old USDA soils survey books is not permitted as the soils data is not updated on the website.

5.19.4. Easements

A. All detention basins serving more than one (1) lot or property shall be located within a drainage easement. At a minimum, the easement shall include the area of the dam, the area downstream of the dam to a point twenty feet (20') downstream of the end of the outlet structure, including the area provided for erosion control or energy dissipation; and the area covered by the reservoir including freeboard, plus an additional twenty feet (20') around the perimeter. Detention basins for a development may be located on adjoining property downstream from the development provided that a drainage easement is obtained and adequate means of maintenance access (including ingress/egress easements where necessary) is provided. The easement shall be granted to the developer or to property owners' association. Where the detention basin does not immediately adjoin the development, a drainage easement covering the area inundated by the peak flow from the 1% AEP (100-year) storm shall be provided to connect the development site with the detention basin.

5.19.5. Construction Requirements

A. Dams shall be constructed of properly compacted earth fill and shall be keyed a minimum of two feet, (2') into existing ground.

B. Minimum embankment width at top of dam shall be three feet, (3')

C. Concrete retaining walls used at outlet structures or spillways and that exceed 3'-6" in height shall be provided with four foot, (4') high chain link or solid fence.

D. Spillways and outlet structures shall be provided with toewalls extending eighteen inches, (18") below finish grade at upstream and downstream ends to prevent undercutting.

E. Where wet ponds are specified; the pond lining must be designed to retain water. Site soil conditions shall be evaluated by a soils engineer and an appropriate lining to be provided.

5.19.6. Payment in Lieu of Constructing Stormwater Detention

A. The City may accept payment in lieu of constructing Storm Water Detention, as required in Part IV of this regulation, provided that one of the following conditions exists:

1. The property directly discharges into a FEMA flood plain; or

2. The property discharges into public facilities which were designed to convey the developments fully developed flow to an existing FEMA flood plain.

B. The Developer shall submit a completed application for payment in lieu of constructing stormwater detention on a form provided by the Department of Public Works. The Developer's engineer must provide a downstream impact analysis which shows that downstream properties will not receive increased flooding as part of the proposed payment in lieu of constructing storm water detention.

C. If the City approves the application, payment in lieu of detention will be based on the rates set forth in Section 4 of the Application for Payment In Lieu of Construction Storm Water Detention.

D. Approval of an application for Payments In Lieu of Detention is not guaranteed and all applications will be reviewed by the City's engineer and approved by the City on a case by case basis. Approval will be based upon the amount of discharge and the potential impact upon downstream properties. The City reserves the right to require detention on any site it determines will have an adverse impact upon downstream properties.

E. "Water Quality" as defined in Part V of this regulation is required on all sites regardless of whether detention is provided.

PART V - WATER QUALITY PROTECTION

SECTION 5.20 Purpose

5.20.1. This section covers the design of Best Management Practices (BMPs) to minimize the adverse effects of urban stormwater runoff on the quality of receiving waters. This policy applies to all developments in the residential, commercial, office, and industrial zoning districts It does not apply to A-1, Agriculture District.

5.20.2. It is recognized that specific water quality standards, other than those contained in the Missouri Clean Water Laws, have not been developed or adopted for the receiving waters. The objective of this policy is not to meet specific reductions of targeted pollutants, but rather to provide a generally effective level of pollutant removal by using reasonable, cost effective measures. The goal is to minimize, to the maximum extent practical, adverse impacts on the quality of the receiving waters.

SECTION 5.21 The Role of On-site Water Quality Management Practices

5.21.1. It is important to recognize that the *structural Best Management Practices* (BMPs) for which design guidance is given in this section represent only one aspect of stormwater quality management. The most effective means of managing stormwater quality lie in overall watershed planning and zoning controls, and other *nonstructural* practices which are generally beyond the control of an individual development.

5.21.2. It is clear that a strategy based upon full development in a watershed, with reliance solely upon structural BMP's to maintain water quality, will not be successful. A combination of non-structural and structural measures was recommended as the best means to manage the impacts of development on water quality.

5.21.3. Data from communities across the country has shown that, as the total impervious area in a watershed exceeds ten to fifteen percent (10-15%), water quality declines unless mitigative measures are taken. The most important management tool is to limit the impervious area in these watersheds to these values. While these limits may be attainable for the watershed as a whole, they may not be possible for individual development or sub-basins. Structural BMP's will be required for these developments.

SECTION 5.22 General Design Guidelines

5.22.1. Minimize the amount of runoff.

A. The total quantity of pollutants transported to receiving waters can be minimized most effectively by minimizing the amount of runoff. Both the quantity of runoff and the amount of pollutant wash-off can be minimized by reducing the amount of *directly connected impervious area (DCIA)*. Impervious areas are considered connected when runoff travels directly from roofs, drives, pavement, and other impervious areas to street gutters, closed storm drains or concrete, or other impervious lined channels. Impervious areas are considered disconnected when runoff passes as sheet flow over grass areas, or through properly designed BMP's, prior to discharge from the site.

5.22.2. Maximize contact with grass and soil.

A. The opportunity for pollutants to settle out is maximized by providing maximum contact with grass and soil. Directing runoff over vegetative filter strips and grass swales enhances settling of pollutants as the velocity of flow is reduced. Infiltration of runoff into the soil is also increased.

5.22.3. Maximize holding and settling time.

A. According to ASCE (Reference 115.2), the most effective runoff quality controls reduce the runoff peak and volume. The next most effective controls reduce peak runoff rates only. For small storms the runoff rate should not exceed the pre-project peak flow rate from the fifty percent (50%) AEP (2-year) storm. Most obnoxious pollutants (exceptions include water soluble nutrients and metals) can be settled out.

B. By reducing the rate of outflow and increasing the time of detention storage, settling of pollutants and infiltration of runoff is maximized.

5.22.4. Design for small, frequent storms.

A. Drainage systems for *flood control* are designed for large, infrequent storm events. In contrast, stormwater quality controls must be designed for small, frequent storm events. In the City ninety percent (90%) of all twenty-four (24) hour rainfalls are one inch (1") or less. Most pollutants are washed off in the "first flush", generally considered the first one-half inch (½") of runoff.

5.22.5. Utilize BMP's in series where possible.

A. Performance monitoring of BMP's in Florida, Maryland, and Delaware has shown that the combined effect of providing several BMP's in a series can be much more effective in reducing the level of pollutants than providing a single BMP at the point of discharge. To the greatest extent practical, runoff should be directed first to vegetative filter strips, then to grass swales or channels, and then to extended detention basins, sand filters, etc.

5.22.6. Incorporate both flood control and water quality objectives in designs, where practical.

A. Incorporating both flood control and water quality criteria into a single stormwater management facility is not only possible, but is encouraged. Whenever practical, combining several objectives, such as water quality enhancement and flood control, maximizes the cost- effectiveness of stormwater management facilities.

SECTION 5.23 Requirements

5.23.1 The following requirements will apply to any new development within the City's watersheds:

A. Water quality BMP's are required on all sites that increase the amount of impervious area. Stormwater runoff from any new development for which the total impervious area exceeds ten percent (10%) of the total land area of the development, must be directed through an extended wet or dry detention basin or other properly designed BMP, prior to discharge from the site. Stormwater runoff from any new development for which the total impervious area does not exceed ten percent (10%) of the total land area of the development may employ BMP's which do not provide the water quality capture volume described in the following regulations. The intent is to allow flexibility for small increases for a site specific design of water quality. For instance, saving a row of trees along a border, or providing a vegetative filter strip that drains to a relatively flat ditch could be substituted for a dry detention basin or other designed BMP.

B. Runoff from fueling areas & other areas having a high concentration of pollutants will be required to be directed to a sand filter or other properly designed BMP which provides filtration as well as settling.

C. The required volume for capture and treatment shall be designed as the *water quality capture volume* (WQCV), and shall be determined as set forth in Section 5.24.1.

D. Detention storage must be provided to limit the peak flow rate from the fifty percent (50%) AEP (2-year) storm to pre-project values. Detention facilities for peak flow control shall be designed as set forth in Part IV.

SECTION 5.24 Design Criteria

5.24.1. Water Quality Capture Volume

A. Water quality BMPs shall be designed to capture the runoff from the 90th percentile rainfall for City as well as to capture the first flush of pollutants from directly connected impervious areas within the proposed development.

B. The required water quality capture volume (WQCV) to be used in design of extended wet and dry detention basins and other BMPs whose design is based upon capture and treatment of storm water shall be the greater of the following:

1. The first one-half inch ($\frac{1}{2}$ ") of runoff from the directly connected impervious area (DCIA) in the development, or
2. The *runoff* resulting from total rainfall depth of one inch (1") in twenty-four (24) hours over the entire development.

5.24.2. Directly Connected Impervious Area (DCIA)

A. Impervious areas are considered connected when runoff travels directly from roofs, drives, pavement, and other impervious areas to street gutters, closed storm drains or concrete, or other impervious lined channels. Connected and disconnected impervious areas are illustrated in Figure 5.1.

B. In order for an impervious area to be considered disconnected, runoff from the area must pass through a vegetative filter strip or other BMP meeting the requirements set forth in this section.

C. For determining the amount of impervious area, the following assumptions shall apply in the absence of more detailed data:

Single Family Lots

Average roof area:	2500 square feet
Average drive area:	800 square feet
Average impervious area per lot:	3500 square feet

If gutter downspouts are directed to drain toward lawn areas, seventy-five percent (75%) of the roof area shall be considered disconnected.

Duplexes and Patio Homes

Average roof area:	2500 square feet
Average drive area:	1600 square feet
Average impervious area per lot:	4500 square feet

If gutter downspouts are directed to drain toward lawn areas, seventy-five percent (75%) of the roof area shall be considered disconnected.

Multi-Family, Commercial and Other Areas

The amount of impervious area contained in multi-family, commercial, office and manufacturing developments shall be determined based upon the site plan for the development.

5.24.3. Vegetative Filter Strips

A. Vegetative filter strips consist either of areas of undisturbed vegetation in good condition, including trees, grass, sod or other vegetative cover which meets the objectives for this BMP, or areas where new vegetation has been established. Vegetative filter strips shall be provided in areas of sheet flow only. The hydraulic loading for filter strips shall not exceed 0.05 cfs per lineal foot of filter strip length for the fifty percent (50%) AEP (2-year) storm (equal to the runoff per unit width from a four hundred feet (400') length of impervious area).

B. The minimum width of the filter strip shall not be less than twenty percent (20%) of the length of the sheet flow from the upstream impervious surface, and in no case shall be less than six feet (6'). The slope along the width of the filter strip shall not exceed 4:1 (25%).

C. Typical details for vegetative filter strips are shown in Figure 5.2.

5.24.4. Grass Swales

A. Grass swales may be provided to convey runoff from vegetative filter strips and impervious areas to BMP's designed for capture and temporary storage of runoff. Design criteria for grass swales shall be as follows:

1. Maximum side slopes: 4:1.
2. Maximum longitudinal slope: 5%.
3. Minimum longitudinal slope: 1%.
4. Maximum velocity: 2 feet per second for peak flow from the 50% AEP (2-year) storm.

B. Roughness coefficients for use in the design of grass swales shall be determined as set forth in Manning's for Grass-Lined Channels.

C. Grass swales shall be lined with sod or seeded and covered with suitable erosion control blanket and mulch.

D. Typical details for grass swales are shown in Figure 5.3.

5.24.5. Extended Dry Detention Basins

A. Extended dry detention basins may be provided to capture and provide temporary storage for the required water quality capture volume. Extended dry detention basins shall be placed outside of the primary watercourses which allow off-site flows to pass through the development (i.e., "off-line") where possible.

B. Design criteria for extended dry detention basins shall be as follows:

C. Volume: Minimum volume shall be one hundred and twenty-five percent (125%) of the required water quality capture volume (WQCV). Detention basins for water quality may be combined with detention basins for flood control. Effects of the WQCV may be considered in the design for flood control.

D. Drain time: The WQCV shall be released over a minimum period of forty (40) hours and a maximum period of seventy-two (72) hours.

E. Outlet structure: Outlet structures shall consist of a perforated riser pipe, outlet pipe and gravel filter material as shown in Figure 5.4. The minimum allowable riser pipe diameter is eight inches (8"). The riser pipe shall be connected to an outlet pipe of equal or greater diameter. The outlet pipe shall have adequate capacity to carry the maximum rate of flow from the riser pipe. Material for the riser pipe shall be Schedule 40 PVC, ductile iron, or corrugated, galvanized metal. A removable cap shall be provided at the top of the riser pipe. The cap shall have a one inch (1") diameter hole for air relief.

F. The outlet pipe shall be bedded in firmly compacted clay, free of stones. For dams exceeding ten feet (10') in height, an anti-seep collar shall be provided around the pipe.

G. Number of rows of perforations, number of perforations per row and diameter of perforations for the riser pipe shall be specified on the plans. Perforation pattern shall be determined based upon orifice calculations to provide for release of the WQCV over the specified time. Perforations shall meet the following requirements:

Minimum perforation diameter:	1/4 inch
Maximum perforation diameter:	1 inch
Minimum number of holes per row:	4
Maximum number of holes per row:	8
Minimum row spacing:	4 inches
Maximum row spacing:	12 inches

H. Freeboard: Where the basin is to be utilized as a water quality BMP only, twelve inches (12") minimum freeboard shall be provided above the WCQV.

I. Forebay: It is preferred that a forebay be provided to dissipate energy from incoming flows and to trap settleable sediment entering the basin. The forebay should be separated from the remainder of the basin by an earth dike meeting the requirements of Section 5.19.6. The top of the dike shall be set six inches (6") above the stage of the WQCV. Outflow from the forebay to the basin shall be through a gravel filter meeting the requirements of Section 5.332 (See detail in Standard Drawing Details). The top of the gravel filter shall be set equal to the stage of the WQCV.

J. The volume of the forebay shall be a minimum of ten percent (10%) and a maximum of twenty percent (20%) of the WQCV. The volume of the forebay is considered to be part of the required WQCV, not additional volume.

K. General construction requirements: The optimal length to width ratio for a water quality detention basin is four (4). The length to width ratio should be no less than two (2). The minimum allowable length to width ratio is one (1). Side slopes, dams or dikes, and retaining walls shall meet the requirements of Section 112.6.

L. Overflow spillways: Where the basin is to be utilized as a water quality BMP only, a spillway or outlet structure meeting the requirements of Section 112.6.5 and capable of passing the peak flow from a 1% AEP (100-year) storm for the drainage area upstream of the basin, shall be provided. The lowest point on the spillway or outlet structure shall be set at the top of the WCQV.

M. Trickle channels: Trickle channels shall be provided to provide grade control and to minimize chronic wet areas. Trickle channels shall be constructed of six inch (6") stone or other porous medium. A typical trickle channel cross section is shown in Figure 5.5.

N. A typical plan and section for extended dry detention basins are shown in Figure 5.6.

5.24.6. Extended Wet Detention Basins

A. Extended wet detention basins may be provided to capture and provide temporary storage for the required water quality capture volume. Extended wet detention basins shall be placed outside of the primary watercourses which allow off-site flows to pass through the development (i.e., "off-line") where possible.

- B. Design criteria for extended wet detention basins shall be the same as for extended dry detention basins, with the following exceptions:
- C. The volume of the permanent pool should not be less than 1.0 to 1.5 times the WQCV.
- D. A bench area (littoral zone) with a width of ten feet (10') shall be provided as shown in Figure 5.7. It is preferred that emergent aquatic vegetation be provided in this zone.
- E. It is recommended that a minimum of twenty-five percent (25%) of the WQCV be provided in the upper eighteen inches (18") of depth. A maximum of fifty percent (50%) of the permanent pool volume shall be provided in the upper eighteen inches (18") of depth.
- F. Depth of the principal portion of the permanent pool shall be a minimum of four feet (4').
- G. It is preferred that a forebay meeting the same requirements as specified for dry detention basins, be provided.
- H. Where perforated riser pipes are not encased in gravel; only corrugated metal or ductile iron pipe may be used.
- I. Typical details for extended wet detention basins are shown in Figure 5.7.

5.24.7. Sand Filters

- A. Runoff from fueling plazas, vehicle maintenance areas, solid waste storage or transfer areas, and other areas having potentially high concentrations of contaminants shall be passed through a sand filter prior to discharge to receiving waters.
- B. Total impervious area draining to a sand filter will generally be one (1) acre or less. Sand filters shall be provided with a sedimentation chamber and a filtration chamber. Design of sand filters shall be based upon the Austin, Texas first flush filtration basin (full sedimentation design) as described in Debo and Reese pp. 596-598 (Reference 115.7). A schematic cross section of a sand filter is shown in Figure 5.8.

5.24.8. Other Structural BMPs

- A. Constructed wetlands, porous pavements and other structural BMPs for which detailed design criteria can be documented in generally accepted literature can be provided in addition to, or in lieu of, the BMPs described above, provided the objectives of this section can be met. The use of infiltration basins and trenches is discouraged due to possible adverse impacts on groundwater.

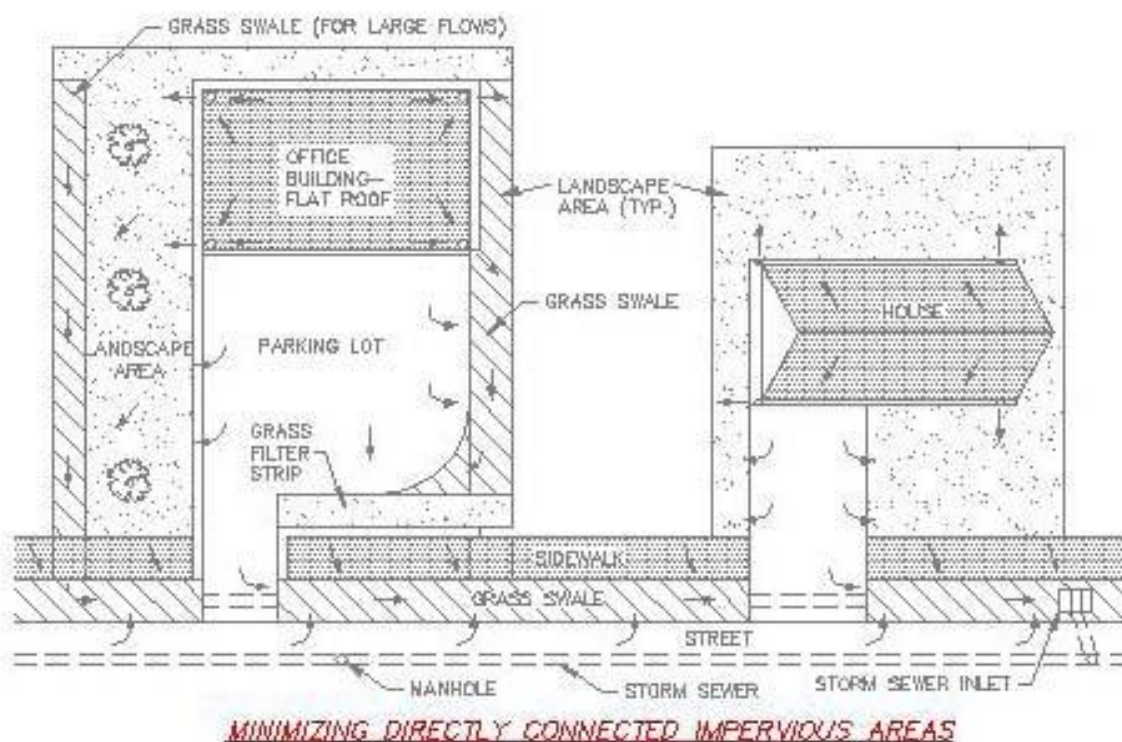
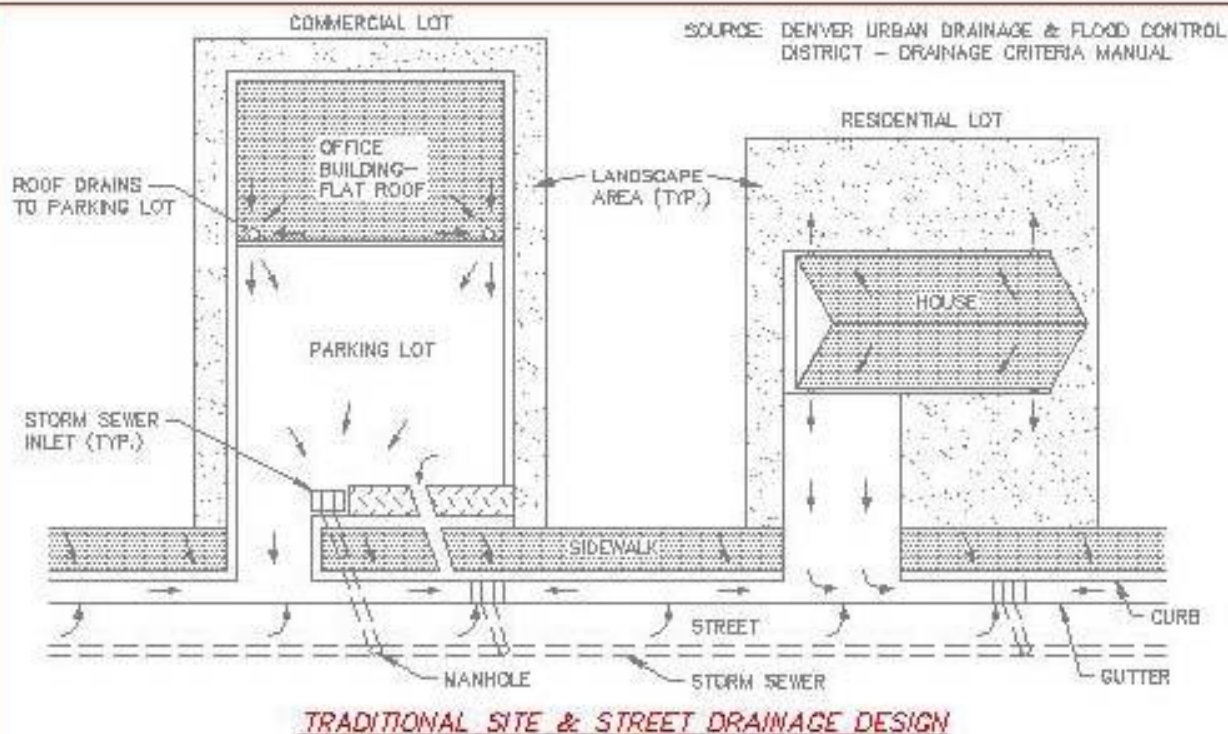
SECTION 5.25. Operation and Maintenance

- A. The City provides no maintenance of water quality BMPs located on private property. Maintenance must be provided by the owner of the property upon which the BMP is located.
- B. Extended detention basins and wetlands or other “capture and storage” BMPs shall be located within a single lot or property, within a designated drainage easement. Where BMPs are located in common areas or adjoining off-site areas, the property upon which the BMP is located shall remain in the ownership of the developer or property owners’ association.

C. Where a property owners' association is formed, restrictive covenants which provide for collection of fees for maintenance of the BMPs shall be filed in the office of the Christian County Recorder of Deeds. Restrictive covenants must be approved by the County legal counselor prior to filing of the final plat.

SECTION 5.26 References

1. Wright Water Engineers, Fulbright Spring Protection Study, Watershed Committee of the Ozarks, Springfield, Missouri, 1995.
2. American Society of Civil Engineers, Manuals and Reports of Engineering Practice No. 77 (WEF Manual of Practice FD-20), Design & Construction of Urban Stormwater Management Systems, Chapter 12. American Society of Civil Engineers, New York, NY, 1992.
3. Urban Drainage and Flood Control District, Urban Storm Drainage Criteria Manual, Volume 3, Best Management Practices, Urban Drainage and Flood Control District, Denver, CO, 1992.
4. Schueler, T., Site Planning for Urban Stream Protection, Center for Watershed Protection and Metropolitan Washington Council of Governments, Washington, DC, 1995.
5. Schueler, T., Controlling Urban Runoff, A Practical Manual for Planning and Designing Urban BMPs, Metropolitan Washington Council of Governments, Washington, DC, 1987.
6. Jones, J.E. and Roesner, L.A., Urban Stormwater Quality Management, Course Notes, American Society of Civil Engineers Continuing Education Services, New York, NY, 1991.
7. Debo, T.N. and Reese, A.J., Municipal Stormwater Management, Chapter 13, Lewis Publishers, Boca Raton, FL, 1995.
8. Missouri Department of Natural Resources and Missouri Department of Conservation, and Conservation Federation of Missouri, Volunteer Water Quality Monitoring Program Training Manual, Jefferson City, MO, 1995.
9. Bullard, L., Water Resources of Greene County, Watershed Committee of the Ozarks, Springfield, MO, 1997
10. U.S. Environmental Protection Agency, Final Report of the Nationwide Urban Runoff Program, Executive Summary, Water Planning Division, USEPA, Washington, DC, 1983.

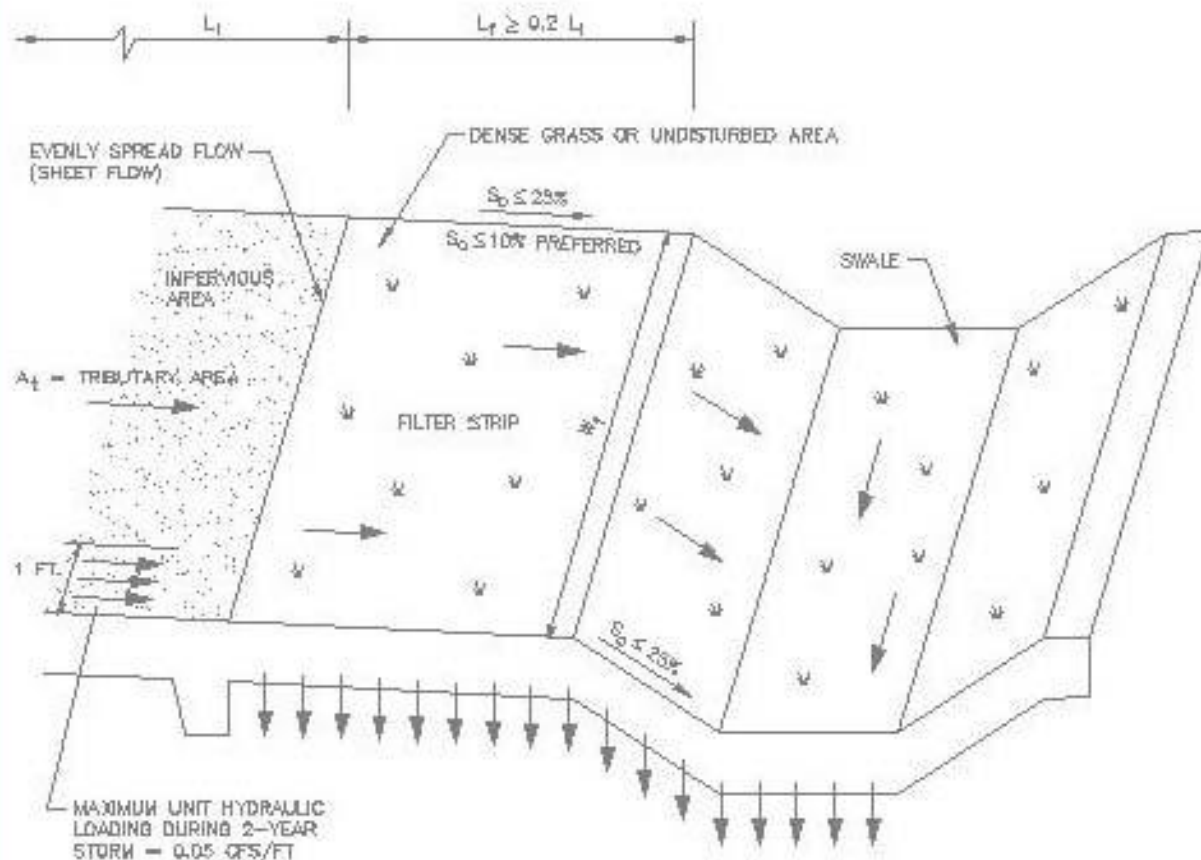


OZARK MISSOURI - STORM WATER DESIGN STANDARDS

EXAMPLES OF MINIMIZING DIRECTLY
CONNECTED IMPERVIOUS AREAS

FIGURE 5.1

DATE: 08/23/08



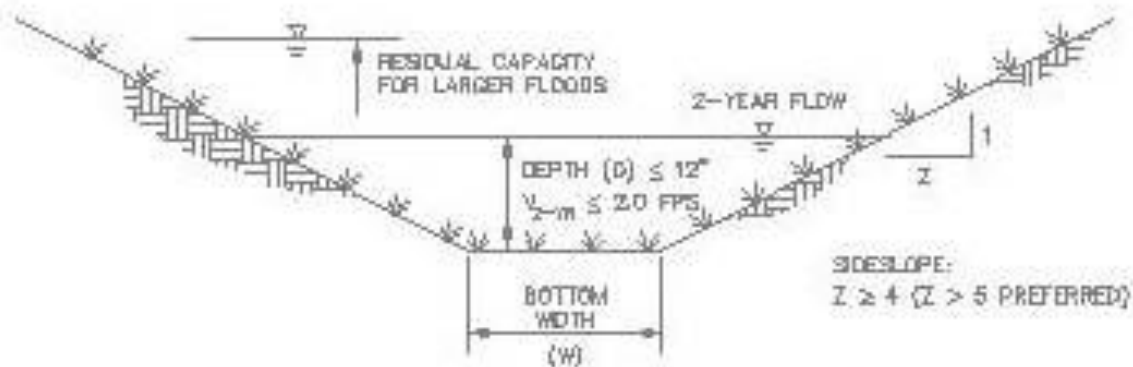
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CONTROL DISTRICT - DRAINAGE CRITERIA MANUAL

OZARK MISSOURI - STORM WATER DESIGN STANDARDS

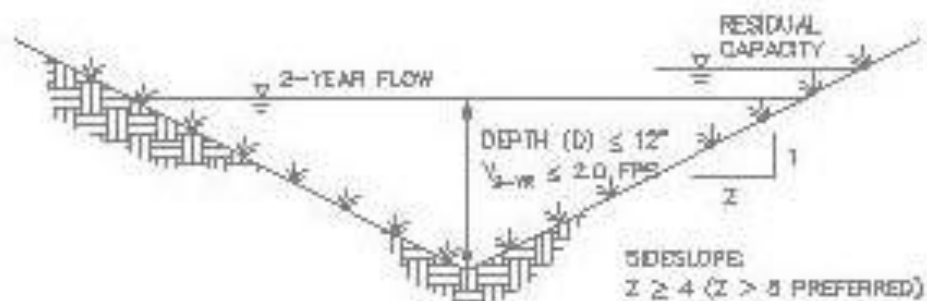
VEGETATIVE FILTER STRIP
WATER QUALITY BMP

FIGURE 5.2

DATE: 08/23/05



TRAPEZOIDAL GRASS-LINED SWALE SECTION



TRIANGULAR GRASS-LINED SWALE SECTION

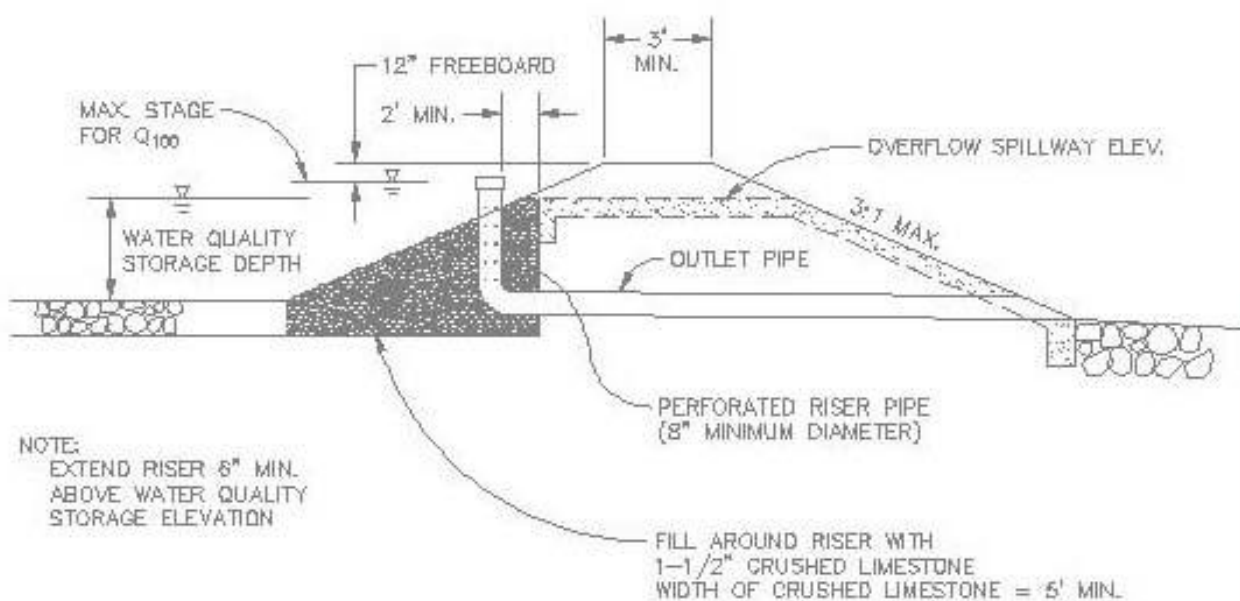
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CONTROL DISTRICT - DRAINAGE CRITERIA MANUAL

OZARK MISSOURI - STORM WATER DESIGN STANDARDS

GRASS SWALE
WATER QUALITY BMP

FIGURE 5.9

DATE: 09/23/08

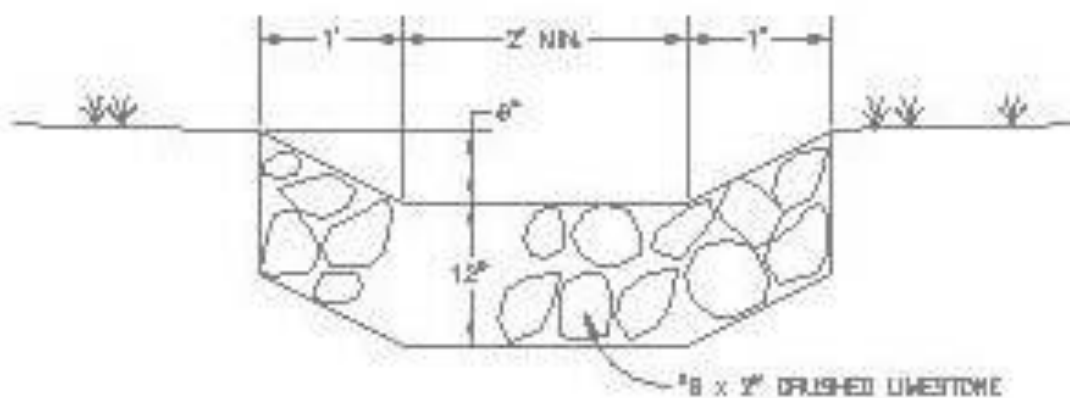


OZARK MISSOURI - STORM WATER DESIGN STANDARDS

EXTENDED DRY DETENTION
DAM & OUTLET CONFIGURATION
WATER QUALITY BMP

FIGURE 5.4

DATE: 08/23/08

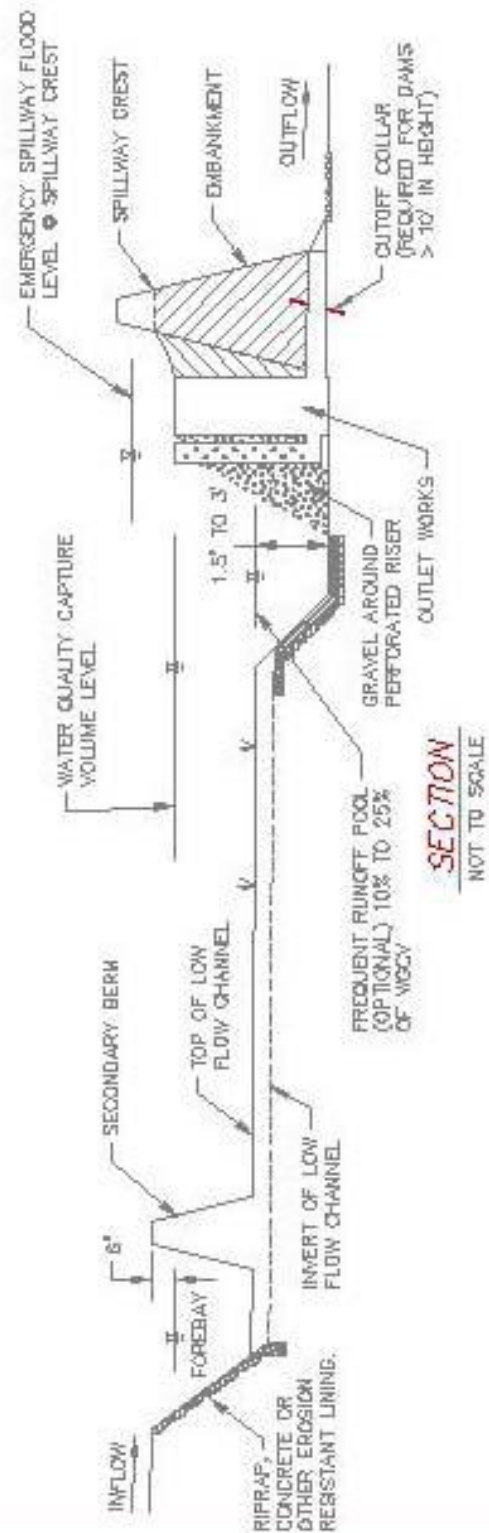
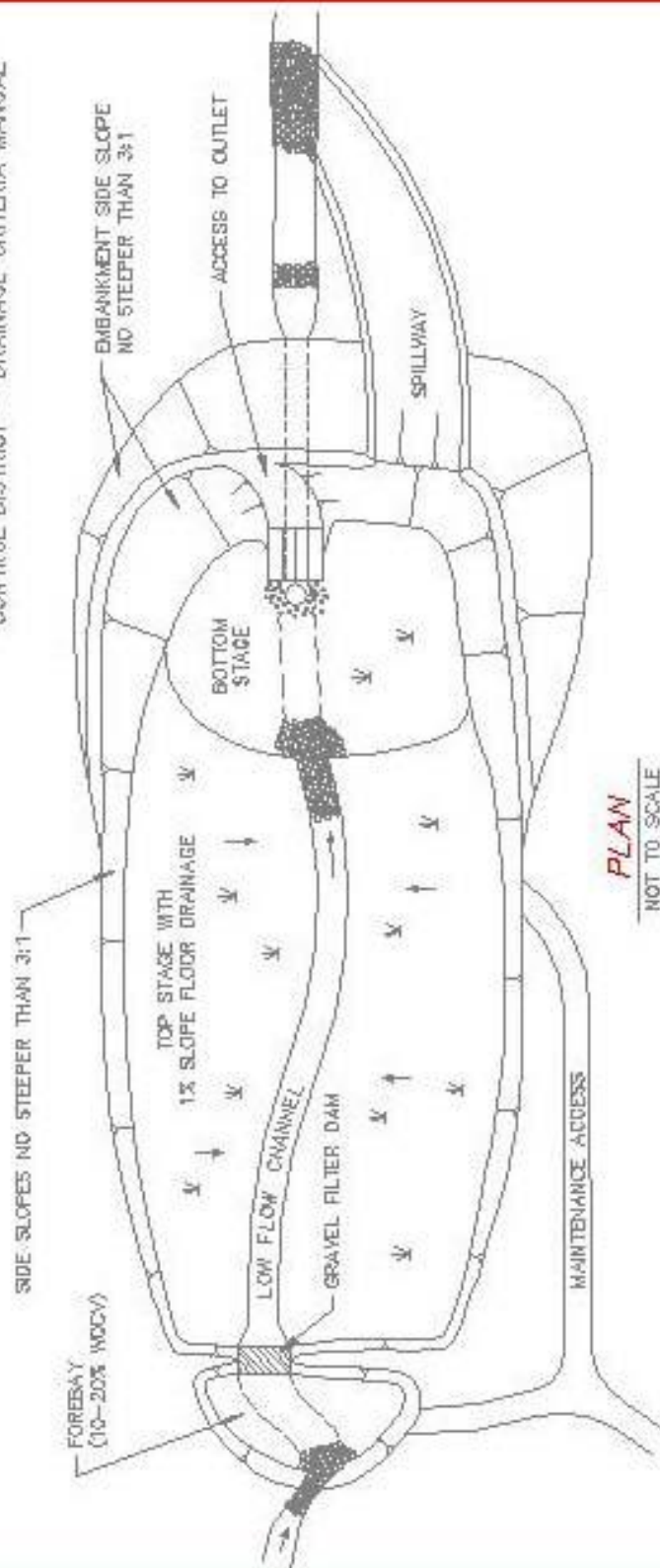


UZARK MISSOURI – STORM WATER DESIGN STANDARDS

TRICKLE CHANNEL FOR EXTENDED DRY
DETENTION BASINS – TYPICAL CROSS-SECTION
WATER QUALITY BMP

FIGURE 5.5

DATE: 08/23/00

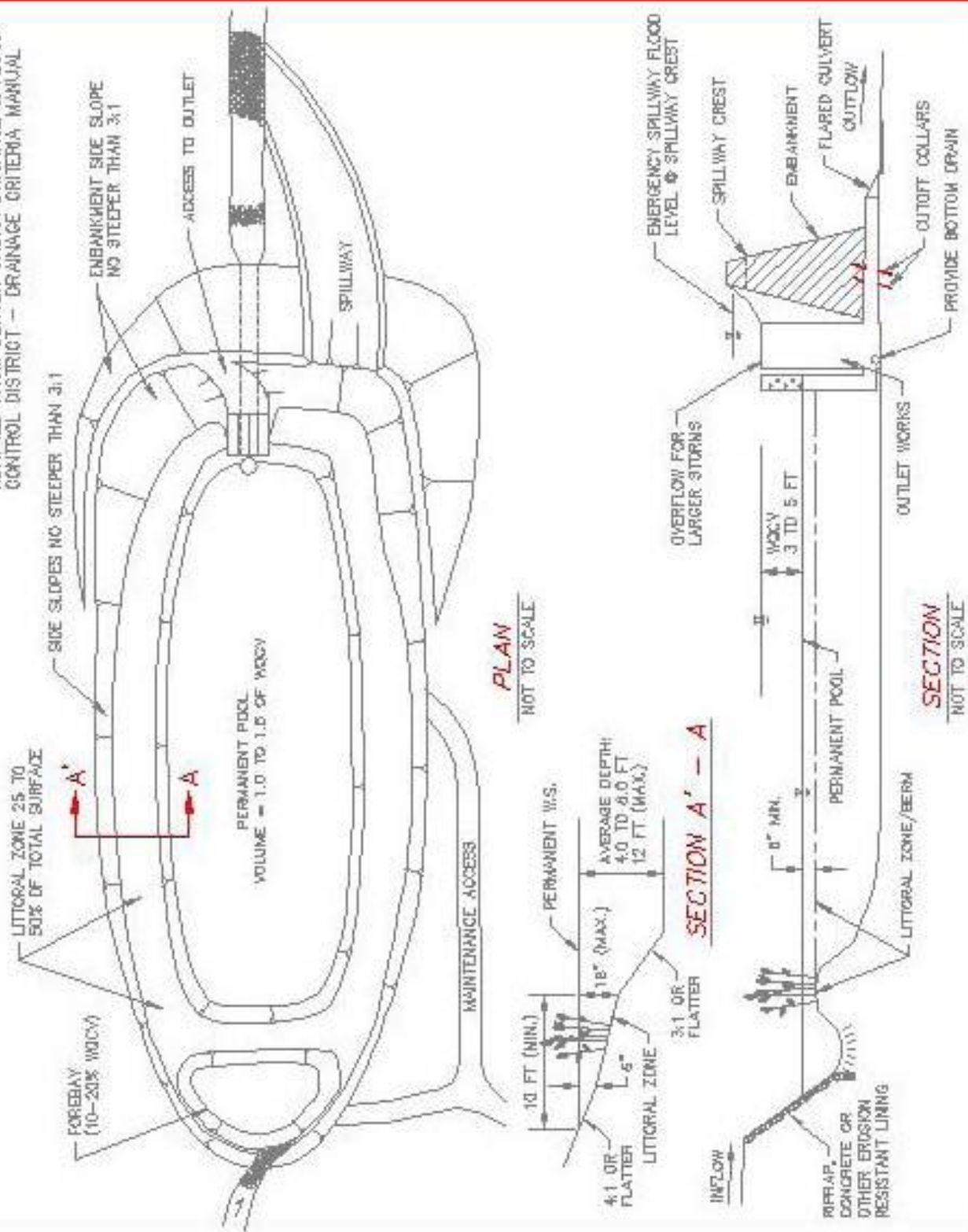


OZARK MISSOURI - STORM WATER DESIGN STANDARDS

SCHEMATIC PLAN AND SECTION OF A
DRY EXTENDED DETENTION BASIN

FIGURE 5.6

DATE: 08/23/06

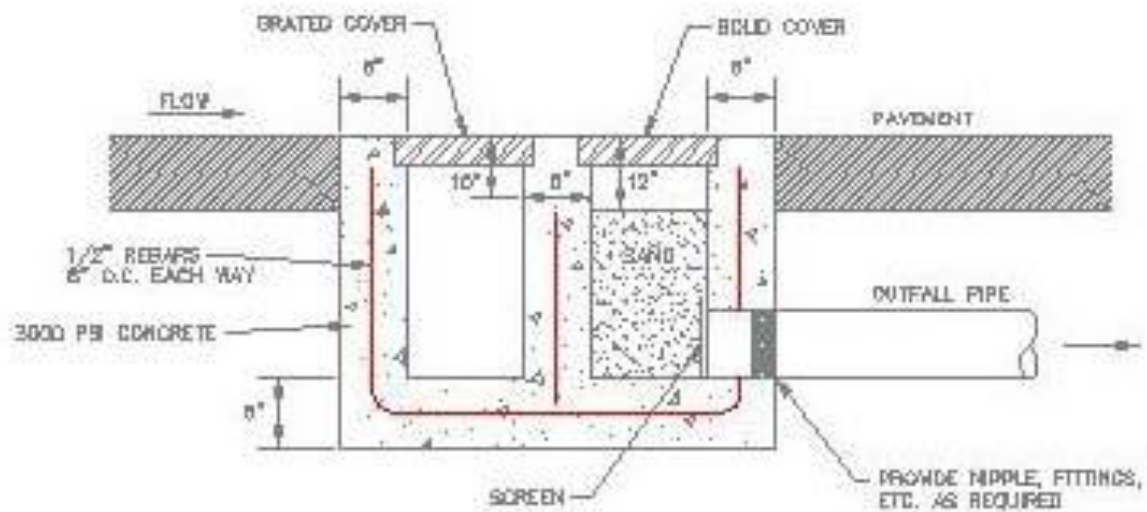
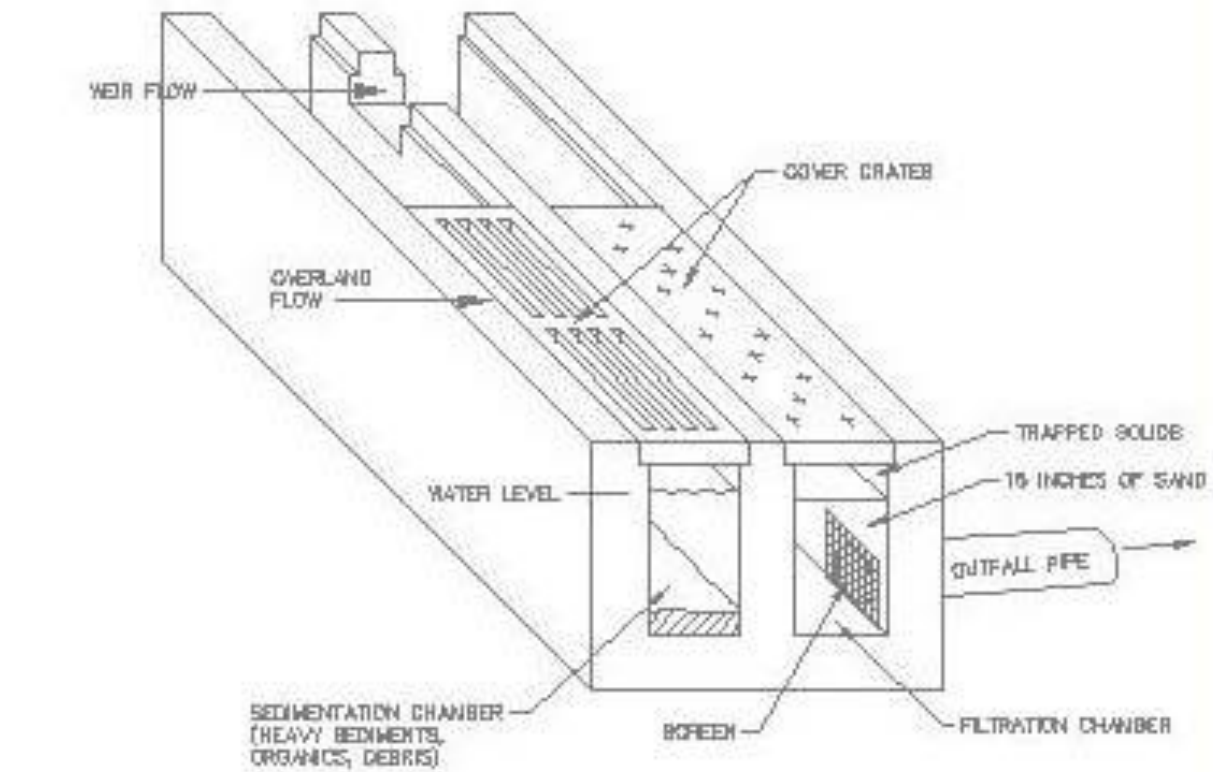


OZARK MISSOURI - STORM WATER DESIGN STANDARDS

SCHEMATIC PLAN AND SECTION OF A
WET EXTENDED DETENTION BASIN

FIGURE 5.7

DATE: 08/23/06



FROM: EPA 1992

OZARK MISSOURI – STORM WATER DESIGN STANDARDS

SAND FILTER SCHEMATIC

FIGURE 5.8

DATE: 08/23/06

PART VI - SINKHOLES AND KARST FEATURES

Section 5.27 General

- A. The City is located on the Springfield Plateau of the Ozarks physiographic region. This area is underlain by Mississippian Age limestone which is highly susceptible to solutional weathering. As a result, sinkholes, springs and caves are common.
- B. In many areas of the City, special consideration must be given to flood hazards and potential for groundwater contamination due to the presence of sinkholes, caves, losing streams, springs, and other features associated with karst geology.
- C. The requirements set forth herein are intended to provide specific criteria for design and construction for any site upon which sinkholes or other karst features are located.
- D. Interpretations of these requirements shall be made and appeals may be made according to the procedures set forth in section 1.6 of Article I.

Section 5.28 Policy

A. It is the policy of the City to discourage land disturbance, development, and/or construction in or around sinkhole areas. Where sinkholes exist the city will require developers, builders and their design professionals to make the maximum effort to avoid sinkholes. The City recognizes that extreme and/or unique circumstances may occur when living in an area where sinkholes are prevalent. Exceptions will be made only when it can be conclusively demonstrated to the Board of Aldermen, by a Missouri Registered Geologist, that such extreme and/or unique circumstances exist as defined in items “B” and “C” below. Any request for an exception shall clearly prove that no adverse effects on surrounding properties, sensitive biological receptors, or endangered species will occur as a result of said construction proposal.

B. Extreme Circumstance:

1. An underground cavity has caused a collapsed sinkhole to form, after construction drawing approval, and during street or building construction, and the relocation of proposed street, utility or building would render access or utility service to a property impractical or cost prohibitive.
2. An underground cavity has caused a collapsed sinkhole to form under an existing street, utility or building and the relocation of street, utility or building would be impractical or cost prohibitive.

C. Unique Circumstances:

1. In the case of previously altered sinkholes the developer may only propose to use this geologic feature as a private park and his/her design professional shall:
 - a. Not alter the sinkhole further until a disturbance plan has been approved by the Board of Aldermen;
 - b. Provide information as to when and to what extent the previous disturbance occurred and that such disturbance occurred prior to the submittal of a preliminary plat application;

- c. Show that construction in the sinkhole might be appropriate if it serves to improve structural stability, better protects groundwater quality and/or public health;
- d. Provide the location of said sinkhole rim, as determined by a Missouri Registered Geologist, on all submitted documents;
- e. Provide grading, land disturbance, erosion control, and sinkhole modification plans that minimizes the removal of vegetation and that does not require the use of heavy construction equipment;
- f. Provide a fill plan (if applicable) approved by both a Registered Missouri Geologist and Engineer;
- g. Identify the boundaries of both the sinkhole rim and park boundary on all drawings and label said area as open space/common area to be dedicated to a Homeowners and/or Property Owners Association;
- h. Provide a copy of the sinkhole modification plan to the Missouri Department of Natural Resources-Division of Geology and Land Survey (DGLS) as well as register said sinkhole with the DGLS.

D. In these types of cases, measures that will have minimal impact on the sinkhole or receiving water may be proposed. A sinkhole stabilization plan shall be prepared and sealed by a qualified professional engineer or qualified geologist and submitted to the Public Works Director. Plans for minimal alteration may be approved, provided it is conclusively demonstrated that the proposed plan is the minimum practical alternative

E. In these cases potential impacts of construction on the sinkhole and receiving waters must be studied and assessed, and recommendations made for mitigation of potential impacts upon surface flooding and groundwater quality before the plans can be approved. The degree and sophistication of study required will increase in proportion to the potential impacts.

Section 5.29 Definitions

A. Sinkhole: Any depression in the surface of the ground, with or without collapse of adjacent rock that provides a means through which surface water can come into contact with subsurface water.

1. Sinkhole depressions may be gradual or abrupt; they may or may not have a well-defined eye. While most sinkholes can be defined as the area within a "closed contour", some sinkholes such as those located on the sides of hills may not.

2. All sinkholes provide discreet points of recharge to groundwater.

B. Sinkhole Watershed: The ground surface area that provides drainage to the sinkhole. This area extends beyond the sinkhole depression, and generally crosses property boundaries.

C. Unaltered Sinkhole: A sinkhole that has never been altered or disturbed.

D. Altered Sinkhole: A sinkhole that has been filled, excavated or otherwise disturbed.

E. **Collapsed Sinkhole:** A subsidence or cave-in of the ground surface caused when soil overburden can no longer be supported by underlying strata due to the presence of subsurface solution cavities.

F. **Sinkhole Eye:** Generally, a visible opening, cavity or cave in the bottom of a sinkhole, sometimes referred to as a swallow hole.

G. **Sinkhole Rim:** The perimeter of the sinkhole depression. The sinkhole rim will generally vary in elevation.

H. **Sinkhole Cluster Area:** An area containing two (2) or more sinkholes located in close proximity, generally interconnected by groundwater conduits.

I. **Terminal Sinkhole:** The lowest sinkhole in a sinkhole cluster to which any surface water overflowing from other sinkholes in the cluster will flow.

J. **Sinkhole Flooding Area:** The area inundated by runoff from a storm with an annual exceedance probability of 1% and duration of twenty-four (24) hours.

K. **Construction in sinkholes:** Those actions necessary to stabilize the sinkhole, preserve groundwater quality and provide suitable support for the street, utility or building.

L. **Qualified Geologist:** A person registered to practice geology according to the laws of the State of Missouri, who has met or exceeded the minimum geological educational requirement and who can interpret and apply geologic data principles, and concepts and who can conduct field or laboratory geologic investigations (per RSMo); and who by reason of experience and education, has an understanding of local karst geology.

M. **Qualified Professional Engineer:** A person registered to practice engineering according to the laws of the State of Missouri, and who by reason of technical education and experience has a background in the fundamentals of storm drainage and karst geology.

N. **Heavy Equipment:** Motorized equipment having a gross weight of more than six (6) tons.

O. **Light Equipment:** Motorized equipment weighing six (6) tons or less.

Section 5.30 Permits Required

A. Permits from State or federal agencies may be required, as outlined in Part I of this Article, depending upon the size and nature of the proposed activity.

B. City of Ozark Land Disturbance Permit

1. In the event a developer, land owner and/or land owner's representative wishes to remove permanent land cover within the City on an area of one (1) acre or more, one (1) of the above mentioned parties must obtain a land disturbance permit from the Public Works Department prior to commencing work.

Section 5.31 General Plan Requirements

A. General requirements for grading and drainage plans are set forth in Article I.

Section 5.32 Sinkhole Evaluation

A. An evaluation including the following information shall be made for all sites upon which sinkholes are fully or partially located:

B. The site plan for the proposed development must show the following items with respect to location of proposed construction, proposed or existing property lines and existing structures:

1. Sinkholes

a. Location and limits of the area of the sinkhole depression as determined by field surveys or other reliable sources as may be approved. Location of sinkholes based solely upon USGS 7-1/2 Minute Series Quadrangle Maps will not be considered sufficient unless field verified.

b. Location and elevation of the sinkhole eye where visible or known.

c. Topographic contours at maximum intervals of two (2) feet, and spot elevations sufficient to determine the low point on the sinkhole rim and the profile of the potential overflow area. The sinkhole rim shall be identified by a registered geologist.

d. Minimum entry elevations of any existing structures located within the sinkhole rim.

e. Elevation of any roadway located within or adjacent to the sinkhole.

2. Water Supply Sources

a. The approximate location of public or private water supply sources such as springs or wells, as determined from information available from the City and MoDNR.

b. Boundaries of any known recharge areas to wells or springs as determined from information available from the City and MoDNR.

3. Other Geologic Features: Location of caves, springs, faults and fracture trends, geologic mapping units based upon information from the City or other reliable sources.

4. Flooding limits for the sinkholes determined as set below.

C. A drainage area map showing the sinkhole watershed area. Where the site is located in a sinkhole cluster area, this map shall be extended to include the watershed area any sinkholes located downstream of the site which may receive overflow drainage from the site.

D. Assessment of potential impacts on groundwater quality and proposed water quality management measures as set forth below.

Section 5.33 Flooding Considerations

5.33.1. Minimum Flooding Analysis

- A. Maximum estimated flooding elevations shall be determined for each sinkhole for both pre-development and post development conditions, assuming no subsurface outflow from the sinkhole.
- B. Where the estimated volume of runoff exceeds the volume of the sinkhole depression, the depth, spread and path of overflow shall be estimated and shown on the map.
- C. The overflow volume shall be included determining the maximum estimated flooding elevations in the next downstream sinkhole. This analysis shall continue downstream until the lowest sinkhole of the sinkhole cluster is reached or overflow reaches a surface watercourse.
- D. The volume of runoff considered shall be that which results from a rainstorm with an annual probability of 1% (100-year storm) and a duration of twenty-four (24) hours (8.0 inches for City of Ozark). The runoff volume shall be determined by the method set forth in Chapter 2 of the SCS TR-55 Manual (Reference 11).
- E. No further flooding analysis will be required provided that:
 - 1. The post-development flooding area of any sinkhole which receives drainage from the site is located entirely on the site.
 - 2. A drainage easement covering the post-development flooding area is provided for any off-site sinkhole or portion of a sinkhole which receives increased peak rates of runoff from the site. If the receiving sinkhole is not contiguous to the site, an easement must also be provided for the waterway which connects the site to the sinkhole.
 - 3. The minimum entry elevation of any existing structure is at least one (1) foot higher than the estimated flooding elevation from the 1% annual probability 24-hour storm.
 - 4. The flooding depth on any existing public road does not exceed the maximum depths set forth in Part III.

5.33.2. Detailed Flooding Analysis

- A. In cases where the conditions set forth above cannot be met, a detailed flooding analysis will be required if any increase in runoff volume is proposed. For detailed flooding analysis a runoff model must be made for the sinkhole watershed and reservoir routing analysis performed using hydrograph techniques as set forth in Part IV.
- B. The following alternative methods may be used singly or in combination to keep flooding levels at pre-development levels:

C. Diversion of Excess Runoff to Surface Watercourses

1. Where feasible, increased post-development runoff may be diverted to a surface watercourse, provided that:
 - a. Increase in peak runoff rate in the receiving watercourse does not create or worsen existing flooding problems downstream; and
 - b. The diverted storm water remains in the same surface watershed.
 - c. Storm sewers, open channels and other appurtenances provided for diversions shall be designed in accordance with applicable sections of these Design Standards.
 - d. The effect of diverted water on downstream watercourses and developments, and requirements for additional detention facilities prior to release of runoff to the surface watercourse shall be determined as set forth in Part IV, Detention Facilities.
 - e. Effects of the diversion shall be shown by reservoir routing analysis. Routing of excess runoff shall be considered satisfactory when it can be demonstrated that the post-development flooding elevation in the sinkhole does not exceed the pre-development flooding elevation within reasonable tolerance (generally 0.1 ft.).

D. Storage of Excess Runoff within the Sinkhole Watershed

1. Where feasible, detention facilities may be constructed within the sinkhole watershed or in perimeter areas of the sinkhole. These detention facilities must be located outside the sinkhole flooding area determined for post-development conditions.
2. The flooding considerations set forth in this section will be met if it can be demonstrated that:
 - a. Inflow rates to the sinkhole can be reduced to a degree that, in conjunction with the observed outflow rate, the post-development flooding elevation in the sinkhole does not exceed the pre-development flooding elevation within reasonable tolerance (generally 0.1 ft.).
 - b. Sediment & erosion control and water quality considerations as set forth elsewhere in this section can be satisfied.

Section 5.34 Water Quality Considerations

5.34.1. Evaluation Factors

- A. Sinkholes provide direct recharge routes to groundwater. As a result, water quality in wells, caves and springs may be affected by discharge of runoff from developed areas.
- B. The Sinkhole Evaluation must consider potential impacts of the proposed construction on receiving groundwaters and propose measures to mitigate such impacts.

C. Four primary factors must be considered:

1. Receiving groundwater use.
2. Relative groundwater contamination hazard associated with the proposed development.
3. Ability to capture pollutants.
4. Management measures to be provided to reduce pollutant levels.

5.34.2. Receiving Groundwater Use

A. The Sinkhole Evaluation Report shall identify whether the site lies within a critical area based upon information available from the City.

B. Where disagreements may arise over whether a site is located within a particular recharge area, dye tracing may be required for confirmation of the destination of water discharges through a sinkhole.

C. Critical Areas

1. The following areas are classified as critically sensitive to contamination from urban runoff:
 - a. Recharge areas of domestic water supply wells.
 - b. Recharge areas of springs used for public or private water supply.
 - c. Recharge areas of caves providing habitat to rare or endangered species such as the Ozark cavefish.

D. Sensitive Areas

1. All other sinkhole areas will be classified as sensitive to contamination from urban runoff.

5.34.3. Groundwater Contamination Hazard

A. The relative potential for groundwater contamination will be classified as low, moderate, or high depending upon the type of land use, development density and amount of directly connected impervious area. The Sinkhole Evaluation shall identify whether the proposed development poses a low, moderate, or high hazard to groundwater uses, as defined below:

B. Low Hazard

1. The following land uses are classified as posing a relatively low hazard to groundwater contamination:
 - a. Wooded areas and lawns.
 - b. Parks and recreation areas.

- c. Residential developments on sewer, provided directly connected impervious areas discharging to the sinkhole are less than one (1) acre.
- d. Low density commercial and office developments, provided directly connected impervious areas discharging to the sinkhole are less than one (1) acre.
- e. Discharge from graded areas less than one (1) acre having required sediment controls per Part VI.

C. Moderate Hazard

- 1. Concentrated discharge from streets and parking lots and roofs and other directly connected impervious areas having an area greater than one (1) acre and less than five (5) acres.
- 2. Multifamily residential developments and higher intensity office developments, provided the directly connected impervious areas discharging to the sinkhole are less than five (5) acres.
- 3. Discharge from graded areas greater than one (1) acre and less than five (5) acres having required sediment controls per Part VI.

D. High Hazard

- 1. Collector and arterial streets and highways used for commercial transport of toxic materials.
- 2. Railroads.
- 3. Concentrated discharge from streets and parking lots and roofs and other directly connected impervious areas having an area greater than five (5) acres.
- 4. Commercial, industrial and manufacturing areas.
- 5. Individual wastewater treatment systems.
- 6. Commercial feedlots or poultry operations.
- 7. Discharge from graded areas greater than five (5) acres having required sediment controls per Part VI.

5.34.4. **Capturing and Filtering Pollutants**

- A. The majority of sinkholes drain a limited watershed area. For sinkholes where the surrounding drainage area is small enough that the area draining to the sinkhole flows predominantly as "sheet flow", potential impacts on water quality can be addressed by erecting silt control barriers around the sinkhole during construction and providing a vegetative buffer area around the sinkhole to filter out potential contaminants.
- B. When the volume of runoff into the sinkhole increases to the point where flow becomes concentrated, the degree of effort required to capture and filter out contaminants increases significantly.

C. Concentrated inflow occurs naturally when the sinkhole watershed area reaches a sufficient size for watercourses leading into the sinkhole to form. Concentrated surface flows result as urbanization occurs due to construction of roads, storm sewers, drainage channels. Subsurface flows can become concentrated through utility trenches.

D. The Sinkhole Evaluation shall include maps showing any existing watercourse which flows into the sinkhole and location of any proposed concentrated storm water discharges into the sinkhole.

5.34.5. **Water Quality Management Measures**

A. Sediment and Erosion Control

1. Non-concentrated flow (sheet flow)

a. In critical areas, existing ground cover shall not be removed within twenty-five (25) feet of the sinkhole rim and a silt barrier shall be provided around the outer perimeter of the buffer area.

2. Concentrated flow

a. A sediment basin will be required at each point where concentrated flows are discharged into the sinkhole.

(1). Sediment basins shall be designed according to the procedures set forth in Part VI.

B. Minimizing Directly Connected Impervious Area

1. The groundwater contamination hazard category for impervious areas may be reduced by reducing the amount of Directly Connected Impervious Area. This is the area of roofs, drives, streets, parking lots, etc. which are connected via paved gutters, channels, or storm sewers.

2. Directly Connected Impervious Areas can be reduced by providing properly sized grass swales, vegetative filter strips or other Best Management Practices to separate paved areas.

C. Diversion of Runoff

1. Concentrated discharges to sinkholes can be reduced to manageable levels or avoided by diverting runoff from impervious areas away from sinkholes where possible.

2. Diversions shall be done in a manner that does not increase flooding hazards on downstream properties and, generally, shall not be directed out of the surface watershed in which the sinkhole is located.

D. Filtration Areas

1. For areas having a low or moderate groundwater contamination hazard and where flow into the sinkhole occurs as sheet flow, water quality requirements can be satisfied by maintaining a permanent vegetative buffer area with a minimum width of thirty (30) feet around the sinkhole.

2. Use of pesticides and fertilizers will not be permitted within the buffer area. Animal wastes will not be permitted to accumulate in the buffer area.

E. Grassed Swales and Channels

1. For areas having a low groundwater contamination hazard, concentrated flows from directly connected impervious areas of less than one (1) acre may be discharged into the sinkhole through grassed swales and channels.
2. Swales and channels shall be designed for non-erosive velocities and appropriate temporary erosion control measures such as sodding or erosion control blankets provided.

F. Storage and Infiltration

1. Storage and infiltration will be required in the following cases:
 - a. All areas having a high groundwater contamination hazard.
 - b. Areas having a moderate groundwater contamination hazard where concentrated inflow occurs.
2. Storage and infiltration basins shall be designed to capture the runoff from storms up to one (1) inch and release runoff over a minimum period of twenty-four (24) hours.

Section 5.35 Development Requirements

5.35.1. Storm water Detention in Sinkholes

- A. Where water quality considerations as set forth in Part VI can be met, the volume of runoff storage in sinkholes can be counted toward storm water detention requirements, provided that proper sediment and erosion control measures are provided as set forth in Part VI.
- B. The volume of required detention storage shall be determined as set forth in Part IV. Excavation within the sinkhole flooding area to provide additional detention storage will not be allowed.

5.35.2. Modification of Sinkholes to Increase Outflow Rates

- A. Increasing outflow rates in sinkholes by excavating the sinkhole eye or installing disposal wells for diverting surface runoff to the groundwater system is prohibited, unless clear and imminent danger to the public health and safety can be demonstrated.

5.35.3. Setbacks and Use Restrictions

- A. No new construction of any of the following shall be permitted within twenty-five (25) feet of the sinkhole rim:
 1. Residential, commercial or industrial structures.
 2. Swimming pools.

3. Streets, highways, or parking lots.
4. Storage yards for materials, vehicles, and equipment.
5. Sanitary sewer lines.

B. No person shall place, or cause to be placed, any substance or objects, other than those approved by the City, in any sinkhole. This specifically precludes any trash, garbage, or refuses material. If an accidental spill of any toxic, petroleum, or hazardous material occurs, it shall be reported to the City and MoDNR immediately.

C. Use of pesticides and fertilizers within thirty (30) feet of the sinkhole rim is prohibited.

D. No waste disposal system of facility which involves storage or handling of hazardous or toxic materials is allowed within one hundred (100) feet of a sinkhole rim.

E. Use of heavy construction equipment in unaltered sinkholes is prohibited.

F. Construction of underground utilities is prohibited within the sinkhole rim.

G. Recreational facilities such as hiking, jogging, and bicycling trails, playgrounds, exercise courses, and grass playing fields are permitted within the sinkhole area provided they are not located within the eye of the sinkhole.

H. Golf courses are permitted subject to approval of a Management Plan for use of pesticides and fertilizers.

I. Clearing and pruning of trees and undergrowth, and limited grubbing of roots is permitted.

J. Landscaping and minor gardening is permitted outside of the sinkhole eye provided erosion and sediment discharge is limited through use of minimum tillage and mulches.

K. Construction of light incidental landscaping and recreational structures such as gazebos, playground equipment, etc. is permitted except in the sinkhole eye.

L. Any property that has a sinkhole present that has been used as a site for dumping of trash, garbage, and refuse will be prohibited from building permits, zoning actions, or land subdivision until the sinkhole has been cleaned out.

5.35.4. Collapsed Sinkholes

A. Collapsed sinkholes may be stabilized and filled using approved techniques. Permits must be issued prior to performing any construction.

B. The probable cause of the collapse and potential adverse impacts of filling the collapse shall be investigated and information submitted with the Permit application.

5.35.5. Altered Sinkholes

A. Filling or altering of sinkholes without a Permit constitutes a violation of these requirements. In such cases corrective measures must be proposed within the time period specified in Article V for enforcement of such violations. No corrective or remedial measures shall be undertaken until the proposed remediation plan has been reviewed by the City and a Permit issued.

B. No Building Permits will be issued, or zoning or subdivision approvals granted until the remedial measures specified in the Permit have been completed and approved.

Section 5.36 Springs & Caves

5.36.1. Springs

A. No new construction will be permitted within one hundred feet (100') of a spring unless a report, prepared by a qualified engineer or geologist verifying that the quantity and quality of the spring flow will not be materially altered by the proposed construction, is submitted and approved by the City.

5.36.2. Caves

A. No new construction will be permitted within one hundred feet (100') of the known alignment of a cave unless a report, prepared by a qualified engineer or geologist verifying that the cave will not be materially altered by the proposed construction and that sound foundations or other support for the proposed construction will not be subject to collapse or undue settling, is submitted and approved by the City.

B. The entrances of caves shall be protected against unauthorized entry, while allowing for the unimpeded flow of groundwater and without disruption to habitat for cave-dwelling animal species. Plans for cave entrance protection must be approved by the City prior to construction.

PART VII - GRADING, SEDIMENT & EROSION CONTROL

Section 5.37 Goals and Objectives

A. The goal of the regulation is to effectively minimize erosion and discharge of sediment by application of relatively simple and cost effective Best Management Practices. This goal can be attained by meeting the following objectives:

1. Minimize the area disturbed by construction at any given time.
2. Stabilize disturbed areas as soon as possible by re-establishing sod, other forms of landscaping, and completing proposed structures, pavements and storm drainage systems.
3. Provide for containment of sediment until areas are stabilized.
4. Provide permanent erosion controls.
5. Require construction to be sequenced whereby all erosion control best management practices, (BMP's), are installed prior to any land disturbance.

Section 5.38 General Design Guidelines

A. The following items shall be considered in preparing a sediment and erosion control plan:

5.38.1. Temporary vs. Permanent Controls

A. The greatest potential for soil erosion occurs during construction. Temporary controls are those that are provided for the purpose of controlling erosion and containing sediment until construction is complete.

B. Temporary controls include straw or hay bale dikes, silt fences, erosion control blankets etc., which are not needed after the area is stabilized.

C. Permanent controls consist of concrete trickle channels, detention basins, etc., which will remain in place through the life of the development.

D. It is possible for the same facility to serve both a temporary and permanent purpose. The difference between temporary and permanent erosion control should be clearly recognized in preparing a sediment and erosion control plan.

5.38 2. Sheet Flow vs. Concentrated Flow

A. In areas where runoff occurs primarily as sheet flow, containment of sediment is relatively simple. In these areas straw or hay bales, silt fences and vegetative filter areas can be very effective.

B. Where concentrations of flow occur, containment of sediment becomes more difficult as the rate and volume of flow increase. In these areas more sophisticated controls such as sedimentation basins must be provided.

5.38.3. Slope

A. Control of erosion becomes progressively more difficult as the slope of the ground increases. Areas with steeply sloping topography, and cut and fill slopes must be given special consideration.

5.38.4. Soils and Geologic Setting

A. Area soils and the geologic setting must be considered in preparing the plan and any special considerations deemed necessary for a particular site provided.

5.38.5. Environmentally Sensitive Areas

A. Where construction occurs within the vicinity of permanent streams, springs, sinkholes, lakes or wetlands, special attention must be given to preventing discharge of sediment.

Section 5.39 Permits

5.39.1. NPDES Storm Water Permit

A. Construction sites where the area to be disturbed is one (1) acre or more must apply for a storm water discharge permit from MoDNR.

B. Permit requirements are set forth in 10 CSR 20-6.200 of the Missouri Clean Water Laws.

5.39.2. "404" Permit

A. Grading activities in streams or wetlands may require a Department of the Army Permit under Section 404 of the Clean Water Act.

5.39.3. City's Land Disturbance Permit

A. In the event a developer, land owner and/or land owner's representative wishes to remove permanent land cover within the City on an area of one (1) acre or more, one (1) of the above mentioned parties must obtain a land disturbance permit from the Public Works Department prior to commencing work.

Section 5.40 Design Standards & Criteria

5.40.1. Grading

A. Maximum Grades

1. Cut or fill slopes shall not exceed 3:1.
2. 4:1 slopes are preferred where possible.

B. Maximum Height

1. Cut or fill slopes shall not exceed fifteen (15) feet in vertical height unless a horizontal bench area at least five (5) feet in width is provided for each fifteen (15) feet in vertical height.

C. Minimum Slope

1. Slope in grassed areas shall not be less than 1%.

D. Construction Specifications

1. Construction for streets must comply with specifications set forth in Article II.
2. For all other areas, construction specifications stating requirements for stripping, materials, subgrade compaction, placement of fills, moisture and density control, preparation and maintenance of subgrade must be included or referenced on the plans, or accompanying specifications submitted.

E. Spoil Areas

1. Broken concrete, asphalt and other spoil materials may not be buried in fills within proposed building or pavement areas.
2. Outside of proposed building and pavement areas, broken concrete or stone may be buried in fills, provided it is covered by a minimum of two (2) feet of earth.
3. Burying of other materials in fills is prohibited.

F. Stockpile Areas

1. Location of proposed stockpile areas shall be outlined on the plans and specifications for proper drainage included.

G. Borrow Areas

1. The proposed limits of temporary borrow areas shall be outlined in the plans and a proposed operating plan described on the grading plan. Borrow areas shall not be located closer than 50 feet from a stream bank.
2. Temporary slopes in borrow areas may exceed the maximums set forth above. At the time that borrow operations are completed, the area shall be graded in accordance with the criteria set forth above, and reseeded.

5.40.2. **Sediment Containment**

A. Existing vegetative filter areas may be used where:

1. Un-concentrated sheet flow occurs,
2. An area of existing vegetation a minimum of twenty-five (25) feet in width can be maintained between the area to be graded and a property line, watercourse, sinkhole, spring, wetland or classified lake,
3. Existing ground slope is no greater than 5:1 (20%),

4. The existing vegetative growth is of sufficient density and in sufficiently good condition to provide for filtration of sediment.

5. Vegetative filter areas are a temporary and permanent practice.

B. Hay/Straw Bale Dike or Silt Fence

1. Containment areas constructed of hay or straw bales, or silt fence may be provided in areas where:

a. Un-concentrated sheet flow occurs,

b. An area of existing vegetation a minimum of twenty-five (25) feet in width cannot be maintained between the area to be graded and a property line, watercourse, sinkhole, spring, wetland or classified lake,

c. Existing ground slope is no greater than 5:1 (20%),

d. Concentrated flow from an area no greater than one (1) acre occurs and a minimum volume of 1000 cubic feet per acre is contained behind the dike.

2. Either cereal grain straw or hay may be used for bale dikes. Straw/hay bale dikes shall be constructed as shown in details in the Standard Drawing Details

3. Silt fence may be used in lieu of hay or straw bales. Silt fence shall be constructed as shown in details in the Standard Drawing Details.

4. Straw bale dikes and silt fences are temporary practices.

C. Temporary Containment Berms

1. Temporary containment berms may be provided for areas where concentrated flow from areas greater than one (1) acre and less than five (5) acres occurs. Temporary containment berms must contain a volume of 1000 cubic feet per acre of drainage area. Containment berms and swales must be installed level, "along the contour". Accumulated sediment must be removed when it reaches one-third (1/3) of the berm height.

2. Temporary containment berms shall have an outlet with a sediment filter or a perforated pipe outlet.

3. Temporary containment berms and accumulated sediment may be completely removed after the tributary area is stabilized, and must be removed prior to final acceptance.

D. Inlet Protection

1. This practice consists of protecting the inlet perimeter or opening with straw bales, silt fence or sandbags. The purpose of this practice is to keep sediment from collecting in storm drains. This practice is also useful when site conditions prevent locating a sediment basin downstream of the storm sewer outfall. Inlet protection described in this paragraph cannot be used where blockage of the inlet opening would result in flooding of residential dwellings, buildings, streets or roads, or off-site property.

2. Curb Inlets

a. Curb inlets can be protected from sediment entry by placing sand bags over the inlet opening. Sand bags must be replaced when deteriorated and removed when the area has been stabilized.

b. Accumulated sediment must be removed from the street after each rainfall.

3. Area Inlets

a. In paved areas, area inlets can be protected by placing gravel filled sandbags up to two (2) courses high around the perimeter of the inlet.

b. Outside of paved areas or before pavement is placed, area inlets can be protected by installing a silt fence of straw bale dike around the inlet perimeter. Open side drop inlets can be protected by placing sandbags over the openings.

c. Accumulated sediment must be removed prior to final approval.

E. Diversion

1. Where flow must be diverted into sediment basins or other sediment retaining facilities, diversion berms or swales or other approved means of diverting runoff may be specified.

2. Where sediment enters a street which is up-grade from an existing street, means must be provided to divert runoff to a sediment basin before discharge from the site. The method of diversion will vary depending upon the phase of construction. After initial grading, an earth berm can be used. This is no longer possible after the street subgrade is completed and curbs are installed. After the street pavement is completed, sand bags can be used to divert the runoff into inlets for discharge into the sediment basin.

F. Gravel Filter Dam

1. Where concentrated flow occurs and less than two (2) acres of tributary drainage area are graded (i.e. a sediment basin is not required) or where construction of a sediment basin is not feasible, a gravel filter dam shall be provided prior to discharge of runoff from the property.

2. Gravel filter dams consist of a layer of filter fabric and crushed rock covering the upstream side of a riprap dike. Riprap shall be six and twelve inches (6"and12") in size. Filter fabric may be woven or non-woven, Mirafi 500X, Mirafi 150NL, or equal. The purpose of the filter fabric is to remove sediment particles as water flows through it. The layer of crushed rock provides additional filtration protects the filter fabric, and holds it in place.
3. Where gravel filter dams are used as sediment basin outlets, one (1) square foot of filter fabric area shall be provided for each one thousand (1,000) cubic feet of storage. The minimum area provided shall be four (4) square feet.
4. Where gravel filter dams are used as ditch checks in channels, the gravel filter area shall extend throughout the width of the dam.
5. Stilling basins shall be provided downstream of the filter dam where discharge is to a grass channel.

G. Sediment Basin

1. Sediment basins shall be provided for all areas where concentrated flow occurs from an area of five (5) or more acres. Sediment basins shall be designed to detain the runoff from one (1) inch of rainfall, for a period of at least 24 hours. Runoff shall be calculated using the methods contained in Chapter 2 of TR-55 (Reference 11), using the recommended curve number for newly graded areas from Table 2-2a.
2. Note: For construction sites in the City an average value of runoff volume from one (1) inch of rainfall is approximately 1000 cubic feet per acre, using a Curve Number of 90, as indicative of a mixture of type B & C soils. This value may be used in sizing sediment basins or the runoff volume determined using the values from Figure 2-1 of TR-55 (Reference 11).
3. Sediment basins shall be provided with an outflow structure consisting of:
 - a. A flow restriction device which provides for the required detention time,
 - b. An outfall pipe sized to carry the maximum estimated outflow rate,
 - c. Protective structures at the pipe outlet to prevent crushing or damage of the end of the pipe,
 - d. Protective structures to prevent blockage of the pipe with debris,
 - e. Erosion protection at the pipe outlet.
4. Provide an overflow spillway capable of discharging the peak flow rate for the 4% annual probability (25-year) storm while maintaining a minimum freeboard of one (1) foot.
 - a. Overflow spillways may be sodded where the depth of flow at the crest is limited to no greater than six (6) inches and outlet channel velocities do not exceed five (5) feet per second for the minor (5-year) storm.

b. Overflow spillways not meeting these restrictions must be constructed of concrete or other approved, non-erodable material.

5. Detention basins can be used for temporary sediment basins provided it can be demonstrated that flood control requirements can also be met until the sedimentation controls are removed.

6. Accumulated sediment must be removed prior to final acceptance of construction.

5.40.3. Erosion Protection

A. Seeding and Mulching

1. Permanent Seeding

a. Permanent seeding fertilizer and mulch shall be applied at the rates set forth in the Constructions Specifications.

b. Permanent seeding seasons are as designated in the Constructions Specifications.

2. Mulching

a. Where slopes are less than 4:1, cereal grain mulch is required at the rate of 100 pounds per 1000 square feet (4500 pounds per acre). Cereal grain mulch shall meet the requirements of Section 802 of the State Specifications (Reference 17) for Type 1 mulch.

b. Where slopes are 4:1 or greater, Type 3 mulch ("hydromulch") meeting the requirements of Section 802 of the State Specifications (Reference 17) shall be used.

3. Temporary Seeding

a. Whenever grading operations are suspended for more than thirty (30) calendar days between permanent grass or seeding periods, all disturbed areas must be reseeded with temporary cover. Temporary seeding season runs from May 15 to November 15.

4. Overseeding

a. During the winter season (November 15 to March 1) temporary seed and mulch shall be placed on all completed areas or areas where grading is suspended for more than thirty (30) calendar days. During this period seed, mulch, and soil amendments shall be applied at the following rates:

Lime:	100% of specified quantity
Fertilizer:	75% of specified quantity
Seed:	50% of specified quantity
Mulch:	100% of specified quantity

b. Areas seeded during this period shall be reseeded and mulched during the next permanent seeding season according to seeding requirements.

5. Maintenance

- a. Seeded areas must be maintained for one year following permanent seeding.

B. Cut and Fill Slopes

1. Cut and fill slopes shall be protected from erosion by construction of straw bale dikes, silt fences, diversion berms, or swales along the top of the slope.
2. Where drainage must be carried down the slopes, pipe drains, concrete flumes, chutes, or other impervious areas must be provided. Suitable erosion control measures such as stilling basins or other approved methods must be provided at the bottom of the slope.
3. Diversions shall be maintained until permanent growth is firmly established on the slopes.

C. Channels and Swales

1. Permanent channels and swales shall be provided with a stabilized invert consisting of one of the following materials:

a. Sod

- (1). Where the average velocity of flow is five (5) feet per second or less and there is no base flow, the channel shall be lined with sod.
- (2). For channels with a bottom width less than fifteen (15) feet, sod shall extend up the side slope to a minimum height of six (6) inches above the toe.
- (3). Channels with a bottom width of fifteen (15) feet or greater, shall be provided with a low flow area, fifteen (15) feet in width lined with sod.

- (a). The remainder of the channel slopes shall be seeded and mulched as provided above.

b. Erosion Control Blanket

- (1). Commercial erosion control blankets may be used in lieu of sod provided that samples are submitted and approved by the Public Works Director. The guaranteed maintenance period shall be one year.

c. Non-Erosive Lining

- (1). In grass channels where base flow occurs, a non-erosive low-flow channel of concrete must be provided. Low flow channels shall have a minimum capacity of five (5) cubic feet per second. Other suitable non-erosive materials may be specified with approval of the Public Works Director.
- (2). For channels which have an average velocity of five (5) feet per second or greater a non-erosive lining or other approved material must be provided.

D. Storm Sewer and Culvert Outlets

1. Erosion protection shall be provided at storm sewer and culvert outlets. Minimum erosion protection shall consist of a concrete toe wall and non-erosive lining.
2. Flared end sections or headwalls are required. The required length of non-erosive lining will not be decreased where flared end sections or headwalls are provided unless calculations and data to support the decrease in length are submitted and approved.
3. Non-erosive lining shall extend to the point at which average channel velocity for the peak flow rate from the minor (5-year) storm has decreased to five (5) feet per second maximum.
4. The length of non-erosive lining to be provided shall be as follows:
 - a. Average outlet velocity less than five (5) feet per second:
$$L = 3 \text{ times the pipe diameter or culvert width.}$$
 - b. Average outlet velocity less than 5-10 feet per second:
$$L = \text{length determined.}$$
 - c. Average outlet velocity greater than ten (10) feet per second:
$$\text{Use MoDOT standard energy dissipater headwall (Reference 17).}$$
5. The height of non-erosive lining shall not be less than the crown of the pipe.
6. Where headwalls or flared end sections are specified, toewalls must be provided at the downstream end.

E. Curb Openings

1. Where drainage flows from paved areas to grass areas through curb openings erosion protection shall be provided.

F. Ditch Checks and Drop Structures

1. In grass channels grades and velocities may be controlled by use of ditch checks and drop structures.
2. Ditch checks may be required in natural channels where average velocity for the peak flow rate from the 5-year storm exceeds five (5) feet per second for post-development conditions.

G. Spillways

1. Erosion protection must be provided at spillways and outlet structures for detention ponds. Erosion protection shall extend to the point where flow has stabilized and average velocity in the outlet channel is five (5) feet per second or less.

5.40.4. Temporary Construction Entrance

A. The temporary construction entrances shall be installed prior to any land disturbance. A minimum of one (1) temporary construction entrance is required at each site, but shall be located at every point where construction traffic enters or leaves a construction site. Additional temporary entrances may be provided if approved. The location of each construction entrance shall be shown on the plan.

5.40.5. Cleaning Streets

A. Streets, both interior and adjacent to the site, shall be cleaned of sediment as needed, after each rainfall and at the end of construction and prior to release of security deposit.

5.40.6. Dust Control

A. The contractor will be required to use water trucks to wet haul roads and construction areas to minimize dust leaving the site when conditions warrant.

5.41. Timing of Construction Activities

- A. BMP's shall be established prior to disturbing any soils.
- B. Detention and water quality facilities shall be constructed prior to disturbing the site.
- C. Weekly inspection reports shall be prepared as required by the MoDNR permit.
- D. BMP's shall be maintained throughout the construction project.
- E. BMP'S shall be removed when all disturbed surfaces have been established with vegetation or permanent surfaces.
- F. Notice of Termination(s) shall be filed with MoDNR.
- G. The City of Ozark closes the land disturbance permit.

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Table I – Manning’s n-Values	
Closed Conduit	
Concrete Pipe	.013
Corrugated Steel Pipe	.024
Corrugate polyethylene, (smooth wall)	.013
Open Channels	
Gabions	.035
Concrete	.015
Riprap	.035
Grouted Riprap	.027
Guniting	.028
Earth Lined	.020 to .040
Grass lined	.029 to .100
Natural Streams	.025 to .100

Table II – Loss Coefficients**A. Expansion Loss Coefficients**

Expansion Angle	Coefficient, K_x	
	D2/D1=3	D2/D1=1.5
10	.17	.17
20	.40	.40
45	.86	1.06
60	1.02	1.21
90	1.06	1.14
120	1.04	1.07
180	1.00	1.00

Where D2 = downstream diameter and D1 = upstream diameter.

B. Contraction Loss Coefficients

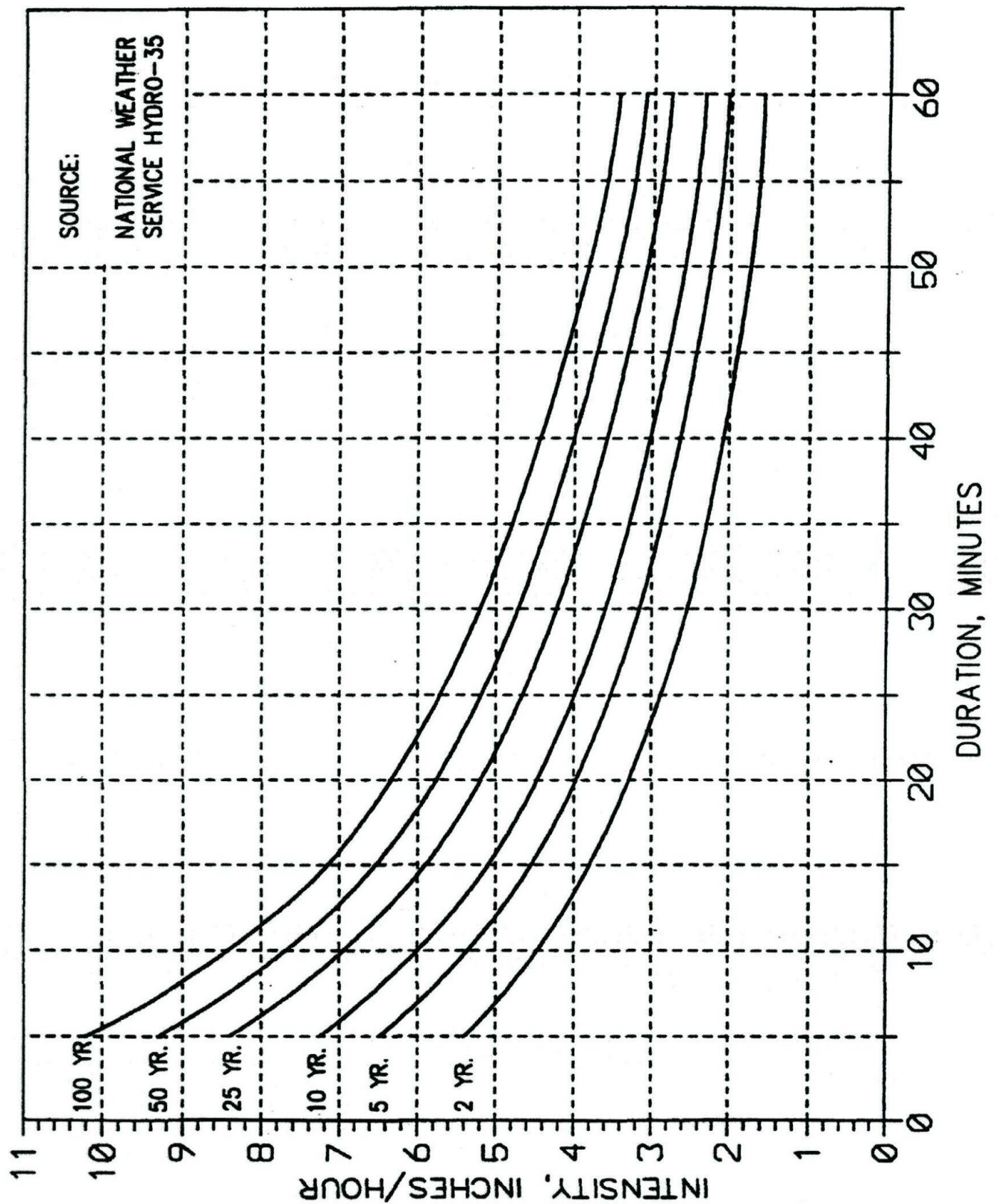
Entrance	Coefficient, K_c
Bell-mouthed	.04
Square-edged	.50
Groove-edged	.20
D2/D1	Coefficient, K_c
< .4	.5
.4	.4
.6	.3
.8	.1

C. Bend Loss Coefficients

Pipe Bends	Deflection Angle	Coefficient, K_b
	90	.50
	60	.43
	45	.35
	22.5	.20
Bends at Manholes (No special shaping)	Deflection Angle	Coefficient, K_b
	90	1.30
	60	0.68
	45	0.44
	22.5	0.14
Bends at Manholes (Curved or deflector)	Deflection Angle	Coefficient, K_b
	90	1.04
	60	0.48
	45	0.32
	22.5	0.10

D. Straight through Loss Coefficients

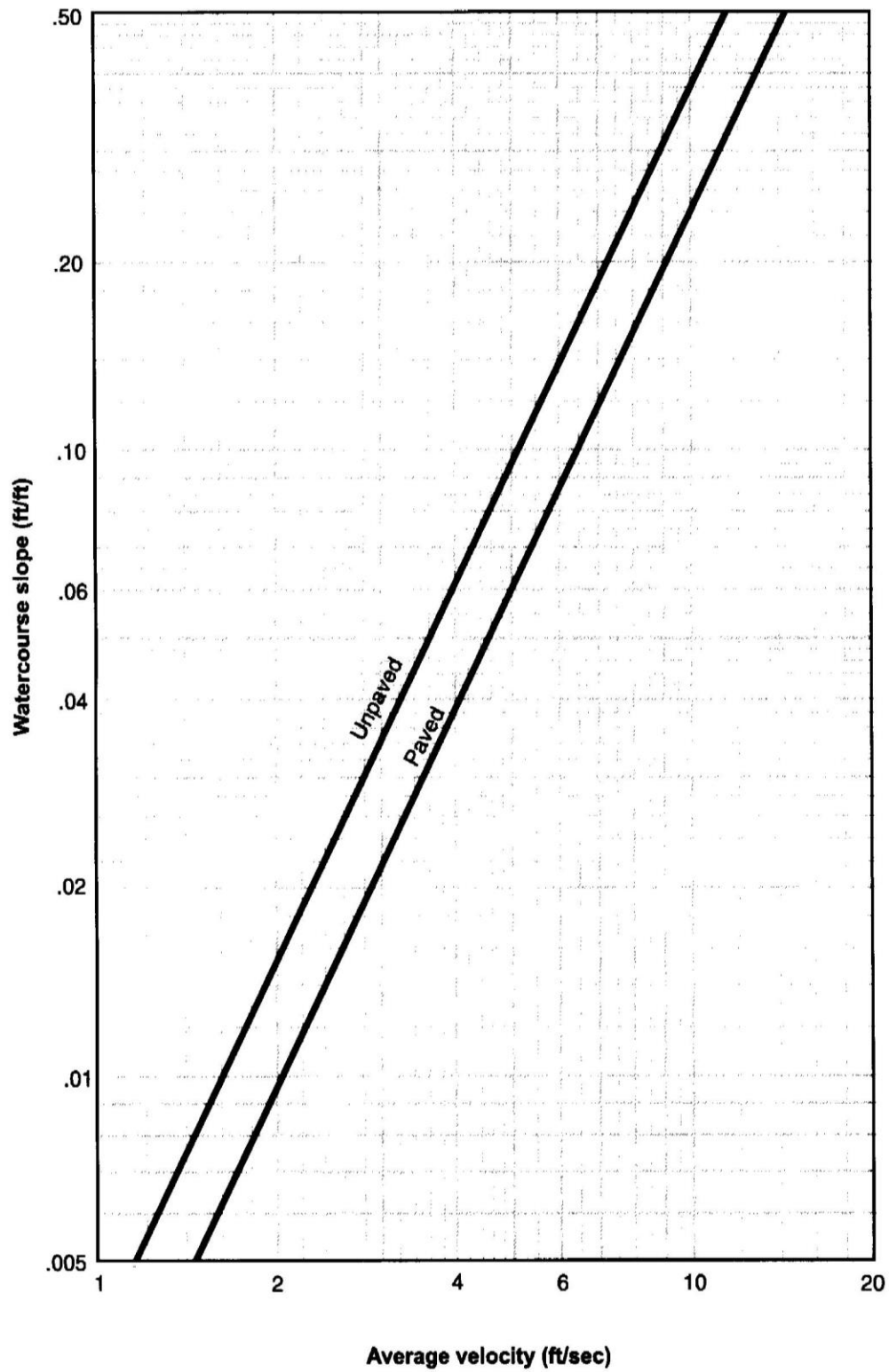
Manholes	Deflection Angle	Coefficient, K_m
	0	.050



RAINFALL INTENSITIES
DURATION < 60 MINUTES

DRAWING NO. 1

Figure 3-1 Average velocities for estimating travel time for shallow concentrated flow



RUNOFF COEFFICIENTS FOR USE IN THE RATIONAL FORMULA

<u>Surface Type</u>	<u>Runoff Coefficient</u>	<u>Notes</u>
Asphalt, concrete pavement	0.95	(1,3)
Roofs	0.95	(1,3)
Gravel	0.70	(2,3)
Lawns, pasture, hayfields		
Flat (<2% slopes)	0.15	(1,3)
Average (2-7% slopes)	0.20	(1,3)
Steep (>7% slopes)	0.30	(1,3)
Woods	0.10	(2,3)

COMPOSITE RUNOFF COEFFICIENTS FOR SINGLE FAMILY RESIDENTIAL AREAS

(using recommended values for runoff coefficients and estimates of impervious area given in this table)

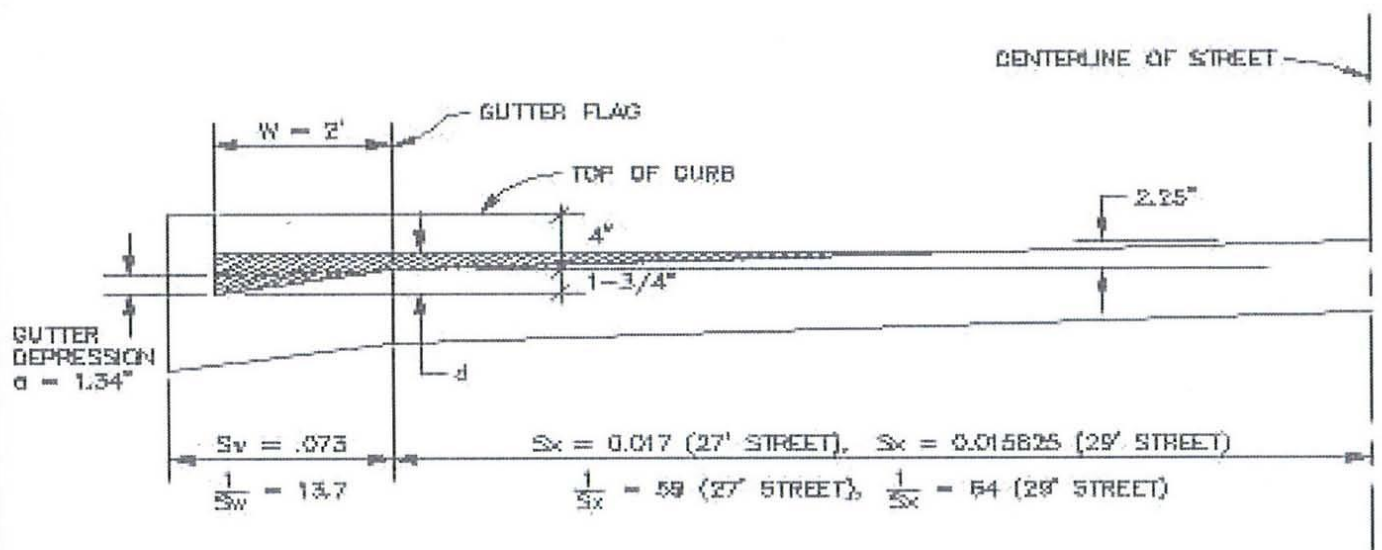
	<u>Terrain</u>			
	<u>Flat</u>	<u>Average</u>	<u>Steep</u>	
Avg. Lot size, 1/4 acre		0.45	0.49	0.55
Avg. Lot size, 1/3 acre		0.40	0.43	0.50
Avg. Lot size, ½ acre		0.35	0.40	0.46
Avg. Lot size, 1 acre		0.25	0.30	0.38
Avg. Lot size, 3 acres		0.20	0.24	0.33

IMPERVIOUS COVERAGE FOR TYPICAL DEVELOPMENTS FOR USE IN COMPUTING COMPOSITE RUNOFF COEFFICIENTS

<u>Type of Development</u>	<u>Zoning District</u>	<u>% Impervious Cover</u>
Single Family Residential		
Avg. Lot size, 1/4 acre	R1	38 (Note 5)
Avg. Lot size, 1/3 acre	R1	30 (Note 5)
Avg. Lot size, 1/2 acre	R1	25 (Note 5)
Avg. Lot size, 1 acre	R1	13
Avg. Lot size, 3 acres	A-R	5
Duplex, patio homes	R2	(Note 6)
Multifamily	R3	(Note 7)
Office	O1, O2	(Note 7)
Commercial	C1, C2	70 (Note 8)
Commercial	C3	60 (Note 8)
Industrial, Manufacturing	M1, M2	(Note 7)

(See notes on next page)

- (1) From ASCE Manual of Practice, Table 5.5, p. 91. (Reference 104.13)
- (2) From Ritter & Paquette, Highway Engineering, as referenced in The Rational Method Revisited, by Ronald L. Rosmiller, Proceedings of the International Symposium on Urban Runoff, University of Kentucky, Lexington, KY, June 28-31, 1980.
- (3) Each of the above references suggests a range of values for each type of cover. The values given in this table reflect prevailing local practice.
- (4) The ASCE manual of practice (Reference 104.13) notes that the normal range of runoff coefficients given in the manual are typical for return periods of 2 to 10 years. Because infiltration and other losses have a proportionately less effect, higher values are recommended for storms with larger return periods. Debo and Reese recommend increasing runoff coefficients by 10% for a 25-year return period and 25% for a 100-year return period (maximum value of 1.0). (Reference 104.14)
- (5) Values from SCS TR-55 Table 2-2a. (Reference 104.5)
- (6) Typical value used locally.
- (7) % impervious area should be determined on a case by case basis from the site plan.
- (8) Maximum impervious area coverage permitted by the Zoning Code for this district.



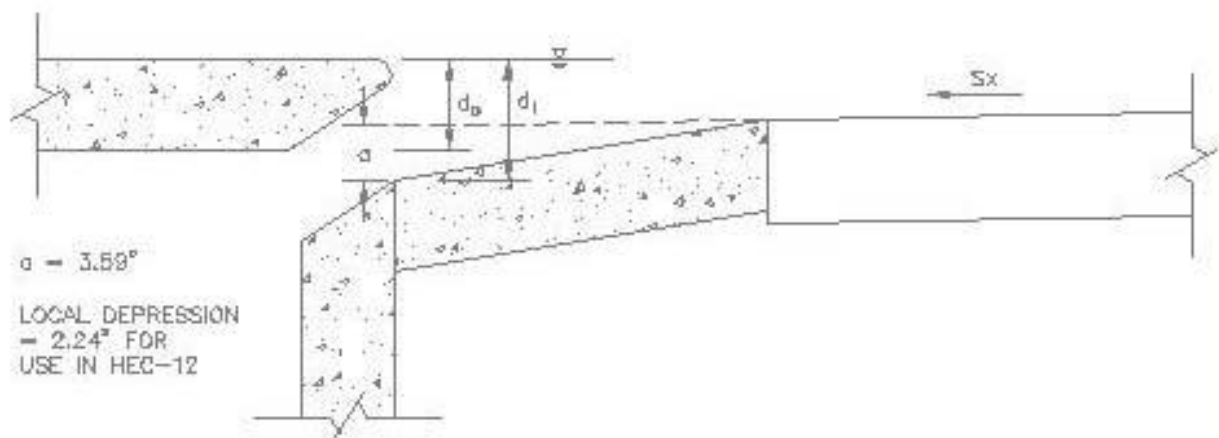
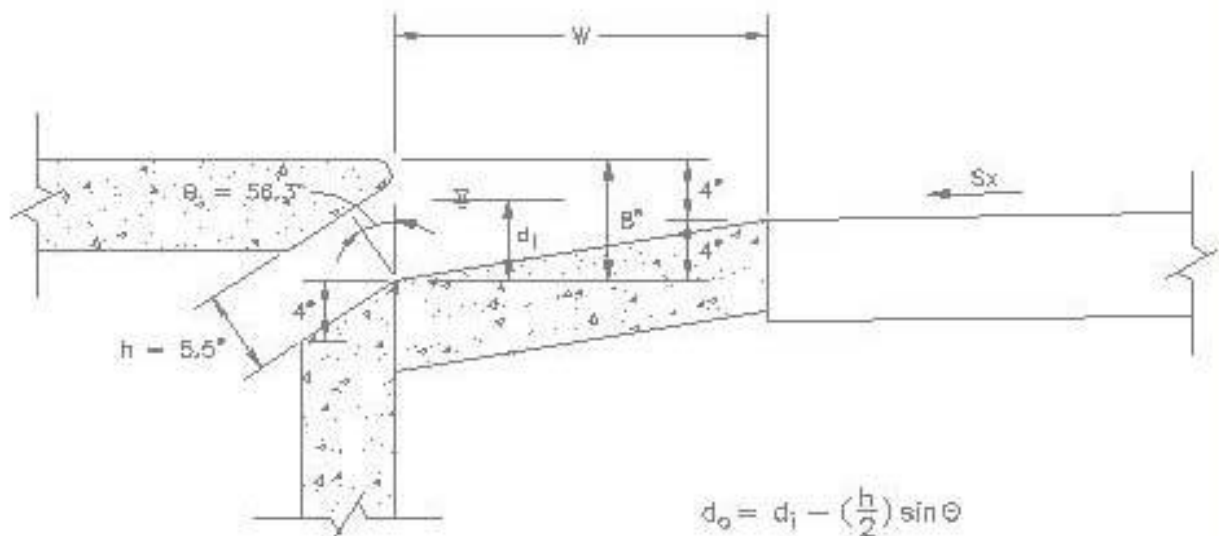
$$S_v' = \frac{a}{12W} = 0.056, \quad \frac{1}{S_v'} = 18.2$$

DEFINITION SKETCH – VARIABLES FOR GUTTER FLOW AND INLET DESIGN

OZARK MISSOURI – STORM WATER DESIGN STANDARDS

STREET FLOODING DEPTHS, VARIABLE DEFINITIONS

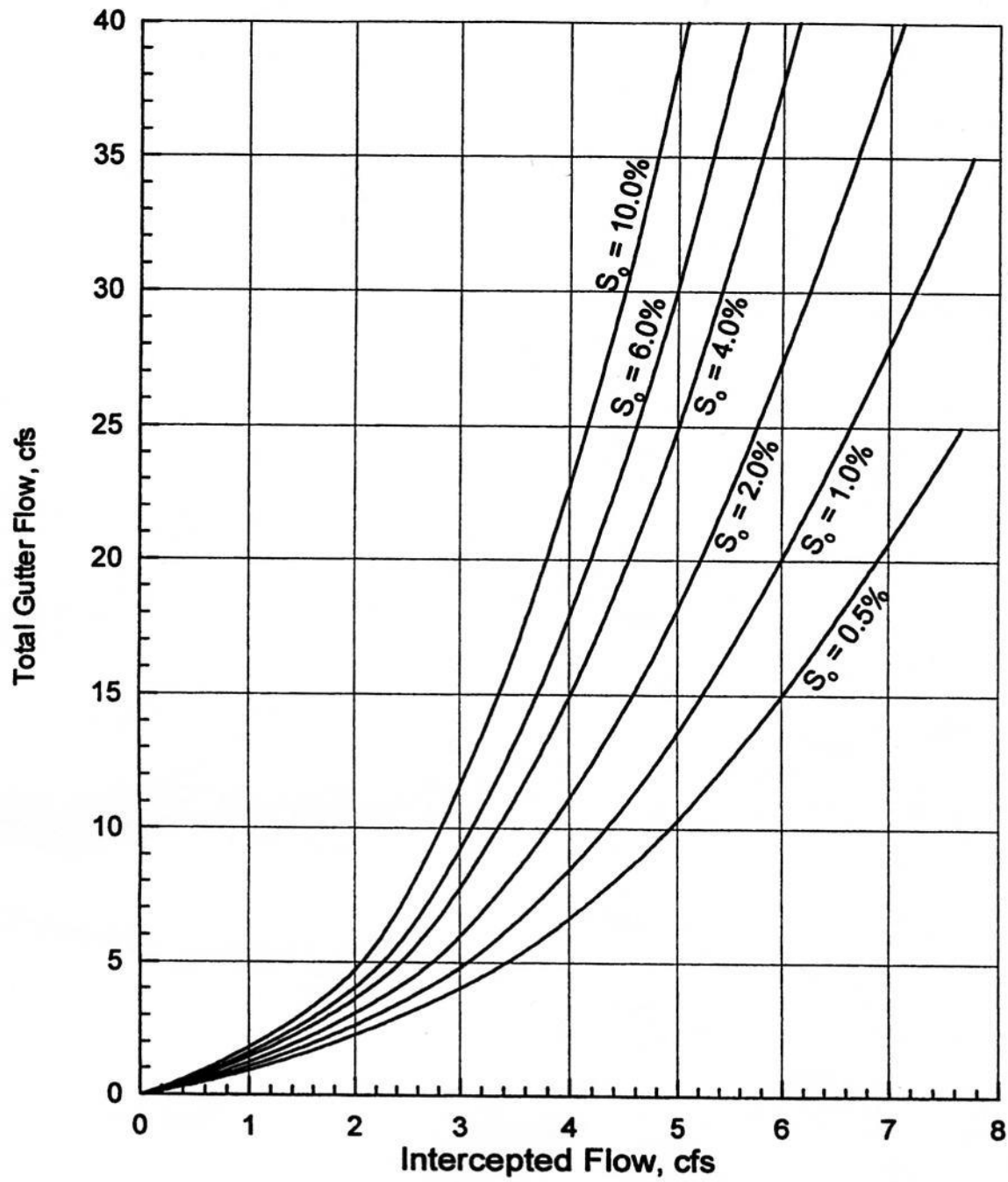
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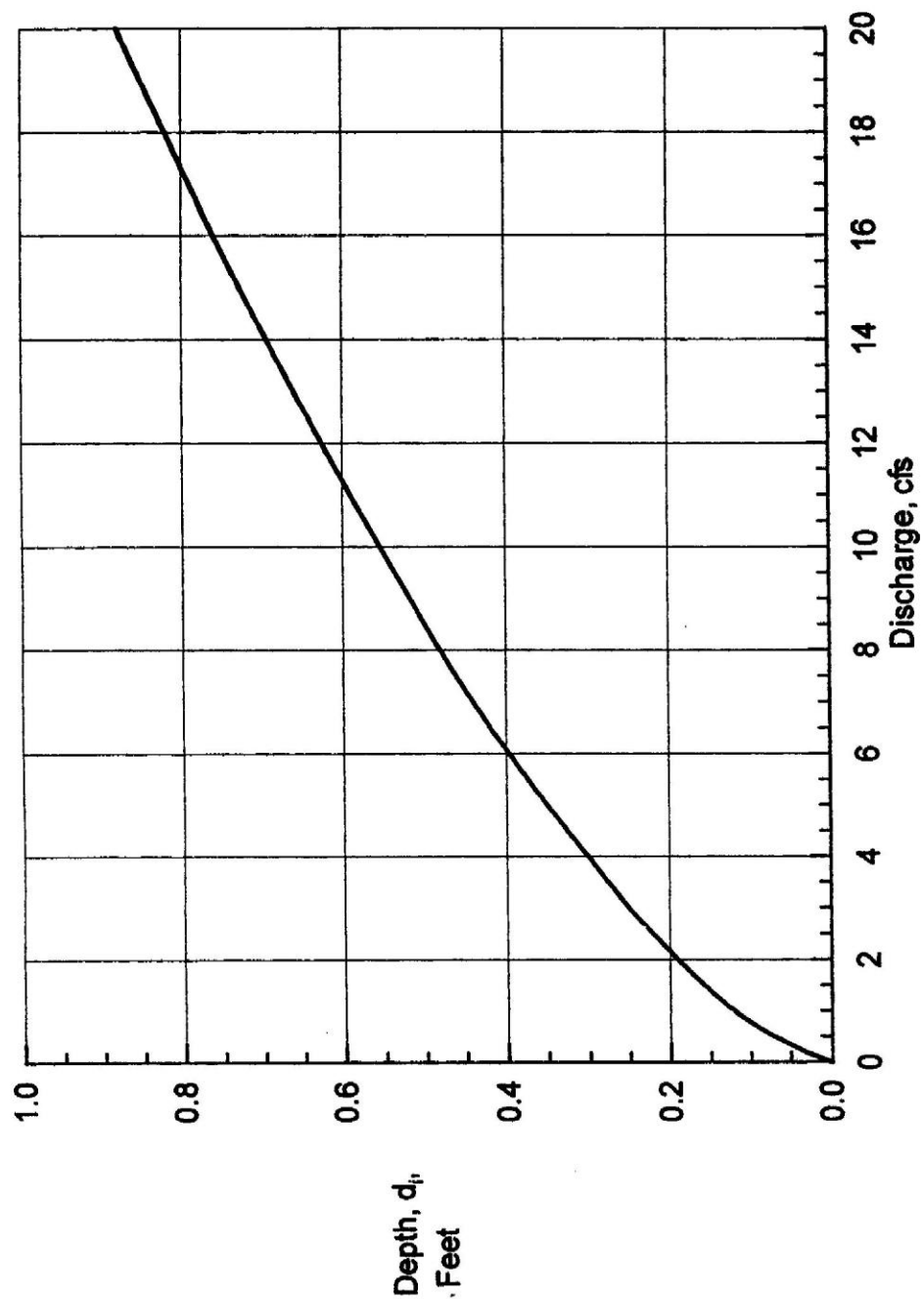
OZARK MISSOURI – STORM WATER DESIGN STANDARDS

STANDARD CURB OPENING INLET – DEFINITION SKETCH

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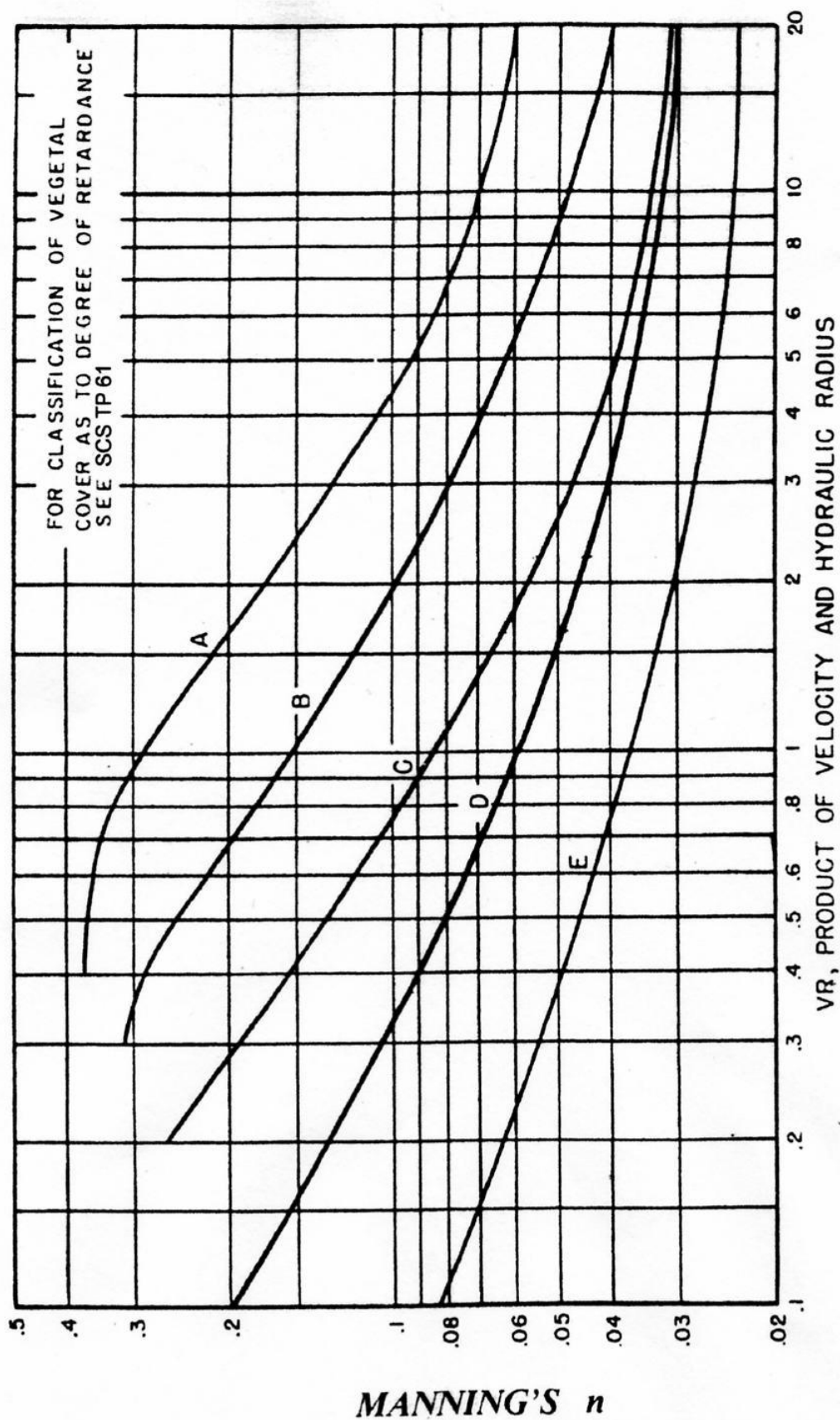


Interception Capacity For Standard Curb Opening Inlet, 7' Opening



Note: For standard 7' inlet with 2" gutter depression.

Capacity For Standard 7' Curb Opening Inlet In A Sump



Manning n for vegetated-lined channels (from handbook of channel design for soil and water conservation SCS-TP-61 revised June 1964).