

DIVISION V
DESIGN CRITERIA

SECTION 5500 SANITARY SEWERS AND APPURTENANCES

Approved and Adopted this 17th Day of April, 1996

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**DIVISION V
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SECTION 5500 SANITARY SEWERS AND APPURTENANCES

Approved and Adopted this 17th day of April, 1996

Kansas City Metropolitan Chapter
of the American Public Works Association

SECTION 5501 GENERAL

5501.1 INTRODUCTION: This document represents a summary of design standards for sanitary sewers used by communities in the Greater Kansas City area. It is intended to assist the professional engineer by outlining minimum requirements for design common to these communities. Specific requirements for certain communities may also apply. For this reason, the designer should contact the reviewing authority concerning specific design criteria. All communities in the Greater Kansas City area retain the right to modify their design criteria with respect to the information contained herein.

These criteria cover design factors and provide guidelines for evaluations of plans and specifications by the reviewing authority. These criteria are not intended to cover extraordinary situations, and in such instances deviations from the criteria may be allowed where justified, upon the approval of the reviewing authority.

The design of sanitary sewers shall be sealed by a professional engineer licensed in the state of the project site. The designer shall submit such additional design information as the reviewing authority requires. Design calculations, soil studies, and field survey data are examples of pertinent design information necessary for plan review.

Qualified construction observation is required by most Greater Kansas City communities. Unless otherwise provided, this service shall be performed by the designer.

Where the term "shall" is used in this document, it is intended to mean a mandatory requirement insofar as any confirmation by the reviewing authority is concerned. Other terms like "should", "recommend", and "preferred" indicate discretionary use.

5501.2 Reviewing Authority Compliance:

- A. **Master Plans:** The proposed design shall be in accordance with master plans for the indicated area if formulated. Otherwise, a predesign conference with the reviewing authority is required.
- B. **Other Requirements :** It shall be the responsibility of the designer to comply with all standards and ordinances applicable to the project. The designer shall refer to the reviewing authority for a complete listing of standards, codes, and ordinances required for conformance.

Other applicable design standards include the most recent published edition of the following:

1. "Minimum Standards for Design of Sanitary Sewerage Facilities" of the Kansas Department of Health and Environment.
2. "Rules of the Missouri Department of Natural Resources, DIVISION 20 - Clean Water Commission".

3. Joint publication WPCF MOP No. FD-5 and ASCE Manual No. 60 "Gravity Sanitary Design and Construction, 1982".
4. Applicable ASTM Standards.
5. Local minimum design standards.

All designs shall meet the minimum required by these standards.

SECTION 5502 SUBMITTALS

5502.1 General: Proper preparation with timely and complete distribution are essential elements of the submittal process.

5502.2 Predesign Conference: A predesign conference with the reviewing authority, the designer, the developer where applicable, and representatives of the State regulatory agencies where appropriate, shall be conducted prior to any extensive design effort. A report or plan outlining the scope and objectives of the proposed project shall be prepared and shall be made available prior to the conference. A primary consideration in the proposed project development is conformance to current sanitary sewer master plans and other adopted policies of the reviewing authority.

The design engineer shall demonstrate an understanding of local sanitary sewer ordinances, sanitary sewer standard specifications and documents, sanitary sewer rights-of-way, easement policies (both public and private), and State standards for sanitary sewerage facilities at the predesign conference.

A preliminary schedule indicating proposed dates for design submittals, construction drawings and specifications reviews, construction bidding and award schedule, construction period, and conforming to construction records submittal shall be presented at the predesign conference.

The design engineer shall be responsible for preparing minutes of the predesign conference and furnishing a copy to all conference attendants within one week following the conference. The purpose is to provide mutual understanding and documentation for reference of principal matters covered at the conference. Proposed dates for furnishing the Preliminary Design Memorandum submittal and Final Design submittal and distribution shall be included in the conference minutes.

5502.3 Preliminary Design Memorandum:

A. Purpose: The design engineer shall prepare a preliminary design memorandum and distribute as agreed at the predesign conference for reviews and approvals prior to beginning final design work. The preliminary design memorandum shall be a condensed version of the final design submittal, but must contain sufficient detail to display adequate knowledge of the overall project requirements and scope.

The purpose of a preliminary design memorandum is to establish a common understanding, through review comments, among all principal representatives involved in the project as to requirements and objectives of the project. Decisions and agreements reached at the predesign conference, as included in the conference minutes, shall be reflected in the preliminary design memorandum.

The preliminary design memorandum shall outline the project from concept through detailed implementation. It shall briefly present the purpose and scope of the proposed sanitary sewer project and follow with a more detailed description of the project, including:

1. General location and information concerning the area to be served, including service area boundaries.

2. Relative location of the project to existing sanitary sewerage facilities within and adjacent to the proposed service area.
3. Review of planning studies to determine land use, population projections and other factors affecting wastewater discharges within the proposed service area, as to both quantity and quality.
4. Estimates of present and future design flows within the proposed service area with consideration of expansion of facilities to serve upstream areas where applicable. (See Section 5503 Design Flows.)
5. Consideration of treatment of wastewater from service area in either existing or new facilities.

B. Facilities Requirements: Following an assessment of project area limits and sanitary sewerage service needs, the design engineer shall evaluate sanitary sewerage system facilities requirements to meet the present and future needs, including:

1. Review available information concerning service area topography, geology, subsurface soil types and ground water table elevation range and assess affects on design, construction and operation of the project.
2. Preliminary routing of proposed gravity sewers and lift station force mains where applicable.
3. Preliminary site selections for lift stations and site access where applicable.
4. Preliminary sizing based on capacity requirements and available slope along proposed routes and consider additional capacity requirements based on overall master planning for future expansion. (See Section 5504 Sewer Line Sizing).
5. Lift station sizing, including holding basins and other site development and associated force main sizing. (See Section 5504 Sewer Line Sizing and Section 5507 Lift Stations.)
6. Proposed construction material alternates for sewer pipe, manholes, castings and other construction based on established standards of the reviewing authority.
7. Determine temporary construction and permanent easement requirements and other site access needs.
8. Prepare location drawings showing proposed facilities on current topographic map suitable for exhibit display.
9. Prepare preliminary opinion of project cost including construction, engineering, fiscal, legal and administrative with separate allowances for easements, rights-of-way, and lift station sites using the best information available without appraisals. A contingency should also be included.

C. Distribution: The design engineer shall make distribution of the preliminary design memorandum as established at the predesign conference. Reasonable time shall be allowed for comments on the preliminary design memorandum reviewing parties with corresponding dates set for receipt of review comments and the final design submittal.

5502.4 Final Design Submittal: The final design submittal shall consist of construction drawings or plans, specifications and contract documents, adequate in detail and clarity for project bidding and construction.

Construction drawings shall be prepared from onsite surveys and/or aerial mapping and other project site investigations. Existing surface and subsurface obstacles, utilities and other conditions affecting the design and construction of the project shall be indicated and identified on the construction drawings with reasonable detail and accuracy.

A. Construction Drawings:

1. **General:** Project construction drawings are a graphic representation of the location and detailed description of the work to be performed. The drawings along with the contract specifications and documents are the directives and guides to be followed in converting a project design into an usable sewerage facility.

After review by the reviewing authority, the design engineer shall make any required revisions to the construction drawings and bids shall then be received for construction of the project. After completion of the project, the construction drawings shall be revised to reflect any changes or modifications to the original bid drawings and any pertinent field information discovered during construction shall be noted.

2. **Content and Organization:**

- a. **Cover Sheet:** The cover sheet for the drawings shall include the following:

- (1) Reviewing authority's name, with name and number designation of the project and year.
- (2) General location map showing section, township and range with project location indicated and locations of highways, streets, rivers, and other identifiable landmarks sufficient to provide convenient access to the project site.
- (3) Name and seal of the design engineer.
- (4) Name and signature of the approving authority, date of approval and construction permit number.
- (5) North arrow and graphic scale.
- (6) Legends, abbreviations, sheet index, sheet titles, and general notes and comments shall appear either on the cover sheet or on the following General Layout Sheet.

- b. **General Layout Sheet:** The general layout sheet shall contain a map or plat, depending on the size of area over which the project is located, at an engineering scale necessary to show the entire system on one plan sheet of minimum size of 22" x 36". All elements of the project shall be identified and pipe sizes and limits of each size shown. Street names, references to USGS township, range, section lines and quarter section lines, and names of surrounding developments shall be shown. A table of the coordinate values for each manhole shall be shown if a regional coordinate system is available to the project area.

Sheet numbering, usually one (1), project identification, design engineer identification, Professional Engineer's seal, revisions and record of issue identification blocks, north arrow, and scale shall be shown.

Abbreviations, legends, list of drawings and sheet titles, general notes and comments, if not shown on the cover sheet, shall be included on the general layout sheet.

- c. **Sewer Plan:** Sewer plan shall be on plan and profile sheets of minimum size of 22" x 36" and shall be drawn directly above the sewer profile. Normally the sewer plan should be drawn with lower stationing starting at left and ending at the right side, with direction of flow from right to left. A single plan and profile shall be shown on each sheet.

The sewer plan view shall show the sewer survey alignment with the final location of the sewer center line relative to the field survey alignment by using angles and stationing. The plan view shall present the proposed design including the surface topography and utilities which are located along, across, or near the proposed sewer alignment, and any other existing or proposed improvements or conditions in the vicinity of the proposed construction.

Temporary construction and permanent easements and rights-of-ways and project site access easements shall be shown in plan on the drawings. Property owners, both private and public, within the easements and right-of-way shall be shown by name and property lines.

Survey elevation reference points (bench marks) shall be described and elevations with datum plan (U.S.G.S., etc.) shall be clearly identified on the plan strips.

In addition, the following shall govern sewer plan drawings:

- (1) Scale: 50 feet to one inch.
- (2) North arrow shown on all a plan areas of each sheet.
- (3) Matching line must be clearly indicated.
- (4) Lot lines, lot numbers, block numbers, minimum finish floor elevations, building locations, and building designations shall be shown.
- (5) Stationing shall be indicated at every 100 feet.
- (6) Manholes, with internal diameters and identification numbers or letters, special structures, wye and tee locations shall be indicated and stationed.
- (7) Horizontal angles between incoming and outgoing pipes at manholes and other structures shall be indicated.
- (8) The existing sewer facility that is being connected to by the proposed project shall be identified by previous project number and/or name, previous project stationing or manhole identification.

- d. **Sewer Profile:** Sewer profile drawings shall be on plan and profile sheets and located directly below the sewer plan drawing of the respective profiled section of sewer. Layout arrangements by stationing and flow direction shall be as described for the sewer plan drawing under 5502.4.A.2.c.

Sewer profile drawings shall be continuous profile of all sewer runs showing existing and proposed surface elevations. At all structures, the location (stationing) including the top casting and invert (in and out elevations) shall be indicated. Between structures, the pipe size, special pipe embedment on encasement, and tunneling or pipe casing shall be shown including the limits of each if not continuous throughout. In addition, the grade (slope) of the pipe between structures shall be shown as a percent expressed to the nearest hundredth.

Sewer profile drawings shall also conform to the following:

- (1) Scale: Vertical - 10 feet to one inch.

Horizontal - 50 feet to one inch to match plan drawing.

- (2) Stationing at every even 100-foot (4+00, etc.) shall be indicated, with intermediate stationing to locate and/or indicate limits of existing facilities or new construction, including manholes.
 - (3) Existing underground utilities crossing or paralleling within 100 feet of the new sewer alignment shall be indicated, based on best information available from utility owners and records.
 - (4) Subsoil and other subsurface conditions, as desired by each reviewing authority.
 - (5) Parallel creek flowlines within 200 feet horizontal distance from the sewer alignment, shall be shown at the proper elevation with dashed lines on the profile.
- e. **Sewer Details:** A standard detail sheet showing each type of standard manhole, connections for dissimilar pipe materials between manholes, concrete encasement alternatives, sewer installation inside carrier pipe casings and liner plate tunnels, special structure details not requiring additional drawings and other appropriate details, shall be provided following the plan and profile sheets, unless reference is made to the reviewing authority's approved standard details.
- f. **Right-of-Way/Easement Sheets:**
1. **General:** Right-of-way and easement sheet(s) shall be provided with most plan sets. The right-of-way/easement sheet shall be of minimum size of 22" x 36" and the size shall match all other sheets of the plan set. The scale may be the same as the plan/profile sheet. Only on small projects, where the required information could be included on the plan-profile sheets, without undue clutter, may this sheet be eliminated. When a separate easement sheet is not provided, the right-of-way and easement documentation shall be differentiated by utilizing such features as "hatching" or "gray shading" in order that the plan sheet remains clear and legible.
 2. **Required Information:** Right-of-way and easement sheet(s) shall identify lot dimensions, ownership boundaries, owners names, address, tract and lot numbers, areas of each ownership, easement boundaries, areas of each easement, and the construction limits. Sufficient data shall be provided to identify the size and shape of each ownership and easement boundary, including dimensions, bearings and angles. All proposed and existing easements and/or rights-of-way intended to be used as part of the project shall be identified. Survey centerlines and/or base lines which relate the right-of-way to the construction plans shall be identified. A legend shall be included for clarification. A north arrow and bar scale shall be shown.
- g. **Record Drawings:** Record drawings conforming to construction records shall be prepared and maintained during the life of the project. Recording details and submittal shall be as outlined in 5502.5 - Conforming to Construction Records Submittal.

B. Construction Specifications: The technical specifications for sewer projects shall be in conformance with Section 2500.

5502.5 Conforming to Construction Records Submittal: During construction of the project the Contractor shall keep one record copy of all Specifications, Drawings, Addenda, Modifications and Shop Drawings at the site in good order and annotated to show all changes made during the construction process. These documents shall be available to the design engineer and shall be delivered to him for preparation of mylar reproducible drawings conforming to construction records. The reproducible drawings shall be given to the reviewing authority along with two complete sets of black line prints of the drawings at the end of the project.

A record of the locations of all sewer wyes and tees, and other buried facilities such as existing utility lines, in addition to all construction changes and noteworthy underground soil conditions, shall be accurately indicated on the construction record drawings. Unless otherwise required by the sewer entity, measurements to underground locations shall be made in the upstream direction from the center of the nearest downstream manhole cover.

SECTION 5503 DESIGN FLOWS

5503.1 General: Sanitary sewers shall be designed to provide capacity for the anticipated maximum hourly quantity of sewage and industrial wastes, with approved allowance for infiltration and other extraneous flows. It should be noted that the infiltration and extraneous flow allowances vary widely within any given area, depending on a number of conditions. The values presented in this section are minimum general unit design flows. The design engineer should be cautious in the use of these values as a set rule since local conditions may cause variance from any value noted herein.

5503.2 Design Period:

- A. **Collectors Sewers:** Sewers of the size up to and including a nominal diameter of eighteen (18) inches shall be designed for ultimate development using existing and/or projected land use for the estimated ultimate population of the area served.
- B. **Larger Sewers:** Sewers with a nominal diameter of larger than eighteen (18) inches shall be designed for a minimum design period of not less than twenty five (25) years, using existing and/or projected land use. A longer design period shall be justified by a cost-effectiveness calculation using the "present worth" method.

5503.3 Design Flow Factors:

- A. **General:** Sanitary sewers shall be designed to provide capacity for the anticipated maximum hourly quantity of wastewater (hourly peak flow), including appropriate allowance for infiltration and inflow. Actual measured flows shall be used whenever reliable wet and dry weather flow measurements are available.
- B. **Capacity:** In the absence of actual measured flows, the following minimum hourly peak design flows, by land use, shall be used (an infiltration/inflow allowance is included):

Land Use	Minimum Hourly Peak Design Flow Rate (Cubic Feet per Second per Acre)
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Residential Housing:

One-and two-family dwellings	0.020
Apartment: (Actual density to be considered)	
a. One through three story	0.020 cfs/ac
b. Four-story and above	As directed by the reviewing authority

Commercial: (Actual density and tenant types to be considered)

- a. Small stores, offices and miscellaneous businesses 0.010
- b. Strip Shopping centers 0.015
- c. Regional Shopping Centers 0.015
- d. High rise As directed by the reviewing authority

Industrial: (Actual density to be considered)

- a. Light 0.015
- b. Heavy As directed by the reviewing authority

C. **Limitations:** These design factors shall apply to watersheds of 300 acres or less. Design factors for watersheds larger than 300 acres shall be as follows unless otherwise directed by the reviewing authority:

Area in Acres	Minimum Hourly Peak Design Flow Rate (Cubic Feet per Second Per Acre)
301-500	0.017
501-1,000	0.015
1,100-3,000	0.015-0.010 with linear decrease based on watershed

SECTION 5504 SEWER LINE SIZING

5504.1 Gravity Lines: All public sewer lines shall be at least 8 inches in diameter. The downstream sewer pipe shall have the same or larger nominal diameter as the upstream pipe, unless otherwise approved by the reviewing authority. All public sewers shall be designed to have a mean velocity of not less than 2.7 feet per second when flowing full. The maximum mean velocity, when flowing full should be less than 10 feet per second. For maximum mean velocities greater than 10 feet per second, special consideration shall be given to protection against erosion. All public sewers shall be designed to carry the design flow at full depth.

All velocity and flow calculations shall be by the Manning Formula using an applicable "n" value for the pipe material:

$$Q = \frac{A (1.486)(R^{2/3})(S^{1/2})}{n} \text{ where:}$$

Q = Discharge in cubic feet per second

A = Cross sectional area of flow in square feet

n = Roughness coefficient of 0.013

R = Hydraulic radius (R = A/P) in feet

S = Slope in feet per foot

P = Wetted perimeter in feet

For straight sewer alignment between structures, the following minimum slopes shall be used. Subject to the approval of the reviewing authority, these minimum slopes shall be steepened to account for additional energy losses when curved sewer alignment is used.

Sewer Size In inches	Minimum Slope in Percent* n = .013
8	.60
10	.44
12	.36
14	.28
15	.26
16	.24
18	.20
21	.17
24	.14
27	.12
30	.11
33	.09
36	.08

*Exceptions to these minimum slopes may be in the upper reaches of lateral sewers where minimum size pipes will flow only partially full. For a low density residential area, a sewer serving less than thirty houses may have a minimum slope of 0.76 percent and a sewer serving less than ten houses may have a minimum slope of one percent.

All building sewer lines are governed the local plumbing code.

5504.2 Inverted Siphons: Inverted siphons should have not less than two (2) barrels. Each barrel shall have a minimum pipe size of 6 inches. There should be no change of pipe diameter in the length of the barrel. Sufficient head shall be provided and pipe sizes selected to provide mean velocities of at least 3.0 feet per second for average flows. Each barrel should be sized to accommodate additional flow from the other barrel should this other barrel be removed from service for cleaning. The rising leg should have these maximum deflections above horizontal:

6-inch pipe	11.25°
8 to 12-inch pipe	22.50°
Greater than 12 inch pipe	45.00°

An air jumper pipeline may be constructed in conjunction with the sewage barrel(s). Provisions for dewatering the air jumper pipeline must be made when the air jumper pipeline is below the hydraulic grade line of the sewer.

5504.3 Force Mains: All force mains for public sewers shall have at least a 4-inch nominal diameter, except force mains with grinder pump installations may have a smaller size diameter when necessary to insure an adequate flushing velocity. Force mains shall have a velocity in excess of 2 feet per second at design average flow. Force mains should have normal operating velocity in suction lines between 2 feet per second and 8 feet per second and in discharge lines between 3 feet per second and 8 feet per second. Construction and pumping costs are factors that should be considered before selecting the size of the force main. Flat sections of force mains 100 feet or longer in length should not be installed on a zero slope.

SECTION 5505 SEWER ALIGNMENT AND LOCATION

5505.1 Gravity Lines:

- A. **Straight Alignment:** All sewers shall be designed on straight alignment between manholes, unless otherwise directed or approved by the reviewing authority.
- B. **Curved Alignment:** Subject to the approval of the reviewing authority, sewers 24 inches in diameter or larger with curvilinear alignment and gradient may be used. If permitted, the following limitations apply:
 - 1. The maximum allowable deflection at any pipe joint shall not exceed 80% of either the pipe manufacturer's maximum allowable deflection per joint or that allowed by the applicable ASTM Specification.
 - 2. In no case will the radius be less than 150 feet.
 - 3. Curved sewers in street right-of-way shall be concentric with the street horizontal alignment.
 - 4. The designer shall include in the plans supporting information for horizontal curvature as necessary for staking, construction and design consideration.
- C. **Location:**
 - 1. **General:** Sanitary sewer should be located within street or alley, or if necessary, in a permanent easement on private property. Imposed loading shall be considered in all locations. Manholes should be located outside of paved areas and not within water courses. Manholes should be offset from property lines a minimum of two-feet.

Not less than six (6) feet of cover shall be provided over the top of the pipe in street and alley rights-of-way. In all other areas, not less than four (4) feet of cover shall be provided over the top of the pipe. Sanitary sewers shall be located deep enough to serve existing basements, proposed basements or the first floor of buildings with no basements.

- 2. **Easements:** Where public sanitary sewers are located outside of existing rights-of-way, a minimum permanent easement of ten (10) feet (five feet from the centerline in each direction) and the necessary temporary construction easement shall be provided. In addition, provisions shall be made for access to maintain the entire sanitary sewer system. The types and sizes of equipment used for sewer maintenance shall be considered for both manhole location and access easements.

3. Streams:

- a. **Alignment:** Sewers crossing streams should be designed to cross the stream as nearly perpendicular to the stream flow as possible and shall be on a constant grade. Sewer systems shall be designed to minimize the number of stream crossings. Sewers adjacent to streams shall be located outside of the stream bed and sufficiently removed to provide for future possible stream widening and to prevent siltation during construction.
- b. **Cover Depth:** The top of all sewers crossing streams shall be at a sufficient depth below the natural bottom of the stream bed to protect the sewer line.

All sewers crossing drainage ways with less than 3 feet of cover depth shall be encased in concrete plans. In no case shall the top of the encasement be above the stream bed.

- c. **Structures:** Manholes or other structures shall be located as they do not to interfere with the free discharge of flood flows of the stream as required by the agency governing the stream.
- d. **Materials:** Sewers crossing streams shall be concrete encased unless designed using reinforced concrete pipe or ductile iron pipe.

4. **Aerial Crossings:** Support shall be provided for all joint in pipes used for aerial crossings. The support shall be designed to prevent frost heave, overturning, and settlement.

Precautions against freezing, such as insulation and increased slope, shall be provided. Expansion jointing shall be provided between above-ground and below ground sewers.

The aerial crossing shall be located as not to interfere with the flow of the stream as required by the agency governing the stream.

Aerial crossings shall be designed using ductile iron pipe or concrete pressure pipe.

5. Utility Protection:

- a. **Water Line:** A minimum horizontal distance of ten (10) feet shall be maintained between parallel water and sanitary sewer lines. At points where sanitary sewers cross water mains with less than two (2) feet of clearance, the sanitary sewers shall cross under the water main and shall be designed using ductile iron pipe or concrete pressure pipe, or encased in concrete for a minimum distance of 10 feet in each direction. The crossing shall be arranged so that the sewer joints will be equal distance and as far as possible from water main joints.

Water and sanitary sewer lines shall not be placed in the same trench or excavation.

- b. **Water Works Structures:** While no general statement can be made to cover all conditions, it is generally recognized that sewers shall meet the requirements of the appropriate reviewing agency with respect to minimum distances from public water supply wells or other water supply sources and structures.
- c. **Gas, Electric, Telephone, Storm Sewers and Other Utility Lines:** A minimum horizontal distance of five (5) feet should be maintained between parallel sanitary sewer lines, storm sewers and utility lines other than water lines.

The vertical separation between storm sewers and sanitary sewers should be two (2) feet minimum. If tees and wyes are installed, they should be routed from under gas, electric, telephone, storm sewer and other utility lines.

6. Steep Grades: Sewers on 20 percent slope or greater shall be anchored securely with concrete anchors or approved equal, where spaced as follows: not over 36 feet center to center for grades 20 percent to 35 percent; not over 24 feet center to center for grades 35 percent to 50 percent; and not over 16 feet center to center for grades 50 percent or greater.

5505.2 Force Mains: Force mains should be placed in the street or alley right-of-way or if necessary, in a permanent easement on private property.

Force mains shall be placed at least forty-two (42) inches below the finished ground and generally may follow the topography of the terrain. The location of force mains with respect to water mains and other utilities, aerial crossings, stream crossings and steep grades shall be the same as for gravity sewers.

5505.3 New Development Building Services:

- A. Where sewers are located in the street or alley right-of-way a connection (wye, tee, saddle or stub) shall be provided for each building site in new development. The connection shall be extended with a service line to the property line of the building site. The connection shall be designed to provide a vertical angle of not less than thirty (30) and no more than forty-five (45) degrees to the horizontal centerline plane of the sanitary sewer.
- B. In conformance with the applicable plumbing code, a minimum drop shall be provided of not less than 3.0 feet between the basement floor elevation and sanitary sewer flowline elevation at the point of service line connection. The minimum basement floor elevation which sanitary sewer service can be provided shall be indicated. Consideration shall be given in providing sufficient depth where extra long connections, deep building service connections, or other atypical conditions may exist. Service line stubouts shall be referenced to the downstream manhole and the centerline of the sewer. Stubouts at angles other than 90° off of the sanitary sewer shall be referenced by providing the angle between the sewer line and the service line and distance along the service line stubout.

SECTION 5506 SEWER APPURTENANCES

5506.1 MANHOLES:

A. **General:** Manholes shall conform to the standards of the governing agency.

B. Manhole Casting:

1. **Flooding:** When located in areas subject to inundation by flooding or sheet flow, unvented and bolted covers shall be provided.
2. **Internal Pressure:** When designed to function with internal pressure, unvented, gasketed and bolted covers shall be provided and rings shall be anchored to manhole walls.
3. **Vandalism:** When located in areas where theft and vandalism are expected, bolted covers may be required.
4. **Larger than 15-inch Diameter Sewers:** When the diameter of the manhole's outgoing sewer is at least 15-inches, bolted covers shall be provided.

C. **Inverts:** The difference in elevation between the invert of any incoming sewer and the invert of the outgoing sewer shall not exceed 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. The drop through manholes shall be as tabulated below.

Deflection Angle Range (degrees)	Drop Through Manhole (feet)
0 to less than 10	None
10 to less than 45	0.2
45 and greater	0.4

- D. **Drop Manholes:** Drop manholes should be avoided when possible. Freefall drop manholes shall not be used. Where inside drops are used, the incoming flow shall be piped to the manhole invert.
- E. **Diameters:** The minimum horizontal clear distance within the barrel of manholes shall be 48-inches.
- F. **Cleanouts and Lampholes:** The use of cleanouts and lampholes is prohibited.
- G. **Manhole Location:** Manholes shall be installed at the end of each line, changes in pipes size, grade at intersections and at changes in alignment except for curved sewer. The distances between manholes shall not be greater than 400 feet for sewers 16" and smaller and 500 feet for sewers 18" and larger. When a sewer is located in an easement not abutting street or alley right-of-way, access shall be provided to all manholes.

5506.2 Air and Vacuum Relief Valves: Air relief and vacuum relief valves shall be provided in the lift station discharge piping and forcemain to adequately vent air and gas and to allow entrance of air as required. Air relief valves shall be sized to prevent line entrapped gas blockage. Vacuum relief valves shall be sized to protect the discharge pipe from collapsing.

SECTION 5507 LIFT STATIONS

5507.1 General:

- A. Lift stations are pumping facilities which are used to convey wastewater from a point beyond which gravity flow is not practical.
- B. All lift stations shall have at least two pumps with the size and number of pumps such that the rated capacity of the lift station can be met with the largest pump out of service.
- C. The time between starts for any given pump shall be a minimum of 10 minutes, with maximum number of starts per hour not to exceed that recommended by the pump motor manufacturer.
- D. Unless equipment or facilities are provided which will limit the size of solids reaching the pump suction, lift station pumps shall be capable of passing 3-inch diameter.
- E. All equipment in the lift station wet well and that equipment or which can be exposed to gases from the wet well shall conform to the National Electric Code Class I, Group D, Division I.

5507.2 Types: Acceptable types of lift stations are as follows:

- A. Dry well:
 1. Flooded suction
 2. Wet well mounted with vacuum primed
 3. Wet well mounted with self-priming pumps
- B. Wet well:
 - a. Submersible pump and motor

- b. Wet well centrifugal with motor located above the wet well

5507.3 Layout and Siting:

- A. Lift stations shall be located on public properties or on easements allowing for construction and access for maintenance of lift station structures, piping, valves, electrical service and all other required appurtenances.
- B. Lift station sites shall be fenced to adequately protect the lift station equipment.
- C. All weather vehicular access shall be provided to lift station sites. Adequate vehicular turnaround shall be provided. Lift station structures and equipment shall be suitably protected from vehicular damage.
- D. To allow for maintenance, access shall be available to all mechanical equipment. Means of access shall meet all applicable requirements of the latest edition of applicable OSHA regulations. Access doors and hatches to lift station structures and control panels shall be equipped with lockable features.
- E. Lift station wet and dry wells shall be vented with vent openings which prevent entrance by birds, small animals and rain. Wet well vents shall be equipped with odor control facilities where required. Wet and dry wells may be ventilated continuously or intermittently. Wet wells shall be ventilated at the rate of at least 12 air changes per hour if vented continuously and at the rate of at least 30 air changes per hour if vented intermittently. Dry wells shall be ventilated at the rate of at least 6 air changes per hour if vented continuously and at the rate of at least 30 air changes per hour if vented intermittently.
- F. Allowance shall be made for removal of all equipment and piping through access openings.
- G. Adequate space shall be provided around piping and equipment located inside structures such that personnel can perform all tasks as required for maintenance, removal and replacement of equipment.
- H. A hoisting system for maintenance of the lift station shall be provided when an alternate means for equipment removal is not available.
- I. Lift station structures and equipment shall remain fully operational and accessible during the 25-year flood. Lift station structures and electrical and mechanical equipment shall be protected from damage by the 100-year flood.

5507.4 Power Supply:

- A. Pumping facilities shall be designed to operate using available utility power. The design of the pumping facilities shall be coordinated with the supplying electric utility and meet their requirements. Transformers may be required to provide proper voltage for the lift station.
- B. Autotransformer starters shall be used when required by the electric utility or by the governing authority.
- C. Provision for continued operation during power outages shall be made and based on protection of property safety considerations and the most cost effective alternative which affords the protection acceptable to the governing authority. Acceptable options include: overflow retention basins, standby power generating equipment, alternate electric power supply, alternate pump motor or portable pumping equipment.
- D. Normal utility power supply shall provide power for pump motor starting as well as lights, ventilation, and other auxiliary equipment necessary for safe and proper operation of the lift station. Sequencing controls shall be provided for staging the starting of pump motors unless the power supply is adequate to start all pump motors simultaneously while other electrical equipment is in operation.
- E. An alternate utility power source or standby power generator shall provide power for the starting and operation of one pump as well as lights, ventilating, and other auxiliary equipment necessary for safe and proper operation of the lift station. The emergency power supply need not be required to operate the standby pump if it is demonstrated to the satisfaction of the governing authority that this is justified. This justification shall take into consideration the maximum anticipated flows relative to firm pumping capacity, anticipated length of power outages, and storage capacity.
- F. Transfer from normal power to emergency or alternate power may be accomplished automatically or manually. When manually transferred, adequate storage of wastewater shall be provided to allow time for the transfer to be implemented.

5507.5 Monitoring and Control:

- A. All monitoring and control equipment shall be located outside of the wet well.
- B. Alarm systems shall be provided which activate in the event of any of the following:
 - 1. Power or pump failure
 - 2. Use of a standby or lag pump
 - 3. Unauthorized entry
 - 4. High wet well level
- C. A telemetry system shall transmit alarm signals to the desired location or audio-visual alarms provided locally at the discretion of the governing authority.

5507.6 Appurtenances

- A. The proper type of isolation valves shall be provided in the suction line of each pump between the wet well and the pump (this shall not apply to submersible or to vacuum primed lift stations) and in the discharge piping of each pump after the check valve. Isolation valves shall not be located in the wet well.
- B. Check valves shall be provided in the discharge piping of each pump, located between the pump and the isolation valve and not located in the pump wet well. Check valves shall be the swing or ball check type. Swing type check valves shall be the outside lever type and shall be horizontally mounted. Ball type check valves may be either horizontally or vertically mounted.

- C. Surge protection facilities shall be provided as required to protect the force main and lift station from surge conditions.
- D. A sump pump or other suitable means shall be provided to remove water or sewage from the dry well as required to protect equipment located in the dry well.
- E. Corrosion of underground surfaces shall be minimized through use of passive or active cathodic protection systems, use of appropriate coatings or use of other acceptable means.