

The City of

Liberty
missouri



TECHNICAL SPECIFICATIONS AND DESIGN CRITERIA

FOR PUBLIC IMPROVEMENT PROJECTS

DEPARTMENT OF PUBLIC WORKS
ENGINEERING DIVISION
101 E. Kansas Street
Liberty, MO 64068

Latest Revision
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PROCEDURE FOR
PUBLIC IMPROVEMENT PROJECT PLAN SUBMITTAL

All developers and engineering consultants submitting plans for public improvement projects to the City for review are required to follow the procedures outlined in the following. No public improvement projects may be constructed in the City of Liberty without the prior approval of the office of the City Engineer.

1. Two (2) complete sets of prints, one full-size (24"x 36" min) and one reduced-size (11"x17"), of the project plans shall be submitted to the office of the City Engineer for review.
2. Upon receipt by the City, the checkprints will be date stamped and assigned a project number.
3. The normal time for review shall be 10 working days. In the case of abnormally large sets of prints (greater than 20 sheets) or of extremely complicated drawings, a longer time may be required for review.
4. The checkprints will be routed through appropriate City departments and/or divisions to obtain a complete review of all facilities which may be affected by the proposed construction. In each review, comments and necessary revisions will be noted on the checkprints.
5. Subsequent to the review of the plans, the consultant or his representative shall be notified that the submittal is ready for return.
6. The consultant will be required to make all necessary corrections or revisions as noted on the checkprints and communicated by the City Engineer. Upon completion of the revisions and/or corrections the plans will again be submitted to the City Engineer's office for further review. Revised sheets submitted shall contain a revision block with identifying notations and date of revisions. All previous checkprints must accompany each re-submittal. If the checkprints are not submitted with the revised drawings, the plans shall be returned to the consultant without action until such time as the checkprints are included with the submittal.
7. In conjunction with submittal of final plans, all permits and/or applications for permits shall be submitted to the appropriate agency for approval prior to final approval of the plans by the City Engineer (i.e., State Highway Department, Department of Natural Resources, etc.).
8. The length of time for final plan approval will normally be within 5 working days. Upon notification of final approval of the plans by the City Engineer, the number of sets of plans as specified in the appropriate section of the Design Criteria Manual shall be submitted for signing and distribution.
9. An original title sheet shall accompany the submittal of plans for final approval by the City Engineer. The City Engineer shall sign and date the cover sheet

serving as the City's approval. This original title sheet shall be returned to the consultant and shall be utilized for all further cover sheets in bid documents sent out for proposals.

10. Public improvement plans and engineering reports are approved initially for one (1) year after the date noted on the returned cover sheet. After one (1) year, the plans or report shall become null and void and must be re-submitted prior to approval of construction of that project. Such plans and/or reports shall be re-submitted to the office of the City Engineer in accordance with the foregoing outlined procedures and requirements.
11. The Design Engineer shall send one set of plans to each of the private and public utility companies having territorial jurisdiction in the area of the improvement upon notification that the drawings have been approved.

GENERAL PLAN REQUIREMENTS FOR
PUBLIC IMPROVEMENT PROJECTS

- A. GENERAL. 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 Criteria Manual for Public Improvement Projects of the City of Liberty and with all other applicable City codes and standards.

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 will be required.

The City of Liberty 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). The City of Liberty, through the approval of the plans and/or report, assumes no responsibility for the completeness and/or accuracy of the public improvement plan or report.

- B. REQUIRED NOTES GENERAL. 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 use of additional notes may be required by the Engineer.

1. 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 Engineer before any construction will be permitted.
2. The City of Liberty plan review is only for general conformance with City of Liberty Design Criteria, Technical Specifications and Code of Ordinances. The City is not responsible for the accuracy and adequacy of the design, or dimensions and elevations which shall be confirmed and correlated at the job site. The City of Liberty through approval of this document assumes no responsibility other than that as stated above for the completeness and/or accuracy of this document.
3. The contractor shall have one (1) signed copy of the plans (approved by the City of Liberty) and one (1) copy of the appropriate Construction Standards and Specifications at the job site at all times.
4. Construction of the improvements shown or implied by this set of drawings shall not be initiated or any part thereof undertaken until the City Engineer is notified of such intent, and all required and properly executed bonds and permit fees are received and approved by the City Engineer.
5. The City of Liberty Technical Specifications, latest edition, shall govern construction of this project.

6. 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.
7. All backfill shall be tamped and at the option of the Engineer tested by a certified laboratory. Where footings will bear on compacted fill material, the placement and testing of compacted fill shall comply with the appropriate compacted fill section of the Soils and Foundation Chapter of the International Building Code version most recently adopted by the City of Liberty.
8. Contractor shall not be allowed to work on Saturdays, Sundays or Holiday without prior approval by the City Engineer.
9. All materials and workmanship associated with this project shall be subject to inspection by the City of Liberty. The City of Liberty reserves the right to accept or reject any such materials and workmanship that does not conform to the City of Liberty Standards and Technical Specifications.

The contractor shall notify the City of Liberty Engineering Services Department twenty-four (24) hours prior to the beginning of construction.

10. Relocation of any water line, sewer line or service line thereof required for the construction of this project shall be the responsibility of the contractor at his expense.

C. REQUIRED NOTES INDIVIDUAL

1. WATER:
 - a. The proposed water line improvements shown by this set of drawings have been designed to provide for the following fire flow requirements as determined by the City of Liberty: __GPM (Note to be placed on development drawings that contain areas zoned for higher densities than R-2).
 - b. Each water main shall be de-chlorinated by injecting a solution to safely neutralize chlorine to a concentration level of less than 10-ppm upon flushing chlorinated water mains.
2. SANITARY SEWER:
 - a. All sanitary stublines shall be laid on 2.00% or greater grade unless approved otherwise.
 - b. MBF denotes Minimum Basement Floor Elevation.
 - c. 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.
 - d. The contractor shall be responsible for video of installed sanitary mains

including distance logging between manholes for verification of stub locations. Video shall include all lines in these drawings. Digital video must be received and reviewed by the City Engineer prior to acceptance of the sanitary mains.

- e. Connections to existing manholes shall be core drilled and connected with a watertight Fernco gasket or approved equal. The gasket is to be installed according to the manufacturer's recommendations.

3. STREETS AND STORM DRAINAGE

- a. All sidewalks shown are for informational purposes only. Sidewalks along collectors and arterials will be constructed with this project and will be considered as part of Final Acceptance.
- b. All compactions shall be performed as set forth in the Technical Specifications. All testing laboratory expenses shall be paid for by the contractor.

4. EROSION CONTROL

- a. Erosion protection shall be in place prior to areas being disturbed. All disturbed areas shall be seeded, fertilized and mulched, or sodded, in accordance with the Standards and Specifications of the City of Liberty and good engineering practices. This shall be completed within fourteen (14) days after completing the work, in any area. If this is outside of the seeding period, silt barriers or other similarly effective measures shall remain until such time that the areas can be seeded and a stand of grass established.
- b. All erosion control measures, temporary or permanent, require maintenance to preserve their effectiveness. All erosion control devices shall be inspected immediately after each heavy rainstorm and at least daily during prolonged rainfall. Any required repairs should be made immediately. All costs associated with the repair work including related incidentals will be the contractor's responsibility.
- c. Site inspection reports shall be completed per the project Storm Water Pollution Prevention Plan (SWPPP) following regularly scheduled site inspections by the Developer (or representative) at least once per seven calendar days. A log of each inspection and a copy of the inspection report shall be kept on file by the Developer and be made available to City project inspectors upon request.

- D. APPROVAL BLOCK. A signature block shall be required on the cover sheet of all plans and reports submitted for review and approval. All plans require the signature of the City Engineer and the date of such signing for formal approval by the City.

The general form of the approval block shall be as follows:

APPROVED

City Engineer

Date

APPROVED FOR ONE YEAR FROM THIS DATE

Public Water and Sanitary Sewer improvement plans shall include the following addition to the approval block:

REVIEWED

Director of Utilities

Date

APPROVED FOR ONE YEAR FROM THIS DATE

- E. PRIVATE IMPROVEMENTS. 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 of Liberty and, as such, an appropriate note shall be included on the drawings.

REQUIREMENTS FOR
PUBLIC IMPROVEMENT PROJECT PLAN PREPARATION

- A. INTRODUCTION. The following criteria is being established to provide a uniform system of plan preparation that will aid the Engineer in preparing plans for work within the City of Liberty. It is not intended that the criteria be an iron-clad set of rules that would restrict the Engineer from utilizing imaginative design; however, all items as described below shall be shown on the plans in some manner.
- B. GENERAL. All plans and specification for public improvement construction within either publicly-financed or privately-financed developments shall be prepared by a professional engineer licensed in the State of Missouri and submitted to the office of the City Engineer for review. Subsequent to the review, the engineer will be notified of the approval of the plans as submitted, or of any necessary changes. (Refer to the section "Public Improvement Project Plan Submittal" for plan review procedures.)

In addition, one set of approved plans shall be sent to each of the utility companies providing service in the proposed construction area.

The suggested plan sheet size is 24" x 36" with all sheets in a given set of plans being of the same size. 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 Engineer for special cases.

The plans shall consist of:

1. Title Sheet
2. General Layout Sheet
3. Grading Plan (Street and/or storm drainage improvement plans only unless otherwise required by the City Engineer)
4. Erosion Control plans, including all required elevations.
5. Plan and Profile Sheets
6. Cross-Section Sheets (Street improvement plans only unless otherwise required by the City Engineer)
7. Standard and Special Detail Sheets

Each sheet should contain a sheet number, including the individual sheet number and the total number of sheets, the engineer's seal, revision block, proper project identification and date.

Each respective type of development project (i.e. sanitary sewer, streets, water mains, etc.) shall be submitted on a separate set of plans unless otherwise allowed by the City Engineer. Plans depicting the location and types of street name and regulatory signs shall be submitted with the street improvement drawings for review. All required signage is to be furnished and installed in connection with the improvement at the developer's expense.

When required by the City Engineer, plans depicting the location of street lights and all related appurtenances shall be submitted with the street improvement drawings for

review of the appropriate power company. Such review shall be for the purpose of verifying easement locations to be indicated on the final plat. Plans for street light installation shall conform to all applicable standards of the power company having jurisdiction over the work.

Unless otherwise directed by the City Engineer, storm sewer construction details should be incorporated into street construction drawings.

C. TITLE SHEET. The following items shall be included on the title sheet.

1. Name of project
2. City project number
3. Index of sheets included in plans
4. A location map adequately showing project location in relation to major streets (minimum scale of 1" = 2000')
5. General description of project area (by Township, Range, and Section)
6. A summary of plan quantities of principal items, such as:

X Pipe sizes and material, lengths, number of manholes, etc. (sanitary sewers).

X Length of curb and gutter, square yardage or tonnage of asphaltic concrete pavement, etc. (streets).

X Pipe sizes and material, lengths, number of inlets, etc. (storm sewers).

X Pipe sizes and material, lengths, number of valves, etc. (water lines)

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 benchmark shall be identified as to location and elevation and be within one thousand (1000) feet of the boundary of the project; USGS datum. (Not required on Water Line Plans.)

8. Name, address and telephone number of the 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)	Water and Sewer
City Engineering Department	

Missouri One-
Call

10. Approval block (see paragraph D of General Plan Requirements)

11. Project engineer's name and seal.

12. Revision schedule.

D. GENERAL LAYOUT SHEET. The following items shall be included on the general layout sheet for all improvement projects.

1. A legend of symbols and abbreviations shall be shown which shall apply to all sheets.
2. North arrow and graphic scale. Scale of the general layout map shall be one(1) 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, elevation of all lot corners, and an accurate tie to at least one quarter section corner. An unplatted tract shall have an accurate tie to at least one (1) quarter section corner.
4. Boundary line of project area.
5. A list of general notes to the contractor that include at least those notes indicated in the "Procedure For Public Improvement Project Plan Submittal" section of this manual.

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

Streets

1. Location of all existing and proposed streets and roadways within and adjacent to the project area (list City project).
2. Location of all existing and proposed drainage system improvements (list City project name and number).

Storm Drainage

1. 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 (for antecedent precipitation)
 - Design storm (return frequency)
 - Incremental tributary acreage
 - Accumulative acreage
 - Rainfall intensity
 - Rainfall runoff

Sanitary Sewer and Water Lines

1. Location of all existing (water or sewer) lines properly designated within or adjacent to the project area (list City project name and number).
2. Connection point or points to existing facilities (tied to a known point on existing facility) and the type of connection to be utilized.
3. Location of all proposed (water or sewer) lines and appurtenances with designation and sheet number on which they appear in plan and profile.
4. All lots located adjacent to drainage ways, channels or overflow channels shall include the lowest basement opening (LBO) for the lot calculated as one (1) foot above the 100-year flood plain elevation or 100-year storm elevation..
5. Sanitary service line summary table containing station, length, size, flowline elevation at the main, and MBF elevation for each service line. The table values shall be corrected in the As-Built plans as necessary reflecting verified post-construction elevations and locations.

Erosion Control

1. Location and type of all devices to be used for erosion control protection within or adjacent to the project area.
2. Show phasing (if any) of the location and type of erosion control protection as work is to progress and structures and facilities are added.

E. SITE GRADING PLAN. The following items shall be included on the general layout sheet for all street and/or drainage improvement projects.

1. Property lines and elevation of lot corners 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 and final grading contours drawn at intervals not to exceed two (2) feet. Intervals of less than two (2) feet may be required by the City Engineer dependent on the character of the topography.

F. PLAN AND PROFILE SHEETS. The plan and profile shall be shown on a single (split) sheet. 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, depth, material, and type of construction.
6. All existing and known proposed improvements within seventy-five (75) feet each side of centerline 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.
 7. All existing easement and right-of-way information recorded with the county.
 8. All proposed easement 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.

In addition, the following items shall be included on the plan and profile sheets for the particular type of improvement stated below.

Streets

1. Station and critical elevation (flowline, invert of pipe, etc.) of all utility or drainage appurtenances, existing and proposed.
2. Flow direction arrows, particularly at intersections.
3. Match lines and consecutive sheet number, beginning with cover sheet.
4. 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.
5. Curb return radii, existing and proposed.
6. Complete horizontal curve data. (R, L, Tan)
7. Centerline stations of all non-single family residential driveways and all intersecting roadways.
8. Basis of plan view and profile elevations shall be the same, i.e., flowline and flowline, top of curb and top of curb, etc.
9. Existing grade above centerline shown as a dashed line; proposed finish grades or established street grades shown as a solid line.
10. 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, gutter and walk. The basis for as-built information shall be the same as the design (both flowline or both top of curb, etc.). All design elevations shall be based on adjacent abutting streets and shall show existing profile a minimum of 150' beyond the boundary of the project.
11. 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.
12. All existing curbs, gutters, sidewalks, and pavement adjacent to the proposed design (minimum distance of 100 feet). Basis for existing grades shall be field verified elevations at intervals not to exceed fifty (50) feet. Previously approved designs are not an acceptable means of establishing existing grades.
13. Station and elevation of all P.C.R.'s, horizontal P.C.'s, P.C.C.'s, etc.;

- existing and proposed.
14. Station and elevation of all vertical grade breaks, existing (as-built) and proposed. (The use of grade breaks with proposed construction is discouraged.)
 15. Distance and grade or slope between grade breaks.
 16. Vertical curves, where necessary, with VPI, VPC, and VPT, 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.
 17. Design speeds and stopping sight distances for all vertical and horizontal curves.
 18. Existing and proposed utilities. 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.
 19. The location and designation of all signs (regulatory and street name) to be installed in connection with the project.

Storm Drainage

1. 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.
2. 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.
3. Roadway section and grade including type of curb and gutter and gutter flow directions.
4. Erosion control and energy dissipation devices.
5. Proposed outfall point for runoff from the project area along with required easement information.
6. Routing and cumulative flows at various critical points along the drainage system for both the standard design storm and major storm runoff.
7. Critical minimum finished floor elevations of all buildings adjacent to the project for protection from major storm runoff.
8. Distances between storm sewer system components and other existing or proposed utilities within the right-of-way or drainage easement.

Sanitary Sewers/Water Lines

1. Existing water distribution facilities including, but not limited to, pipe size and location, valves, fire hydrants, blowoffs, etc.
2. 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.
3. Proposed piping with all appurtenances plainly labeled.
4. Existing or proposed easements and/or tracts through offsite areas.

5. Estimated average quantity of wastewater generated offsite that would be tributary to the proposed development, naturally as developed. The "Land Use Plan", which is a part of the Comprehensive Plan for the City of Liberty shall be the basis for determining the future use of offsite undeveloped land.
6. Proposed minimum, maximum, and average design flows at all junction manholes. (Manholes where two (2) or more branches have peak flows in excess of three (3) c.f.s.)
7. All design elevations shall be invert of pipe.
8. Stationing continuous for the entire length of the utility beginning at the downstream end of the project. Centerline of roadway shall be the basis for stationing whenever possible.
9. Existing utilities, particularly where crossed, with "as-built" elevations and stations.
10. Detailed alignment of the proposed sewer with the manhole designation, either by station and angle shown at each manhole or dimensioned ties to property lines at reasonably frequent control points to provide unquestionable locations of the sewer within street right-of-way or on private property.
11. The channel centerline of waterways within fifty (50) feet either side of centerline of sewer shall be shown.
12. All manholes shall be shown with manhole designation station and invert elevations. Drop manholes 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, indicating whether measured to end of pipe or center of manhole as well as the gradient, pipe size, and type of material.
13. Results of all rock borings shall be shown at the proper locations.
14. Accurate elevations of the lowest 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.
15. A uniform system of line and manhole designation shall be used subject to the approval of the City Engineer's office.
16. Station, length, and size of each stubline, along with MBF elevation.
17. Profile view shall show existing grade above centerline as a dashed line, proposed finish grades or established street grades by solid lines, and shall show the flow line of any drainage channel, either improved or unimproved, within fifty (50) feet either side of centerline. Each line shall be properly identified. The proposed sewer shall be shown as double solid lines properly showing the height of the pipe.
18. Alignment of the proposed water line dimensioned from curb lines or right-of-way lines.
19. Designation by station of all fire hydrants and line valves.

G. CROSS-SECTION SHEETS. 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 to 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 Engineer to clearly describe the extent of the grading operations.

H. STANDARD AND SPECIAL DETAIL SHEETS. Detail sheets shall be included to show all details of appurtenances, materials, and construction whether or not covered by the Liberty, Missouri Standards. Details shall conform to the City of Liberty Standards and are to be drawn clearly and neatly with proper identifications, dimensions, materials, and other information necessary to insure the desired construction.

I. CONSTRUCTION RECORD DRAWINGS. Construction record (as-built) drawings shall be submitted to the City Engineer upon completion of the project and prior to final acceptance of the project by the City of Liberty. The design engineer shall provide the City with corrected construction record drawings in one (1) set of reproducible prints and also in an electronic format, AutoCAD version burned on a CD or as specified by the City Engineer, for all public improvement projects. The drawing shall be corrected to show the project as constructed and 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.

REQUIREMENTS FOR PARKING LOT CONSTRUCTION PLAN PREPARATION

- A. INTRODUCTION. The following criteria are being established to provide a uniform system of plan preparation for work within the City of Liberty relating to parking lot construction.
- B. GENERAL. All plans for parking lot construction are to be prepared by a professional engineer licensed in the State of Missouri and submitted to the office of the City Engineer for review. Subsequent to the review, the engineer will be notified of the approval of the plans as submitted, or of any necessary changes.
- C. CONTENTS OF THE PLANS. The following items shall be included on plans as submitted:
1. North arrow and scale.
 2. General site layout to include building location (if applicable), street names, subdivision, block designation (if any), lot designation, or proposed block and lots, and an accurate tie to at least one quarter section corner. Unplatted tracts shall have an accurate tie to at least one quarter section corner.
 3. All existing property lines, lot lines, street right-of-way lines and easement lines, both permanent and temporary, shall be shown at their proper locations.
 4. All existing and proposed utilities such as power, gas, oil, water, telephone, sewer, and other items located in conformance with the best information available in the records of the owner of such facilities, or field location, and identified as to the size, material, and type of construction.
 5. Site contours, both existing and proposed.
 6. Limits of pavement showing perimeter curbing.
 7. Detail of curb and sidewalks.
 8. Section through pavement.
 9. Detail of driveway entrance.
 10. Storm drainage facilities including inlet location, pipe locations and routing, size, material, gauge, and gradient and related elevations. Connections to existing facilities shall be tied to a known point. Details of proposed inlets are to be shown on plans.
 11. Finish elevations of pavement surface.
 12. General construction notes as required.

**DESIGN CRITERIA FOR
SANITARY SEWERS AND APPURTENANCES**

- A. DESIGN FACTORS. Sanitary sewers should be designed for the ultimate tributary population. Due consideration should be given to current zoning regulations and approved planning and zoning reports where applicable. Sewer capacities should be adequate to handle the anticipated maximum hourly quantities of sewerage and industrial waste together with reasonable consideration given to infiltration/inflow.

Construction, installation, expansion or modification of any collection system or wastewater treatment facility is prohibited until a construction permit is issued by the department, per
10 CSR 20-6.010(4)(A).

- B. SEWER DESIGN. Sewers shall be designed for the total tributary area using the following minimum criteria:

Interceptors and trunk lines	0.01 CFS/Acre
Laterals and sub-mains	0.02 CFS/Acre

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

- C. MAXIMUM SIZE. The diameter of sewers proposed shall not exceed the diameter of the existing or proposed outlet; whichever is applicable, unless otherwise approved by the City Engineer.
- D. MINIMUM SIZE. No public sewer shall be less than eight (8) inches in diameter. Stublines for service connections shall not be less than four (4) inches in diameter and shall be extended at a 90 degree angle to the main sewer line.
- E. MATERIALS OF CONSTRUCTION. 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 materials that may be transmitted by the collection system.

The following types of commercial pipe are approved for gravity sanitary sewer systems constructed in the City of Liberty:

High Density Polyethylene (HDPE) Pipe	ASTM F714; ASTM D-1248; ASTM D-3550; shall be marked with a green stripe to signify its use for sanitary sewer facilities.
Ductile Iron Pipe	ANSI A21.51; ASTM A536, Grade60-42-10; thickness Class 50, unless otherwise required by the City Engineer.
PVC Pipe	ASTM D3034, Type PSM Polyvinyl (Chloride), SDR 35; PVC Material shall conform to ASTM D1784 and shall have a cell classification of 12454-B, 12454-C, 12364-C or 13364-B. The minimum

pipe stiffness for pipe used for stublines shall be SDR 26.

For PVC Pipe the minimum stiffness allowed for depths of:

- SDR 35, for less than 15 feet below finish grade;
- SDR 26, for 15 feet to 20 feet below finish grade;
- SDR 21, for 20 feet to 25 feet below finish grade;
- DIP, for greater than 25 feet below finish grade.

F. MINIMUM SLOPE. 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 the Manning Formula using an "n" value of 0.013. The following slopes shall be minimum for the size indicated.

<u>SEWER SIZE</u>	<u>MINIMUM SLOPE IN PERCENT FULL AND HALF FULL FLOW</u>
8"	0.60
10"	0.28
12"	0.22
15"	0.15
18"	0.12
21"	0.10
24"	0.08

Exceptions to these minimum slopes shall be made at the upper end of the lateral sewers serving under thirty (30) houses and more than ten (10) houses. Said sewers shall have a minimum slope of 0.76%.

Where lateral sewers serve less than ten (10) houses, the minimum slope shall not be less than 1% unless otherwise approved by the City Engineer.

Minimum basement floor (MBF) elevations shall be shown on the plans for each proposed lot, calculated as the flowline at the stub, plus the length of the stubline to the right-of-way line times 2%, plus 3.5 feet. Include all stublines in a Sanitary service line summary table containing station, length, size, flowline elevation at the main, and MBF elevation for each service line.

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

H. HIGH VELOCITY PROTECTION. 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. Where velocities greater than fifteen feet (15')

per second (4.6 m/s) are attained, special provision shall be made to protect against displacement by erosion and impact.

Steep slope protection. Sewers on twenty percent (20%) slope or greater shall be anchored securely with concrete anchors or equal, spaced as follows: A. Not over thirty-six feet (36') (11 m) center-to-center on grades twenty percent (20%) and up to thirty-five percent (35%); B. Not over twenty-four feet (24') (7.3 m) center-to-center on grades thirty-five percent (35%) and up to fifty percent (50%); and C. Not over sixteen feet (16') (4.9 m) center-to-center on grades fifty percent (50%) and over.

- I. ALIGNMENT. All sewers shall be laid with straight alignment between manholes. Angles between pipes at manholes shall be shown. Sewers twenty-four inches (24") (61 cm) or less shall be laid with straight alignment between manholes. Straight alignment shall be checked by either using a laser beam or lamping.

Curvilinear alignment of sewers larger than twenty-four inches (24") (61 cm) may be considered on a case-by-case basis provided compression joints are specified and ASTM or specific pipe manufacturers' maximum allowable pipe joint deflection limits are not exceeded. Curvilinear sewers shall be limited to simple curves which start and end at manholes. When curvilinear sewers are proposed, the recommended minimum slopes indicated in paragraph (5)(D)1 of this rule must be increased accordingly to provide a minimum velocity of two feet (2') per second (0.6 m/s) when flowing full.

- J. MANHOLE CONSTRUCTION. 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.

- K. MANHOLES. The construction of all manholes shall conform to the details shown on the Standard Drawings.

The minimum horizontal clear distance within the barrel of standard manholes shall not be less than four (4) feet. Manholes with inside drops or connecting pipe diameters greater than 24 inches shall have a minimum inside clear dimension of five (5) feet. Wall sections deeper than 16 feet shall be 5 inches minimum thickness. A minimum access diameter of twenty-two inches (22") (56 cm) shall be provided.

Drop manholes should be avoided as much as possible. Outside drop manholes are not allowed. However, if a drop manhole is necessary, an inside drop shall be used. An inside 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 inside drop pipe shall be installed and anchored according to the standard detail for inside drop manholes. The drop pipe shall have the same nominal diameter as that of the incoming sewer. When using precast manholes, drop connections must not enter the manhole at a joint.

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.

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

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

All other sanitary sewer lines (sewer lines across unplatted land, etc.) shall have the tops of manholes set flush with the existing ground elevation. The top of all manholes shall be located at least one (1) foot above the 100-year flood plain, or employ bolt-down lids.

Each sanitary service line in commercial and industrial developments shall have a sampling manhole.

Corrosion Protection for Manholes. Where corrosive conditions due to septicity or other causes are anticipated, corrosion protection on the interior of the manholes shall be provided.

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 City Engineer.

- L. SEWER LOCATIONS. Sanitary sewers shall be located within street or alley rights-of-way (outside pavement limits) unless topography dictates otherwise. When located in easements on private property, access shall be provided to all manholes. A manhole shall be provided at each street or alley crossing.

End lines shall be extended to provide access from street or alley rights-of-way where possible. Imposed loading shall be considered in all locations. Not less than eight (8) feet of cover shall be provided over top of pipe in street and alley rights-of-way and five (5) feet in all other areas unless otherwise approved by the City Engineer.

Structures. The sewer outfalls, headwalls, manholes, gateboxes, or other structures shall be located so they do not interfere with the free discharge of flood flows of the stream.

Materials. 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.

Siltation and erosion. Construction methods that will minimize siltation and erosion shall be employed. 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 siltladen water into the stream. Specifications shall require that clean-up, grading, seeding, planting, or restoration of all work areas shall begin immediately. Exposed areas shall not remain unprotected for more than seven (7) days.

M. CLEANOUTS AND LAMPHOLES. Cleanouts and lampholes will not be permitted on public sanitary sewer mainlines. A two-way cleanout will be required to be installed near the edge of the public right-of-way on proposed private service lines. Service lines shall be stubbed approximately 5 feet beyond the cleanout from the main.

N. PROTECTION OF WATER SUPPLIES. 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: Sewer mains shall be laid at least 10 feet horizontally from any existing or proposed water main. The distances shall be measured edge to edge. In cases where it is not practical to maintain a 10-foot separation, the Engineer may allow deviation on a case-by-case 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 at such an elevation that the bottom of the water main is at least 18 inches above the top of the sewer.
2. Crossings: Sewers crossing water mains shall be laid to provide a minimum vertical distance of 18 inches between the outside of the water main and the outside of the sewer. This shall be the case where the water main is either above or below the sewer. The crossing shall be arranged so that the sewer joints will be equidistant and as far as possible from the water main joints. Where a water main crosses under a sewer, adequate structural support shall be provided for the sewer to prevent damage to the water main.
3. Special Conditions: When it is impossible to obtain proper horizontal and vertical separation as stipulated above, the sewer shall be designed and constructed equal to water pipe, and shall be pressure tested to assure water tightness prior to backfilling.

No water pipe shall pass through, or come in contact with, any part of a sewer or a sewer manhole.

O. AERIAL CROSSINGS. Adequate support shall be provided at all joints in pipes utilized for aerial crossings. Only ductile-iron pipe with restrained joints shall be used unless otherwise approved by the City Engineer.

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 should be placed no lower than the elevation of the fifty (50)-year flood.

P. EASEMENTS. Public sanitary sewer mains outside of the public right-of-way shall be encompassed entirely by a public sanitary sewer easement, at least twenty (20) feet minimum width, and centered over the facilities. Excessively deep facilities, or other

special circumstances may require a wider easement as determined by the City Engineer.

- Q. TRACER WIRE PIPE DETECTION SYSTEM. Tracer wire pipe detection shall be installed on private service lines between the mainline and the two-way cleanout within the public right-of-way per Section 9100 Tracer Wire Pipe Detection System.

DESIGN CRITERIA FOR
WATER LINE CONSTRUCTION

- A. GENERAL. Proposed extensions of the water distribution system shall, in general, follow the pattern established in the Water Facilities Plan as adopted by the City of Liberty. Deviations from this general policy may be deemed necessary by the City Engineer should the provision of adequate service to prospective customers or fire protection needs, existing or anticipated, in the area to be served warrant said deviations.

No public water line shall be constructed less than six (6) inches in diameter.

- B. LOCATION OF WATER MAINS AND APPURTENANCES. Proposed water mains shall be so located within street right-of-way to provide the least interference with the location of other utility lines. Street grades and elevations of proposed main shall be taken into consideration so that once constructed they will not require regrading or relocation.

- C. DEPTH. All water mains shall have a minimum cover of forty-two (42) inches.

- D. MATERIALS OF CONSTRUCTION. Water main material may be ductile-iron, PVC or HDPE described as follows:

1. Ductile-Iron Pipe. Unless indicated otherwise on the construction plans or directed by the Engineer, all 6 inch pipes and larger shall be Class 50 ductile iron, all 4 inch pipes shall be Class 51 Ductile iron complete with all accessories and conforming to ANSI A21.51, AWWA C151, ASTM A536, and Grade 60-42-10.

The outside coating used under normal conditions shall be an asphaltic coating approximately 1 mil thick. The coating shall be applied to the outside of all pipes, unless otherwise specified. The finished coating shall be continuous and smooth, neither brittle when cold nor sticky when exposed to the sun, and shall be strongly adherent to the pipe.

The lining for use under normal conditions shall be a cement-mortar lining in accordance with ANSI/AWWA C104/A21.4, unless otherwise specified.

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.

Restrained joints (if required) shall be Loc-Tite, Meg-a-Lug, or approved equal.

2. Ductile-Iron Fittings. 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, ANSI A21.53/AWWA C153, 350 psi pressure rating. Joints shall be of the standard mechanical joint type conforming to ANSI A21.11/AWWA C104 and shall be coated inside and

out with a bituminous coating. Fittings shall have distinctly cast upon them the pressure rating and letters "DI" or "DUCTILE".

3. PVC Pipe. The non-restrained PVC pipe will be push-on joints. PVC pipe will be DR14 C-900/DR18 C-905 DIPS or C-909 PC150 DIPS. Restrained joints will be Certainteed Certa-lok C-900 Restrained Joint Pipe, EBAA bell restrained harnesses, or Diamond Plastic Bulldog Restraint Joint System.

Bends may either be Certa-lok sweeps or MJ ductile iron bends. Tees and valves will be ductile iron mechanical joints. For changes in alignment less than 11-1/4 degrees but more than the allowable joint deflection, then Certainteed High Deflection Couplings shall be used. Romac Grip Rings or EBAA Iron Mega-Lugs designed for PVC for MJ fittings and valves shall be used.

4. HDPE Pipe. HDPE will be AWWA C906 with a working pressure rating of PC 160 (Diameter Ratio, DR11), nominal Ductile Iron Pipe Size (DIPS).
 - a. Butt Fusion Fittings – All butt fusion fittings will be AWWA C906 and have nominal burst values of three and one-half times the Working Pressure Rating (WPR) of the fitting.
 - b. Electrofusion Fittings – All electrofusion fittings will be PE3408 HDPE. Electrofusion fittings shall have a pressure rating equal to the pipe unless otherwise specified on the plans. All electrofusion fittings shall be suitable for use as pressure conduits, and per AWWA C906, have nominal burst values of three and one-half times the working pressure rating (WPR) of the fitting.
 - c. Mechanical Joint Adapters – Mechanical joint adapters shall be PE 3408 HDPE, Cell Classification of 345464C as determined by ASTM D3350-02. Flanged and mechanical joint adapters shall have a manufacturing standard of ASTM D3261. Fittings shall have a pressure rating equal to the pipe unless otherwise specified on the plans.

- E. FIRE HYDRANTS. Fire hydrants shall conform to AWWA C502 and shall be traffic models with breakaway flanges and shall have one 4 2-inch pumper nozzle and two 2 2-inch nozzles. All hydrants shall be furnished with auxiliary gate valves, and conform to acceptable models as listed in Appendix “A” of Section 5000 Water Lines as set forth in the Technical Specifications of the City of Liberty.

Hydrants should be placed at or near street intersections and at intermediate points when block lengths become long. Under no circumstances shall the spacing of fire hydrants exceed five hundred (500) feet in residential areas or three hundred (300) feet in commercial areas.

Fire Hydrant installations shall conform to the Standard Drawings.

- F. LINE VALVES. Gate valves shall be of the resilient-seated configuration and shall conform to the applicable requirements of AWWA C509. Gate valves shall be used in all water mains twelve (12) inches in diameter and smaller. Butterfly valves shall conform to AWWA C504. Butterfly valves shall be used in mains larger than twelve (12) inches in diameter or where otherwise approved by the City Engineer.

Valves shall be placed in all straight runs of pipe at intervals not to exceed 800 feet. Valves should be placed so that no more than an average of 25 customers (maximum of 30) would be without service due to a line being shutdown.

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.

- H. TAPPING SLEEVES AND VALVES. Tapping sleeves and valves shall be used where required to connect to existing in-service mains.

The valves shall be Stainless Steel as set forth in the Technical Specifications of the City of Liberty.

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.

- I. CONNECTIONS TO EXISTING WATER MAINS. 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, provisions shall be made on the plans for a temporary service.

- J. PROVISIONS FOR FUTURE EXTENSIONS OF WATER MAINS. At the termination of all water mains or at locations as specified by the City Engineer, a dead end assembly in accordance with the Standard Drawings of Section 5000 of the Technical Specifications of the City of Liberty shall be provided to allow for future water main extensions.

Flushing assemblies shall be used only at locations approved by the Engineer 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.

- K. THRUST BLOCKING. Reaction blocking of adequate size shall be provided at all tees, elbows and bends to resist all resultant thrusts due to hydrostatic pressure. All blocking shall conform to the Standard Drawings. Restrictive joints may be used as set forth in the Technical Specifications of the City of Liberty.

- L. HIGHWAY AND RAILROAD CROSSINGS. All crossings of highways or railroads shall be made by boring or tunneling. The work shall be in conformity with all

requirements and regulations and be under the control of the authority owning or having jurisdiction over and control of the right-of-way in each case.

- M. STREET CROSSINGS. Open cutting of streets shall be allowed only where permitted by the City Engineer. 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 City Engineer. All work and materials shall be in conformity with all requirements of Section 6000 Tunneling, Boring, and Jacking (Pipelines) of the Technical Specifications of the City of Liberty. The diameter and length of the casing pipe to be used shall be as determined by the City Engineer.
- N. FIRE FLOW REQUIREMENTS. Public improvement plans for water line projects serving development sites other than single family or duplex subdivisions shall be reviewed for fire protection sufficiency. The Chief Building Official shall determine the amount of water that is required for fire protection based on I.S.O. guidelines for the proposed type of structures to be built within the development. The design engineer shall obtain the flow requirement and then determine if the existing and proposed water lines can provide this flow based on existing operating conditions. Calculations verifying that the required flows can be met shall accompany the drawings when submitted for approval.
- O. BACKFLOW PREVENTION. All private, non-potable water uses shall require backflow prevention devices at all connections to the public main. This shall include but not be limited to fire protection lines.
- P. EASEMENTS. Public water mains outside of the public right-of-way shall be encompassed entirely by a public water line easement, at least fifteen (15) feet minimum width, and centered over the facilities. Excessively deep facilities, or other special circumstances may require a wider easement as determined by the City Engineer.
- Q. TRACER WIRE PIPE DETECTION SYSTEM. Tracer wire pipe detection shall be installed on non-ductile public mains and private service lines within the public right-of-way per Section 9100 Tracer Wire Pipe Detection System.

**DESIGN CRITERIA FOR
STREET IMPROVEMENTS**

A. GENERAL. Proposed street improvements within the City shall conform to the pattern established in the Major Street Plan as adopted by the City of Liberty.

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 of Liberty. Plans for said improvements shall be submitted to the City Engineer for approval and shall include all information as may be required or described hereinafter.

B. FUNCTIONAL CLASSIFICATION OF STREETS. The classification of streets shall be generally defined as follows:

1. Local Streets. A street designed to provide access to abutting property from collector and arterial streets.
2. Collector/Commercial Streets. Streets, which, in addition to serving abutting properties, intercept local streets, connect with community facilities and carry neighborhood traffic to the arterial street systems. Commercial streets serve areas predominately zoned for commercial or industrial uses.
3. Arterial Streets. A street or road of considerable continuity which serves or is intended to serve as a principal trafficway between separated areas or districts and which is the main means of access to the collector street system, highways or expressways.

C. STREET DESIGN STANDARDS.

	ARTERIAL		COLLECTOR	LOCAL
	<u>Major</u>	<u>Minor</u>	<u>2-Lane*</u>	<u>2-Lane</u>
Right-of-Way Width (ft)	120	100	64	54
Street Width(ft)	62' min.	40' min	30' min.	26' min.
Median Width(ft)	15' min.	-0-	-0-	-0-
Minimum Pavement Depth (Asphaltic Concrete) inches	12	12	10	8
Design Volume (VPD) Range	24,000 – 36,000	12,000 - 24,000	15,000 – 24,000	Less than 1,500
**Design Speed (MPH)	50	35	30-35	25-30
Maximum Grade	6%	6%	8%	10%
Minimum Grade	1%	1%	1%	1%
Curb Return Radius	50'	50'	30'	25'
Minimum Radii Horizontal Curve	1300'	700'	300'	185'

Minimum K Crest Vertical Curve	110-150	60-80	30	20
Minimum K Sag Vertical Curve	90-110 (55 w/lights)	60-70 (35 w/lights)	50 (20 w/lights)	30 14 (w/lights)
Minimum Private Curb Cut Spacing (ft)	350'	One per Property	One per Property	One per Property
Minimum Distance from Intersection of R.O.W. to curb cut (ft.)	250	200	150	25
***Sidewalk width(ft)	5	5	5	5
Parking Permitted	No	No	No	One Side Only
Storm Sewers	Yes	Yes	Yes	Yes
Curb & Gutter	CG-1	CG-1	CG-1	CG-1
Pavement Markings	Yes	Yes	Yes	No

* Also applicable to commercial streets.

** 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".

*** Both sides of roadway.

- D. OFF-CENTER STREET INTERSECTIONS. Off-center street intersections shall be separated by a minimum centerline to centerline distance of one hundred and fifty feet (150).
- E. 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. (Design Aid No. 5)
- F. 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.
- G. MAXIMUM GRADIENT. The maximum gradient for streets as noted in Section C may be exceeded only upon written approval of the City Engineer. Such approval will only be granted in unusual cases where grades within the acceptable limits cannot be obtained.
- H. GRADING GRADIENTS. 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 City Engineer.
- I. TANGENT LENGTH. The minimum tangent length between reverse curves shall be fifty (50) feet for local streets and one hundred (100) feet for collector/commercial and arterial streets, except that no tangent will be required for radii longer than five hundred

(500) feet.

- J. 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.
- K. STORM DRAINAGE. All storm drainage works constructed in connection with street improvements shall be designed in accordance with the City of Liberty Design Criteria for Storm Sewers and Appurtenances.
- L. CUL-DE-SACS. At locations where streets are to be terminated and a vehicular connection between adjacent streets is not required a cul-de-sac may be permitted. Such cul-de-sac shall be constructed with a minimum radius of thirty-nine (39) feet to the back of the curb.
- M. 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 five (5) lots, a temporary cul-de-sac shall be constructed with a minimum radius of thirty-five (35) feet. The temporary cul-de-sac shall be constructed of asphaltic concrete with a minimum depth of six (6) inches. Curb and gutter will not be required. The cul-de-sac shall be constructed within the limits of a permanent construction easement.
- N. MONUMENT BOXES. Monument boxes conforming to the Standard Drawings shall be installed at all quarter section corners and any other monuments involved in the street construction.
- O. OTHER DESIGN CRITERIA. All other street design elements not contained within this 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.
- P. DRIVEWAY ELEVATIONS. Driveways shall attain top of curb elevation within the right-of-way. Driveway grades within right-of-way shall be 8% maximum until curb height is reached. Break over grades for crest drives shall be 8% maximum and sag drives shall be 12% maximum. Driveway elevation shall not be more than 6" above or below the normal shoulder elevation at the right-of-way line, to allow for a smooth sidewalk profile.
- Q. DRIVEWAY WIDTHS: Residential driveways shall have a minimum driveway width of 10' and a maximum of 20'. A lot having two (2) driveway access points (i.e. circle drive) must have at least 100' width at the right-of-way line. An existing driveway may be replaced at its existing width.
- R. SIGNAGE. Street name and regulatory traffic signs conforming to the Standard Drawings shall be furnished and installed at the appropriate locations in connection with the street improvement. All regulatory signage shall be in conformance with MUTCD

requirements and shall be approved by the City Engineer.

- S. RAISED PAVEMENT MARKERS. Blue raised pavement markers shall be installed as part of the public improvements for all locations adjacent to fire hydrants. Blue raised pavement markers shall be located 30" from the center of the roadway on the same side as the fire hydrant.

DESIGN CRITERIA FOR
STORM DRAINAGE FACILITIES

- A. GENERAL. All development plans submitted for approval to the City of Liberty must be accompanied by an adequate storm drainage system analysis and design performed by a licensed professional engineer in the State of Missouri in accordance with the criteria described in the Kansas City Metro Chapter APWA Division V – Section 5600 “Storm Drainage Systems & Facilities” as amended by the City. Exceptions and additions to KC APWA Section 5600 are detailed in the following Section.
- B. KC-APWA SECTION 5600 – CITY OF LIBERTY ADDITIONS/EXCEPTIONS.

GLOBAL STATEMENTS

- Any regulations, equations or departments referenced to “Kansas” are not applicable.
- Wherever the term “City/County” is used, replace with “City of Liberty” or simply “City”
- Wherever design manual is in conflict with the City Code, standards or policies, the City’s Code, standards or policies shall rule.

EXCEPTIONS/ADDITIONS

- Section 5601.2 - Replace definition of City: “The City of Liberty.”
- Section 5601.2 - Replace definition of Swale: “A shallow channel intended to convey stormwater.”
- Section 5601.5.A.1 - Add: “d. Storm drainage along the side lot lines of residential property for pipe sizes less than 48” in diameter shall be in conduit to a point seventy-five (75) feet beyond the front yard setback. Extension of the system shall then be continued from this point the full length of the side lot line or to the nearest natural drainage way of a larger tributary stream with a stable ditch section. Pipes 48” in diameter or greater shall terminate at or beyond the right-of-way unless approved by the Director.”
- Section 5601.8.A.2.a. – Replace “openings in a building” with “lowest floor”. Delete “Where 10% storm flows are less than 8 cfs, freeboard may be reduced to 6 inches.”
- Section 5601.8.A.2.b. –Delete “Where 10% storm flows are less than 8 cfs, freeboard may be reduced to 6 inches.”
- Section 5601.8.D.1 – Delete all.
- Section 5604.1.B – Revise: The minimum dimensions are per the City of Liberty Standard Drawings and apply to steep-faced curbs (CG-1).

Opening length, inside	4.0 ft (min)
Width, perpendicular to curb line, inside	3.0 ft (min)
Setback curb line to face	1.0 ft (min)

Opening, clear height	10 in. (min)
Gutter transition length	
(a) Both sides in sump and upstream side on slopes	10.0 ft (min)
(b) Downstream on slopes	5.0 ft (min)

- Section 5604.2 Replace: “Gutter Flow: Inlets shall be located to limit the width of flow in street gutters at the time of peak discharge for the design storm specified in 5601.8.B to provide a minimum 10 foot wide travel lane for emergency vehicles. Spread may exceed these limits within 50 feet of a sump inlet.
- Section 5605.3.B.2 – Delete.
- Section 5605.5.A.5 through Section 5605.5.A.7 – Delete.
- Section 5605.5.B through Section 5605.5.D – Delete.
- Section 5605.5.F – Delete “Riffle Spacing/Bank-full width.....5 to 7”
- Section 5605.5.G – Replace section with “Channel Condition: A qualitative analysis of the general condition of the natural stream prior to development shall be provided. In summary, this should indicate the stability of the stream and stream banks and possibly address any special considerations to protect the stream during construction.”
- Section 5605.10 – Replace section with “Floodplain Fills: Although filling of floodplains is discouraged, Chapter 30 of the City Code shall dictate the conditions for filling of floodplains.”
- Section 5606.1 – Add “A wider easement may be required if the depth of cover exceeds four (4) feet.”
- Section 5607.2 – Replace “..will be publicly maintained.” with “..convey water as part of the public drainage system or overflow for the public drainage system.”
- Section 5607.2.A – Remove “Generally, easements shall be required for swales that collect stormwater runoff from more than two acres or as required by the City/County.”
- Section 5607.5 – Remove “grouted rip rap”
- Section 5608.2.A – Insert: “or easement lines” after “property lines” in the first sentence.
- Section 5608.2 – Replace last paragraph with: “Detention facility easements are required on all detention facilities. If the detention facility is to be maintained by the City, land equal to the minimum area required for easements may be dedicated by recorded deed to the City.”

- Section 5608.3 – Add: “Maintenance of detention facilities may include: 1. Removal of debris from basin surface to minimize outlet clogging and improve aesthetics; 2. Removal of sediment buildup; 3. Repair and revegetation of eroded areas. 4. Performance of structural repairs to inlet and outlets. 5. Routinely mowing to limit unwanted vegetation.”
- Section 5608.4.A.4 – Add: “Areas above the normal high water elevations of the detention facility should be sloped toward the basin to allow drainage and to prevent standing water. Careful finish grading is required to avoid creation of upland surface depressions that may retain runoff.”
- Section 5608.4.E.7 – Add “A low flow orifice capable of releasing the channel protection volume over 24 hours must be provided.”
- Section 5608.4.E.8 – Add “Seepage control or anti-seep collars should be provided for all outlet pipes.”
- Section 5608.4.F.1 – Add: “The emergency spillway shall be designed such that the top of the dam is not breached in the 1% storm.”
- Section 5608.4.G – Delete this subsection.
- Section 5608.4.H – Delete “and drain works” and then Add “and low flow channels within the basins” after “..conveyance system entrances to basins,”
- Section 5608.4.I – Add: “Inflow: Inflow channels may be stabilized with flared riprap aprons, turf reinforcement mats, or other methods to prevent erosion at the expected velocities.”
- Section 5608.5.B.2 – Replace “sodded” with “vegetated”.
- Section 5608.5.B.3 – Delete “...and at least 25% of the perimeter shall have a slope of 5 to 1 or flatter.”
- Section 5608.5.C – Add “Additionally, “green” roof technology that utilizes plant material to provide storage, treatment and evapotranspiration of the stormwater can be utilized to achieve quantity control requirements as well as water quality objectives. The green roof industry has a resource portal at www.greenroofs.com.”
- Section 5608.5.D – Remove and replace with “Parking lots paved with traditional impervious pavements may be designed to provide temporary detention storage of stormwater on a portion of their surfaces. Generally, such detention areas shall be in the more remote portions of such parking lots. Depths of storage shall be limited to a maximum depth of six inches, and such areas shall be located so that access to and from parking areas is not impaired.

Parking lots paved with pervious pavements or that are designed with innovative turf reinforcement techniques may be designed to provide temporary detention storage of stormwater below their surface in the pore spaces of granular media. The designer

should consider the infiltration rate of the soil beneath the media. Soil infiltration, underdrains or a combination of the two should provide discharge of at least 80 percent of the detention storage volume within 24 hours.”

- Section 5608.5.E – Add “microdetention, bioretention, bioswales, cisterns” before the “etc.” Then after that sentence add “Design underground detention facilities with adequate access for maintenance (cleaning and sediment removal). Provide such facilities with positive gravity outlets. Design venting sufficient to prevent accumulation of toxic or explosive gases.”
- Section 5609.3 – Add “It may be acceptable to combine elements of the above types of sheets in lieu of separate sheets.”
- Section 5609.4 – Replace “22” with “24”.
- Section 5609.5 – Revise to [Plan: 1”=50’ and Profile: Vertical: 1” = 10’; Horizontal: 1” = 50’].
- Section 5609.6.F – Remove “as well as signature block for the owner/developer.”
- Section 5609.7.B – Remove “bar” and Add “where possible” to the end of the second sentence.
- Section 5609.8.A – Remove “bar” and Add “where possible” to the end of the second sentence.
- Section 5609.8.N – Delete “..and invert elevations.” (duplicate)
- Section 5609.9 – Replace this section with “A typical cross-section shall be provided showing bottom width, side slopes, and lining information. Additional cross-section details may be required at structures and intersecting drainage systems or as necessary to provide detail beyond that shown on any grading plan. Cross-sections may also be required for overflow drainage paths that are designated to convey overland flows in excess of the underground system capacity.”
- Section 5609.10.A - Remove “bar” and Add “where possible” to the end of the second sentence.
- Section 5609.14 – Replace section with “Grading Plan Sheets: Grading plan sheets shall be included as necessary to show sufficient detail in how overall drainage is being handled on the site (including areas outside of street rights-of-way). This shall include, but is not limited to, addressing how sheet flow is handled as it enters and exits the site and how overflow drainage is handled. More detail will be required for site plans where final building layouts are known.”

- C. MINIMUM STANDARDS OF DESIGN. Storm water runoff shall be carried by enclosed systems or open channels on the basis of criteria established in this section, or otherwise managed utilizing stormwater Best Management Practices (BMPs) as designed per criteria set forth in the most recent version of the MARC/APWA Manual for Best Management Practices for Stormwater Quality, and subject to the final determination and approval of the City Engineer.

Best Management Practices for Stormwater Quality: The Kansas City Mid-America Regional Council (MARC) and the Kansas City Metro Chapter of the American Public Works Association (APWA) have developed the Manual for Best Management Practices for Stormwater Quality as a guide for applying stormwater Best Management Practices (BMPs) to land development within the Kansas City Metropolitan Area and the MARC planning region. The manual addresses the need to control the volume and quality of stormwater discharges from developed sites, both of which are crucial requirements for protecting human life and property, maintaining overall water quality, and for creating more environmentally sensitive site designs.

BMP designs shall conform to the criteria as set forth in the most recent version of the MARC/APWA Manual for Best Management Practices for Stormwater Quality.

Storm Detention Facilities Easements: Easements for storm detention facilities shall be the area providing storage for the peak design storm, plus additional width on all sides deemed necessary by the City to allow access for maintenance equipment.

EROSION AND SEDIMENT CONTROL

- A. GENERAL. All development plans submitted for approval to the City of Liberty must contain an erosion and sedimentation control plan designed by a licensed professional engineer in the State of Missouri in accordance with the criteria described in the “City of Liberty Erosion and Sedimentation Control Manual”. The criteria are intended to provide the designer, contractor and builder with design criteria and minimum standards for the installation of erosion and sediment controls to comply with the Erosion and Sediment Control Regulations in the City of Liberty. The regulations were enacted to protect the health, safety, and property of the citizens and to help protect area water resources from pollution due to erosion and transportation of sediment. The regulations require that no person cause or allow sediment to be deposited in any public street, public land, or on any property not under their control as a result of land disturbance from construction activities.

DESIGN CRITERIA FOR PARKING LOT CONSTRUCTION

- A. GENERAL. Proposed parking lot construction in the City of Liberty shall, in all respects, be designed to conform to applicable codes, regulations, and ordinances as established by the City of Liberty. Any person, firm, or corporation proposing to construct any parking lot improvement within the City shall apply to the City Engineer for approval of the location, dimensions, design, construction methods, and materials of such parking lot construction. Plans shall be submitted to the office of the City Engineer for approval and shall include all information as may be required or described hereinafter.
- B. MATERIALS FOR CONSTRUCTION. The following materials and related information are acceptable for parking lot construction in the City of Liberty:
- Pavement - Full depth asphaltic concrete (minimum five (5) inches) or equal over subgrade (minimum six (6) inches), compacted to ninety-five (95) percent of maximum density as determined by standard proctor.
- Driveway Entrances and Curbing Within Public Right-of-Way - Concrete (4000 psi minimum acceptable 28-day compressive strength with 6%, \pm 1%, entrained air).
- Curbing (interior) - Concrete (3000 psi minimum acceptable 28-day compressive strength with 6%, \pm 1%, entrained air).
- C. CURB AND GUTTER. Concrete curbing shall be provided on perimeter of parking areas and along drives connecting parking areas with public streets. Curbing shall have a vertical face and shall be securely connected to the pavement to prevent movement. Curbs may be constructed as poured-in-place or may be precast concrete. In all cases, the type and construction of curbing to be used shall be approved by the City Engineer prior to construction. Curb cuts, ribbon curb, or perimeter permeable pavements may be used in conjunction with stormwater BMPs in lieu of standard curbing.
- All work within public right-of-way shall conform to applicable City Standards. Driveway approaches shall be constructed with integral curb and gutter conforming to City of Liberty type C-1 specifications. Transition to existing curb or curb and gutter shall be made at saw joints in existing curb or at existing expansion joints. Construction and expansion joints, dimensions, elevations, and surface finish shall match as closely as possible that of existing adjacent curb and gutter. Expansion joints shall be placed where new curbing abuts existing curbing.
- D. DRAINAGE FACILITIES. All parking areas shall be provided with adequate drainage facilities as approved by the City Engineer. Natural filtration of stormwater runoff through Stormwater Best Management Practices (BMPs) which incorporate natural infiltration of stormwater (such as bio-swales, rain gardens, etc.) is the preferred method of managing stormwater. Enclosed storm sewers may be used to collect and convey drainage on, across, and through public right-of-ways. Runoff will not be permitted to exit directly onto streets or adjacent property through curb cuts or open channels. In the event storm sewer facilities do not exist within a reasonable distance, exceptions to this may be made where approved by the City Engineer.

Up to 10%, but not more than 1 acre, of a site's total driving surfaces may discharge in a sheet flow condition through existing established vegetation such as may exist in a stream buffer without otherwise being treated. However, this quantity should still be considered in the overall stormwater quantity management.

Runoff calculations shall be in accordance with the Design Criteria for Storm Drainage Facilities of the City of Liberty and comply with the regulations and requirements set forth in the Stormwater Management Ordinance. All calculations shall be submitted to the City Engineer for review and approval. Drainage structures located in public right-of-way used and constructed as a portion of the storm drainage facilities for parking lots shall be in accordance with the Technical Specifications of the City of Liberty.

- E. DRIVEWAY ENTRANCES. Driveway entrances constructed within the public right-of-way shall be constructed of concrete with minimum thickness of six (6) inches. Each commercial or industrial property shall be allowed at least one driveway approach but may have more as long as the total maximum summation of the widths of all driveway approaches upon the property does not exceed twenty (20) percent of the length of the real property that fronts the abutting City street. Should more than one driveway approach be desired, there shall be not less than ninety (90) feet between the center lines of each driveway approach. In addition to the above, the following dimensions shall govern construction of driveway approaches:

1. Width of Driveway Approach.

a. Commercial Driveway Approach. The width of commercial driveway approaches shall not exceed thirty-five (35) feet or be less than twenty-five (25) feet measured parallel to the center line of the street at the property lines for two-way driveway approaches; provided, however, that commercial property may be allowed to have a driveway approach not exceeding fifty-two (52) feet, if said driveway approach does not exceed twenty (20) percent of the length of the length of the real property abutting the adjacent City street and a four (4) foot raised median is placed within such driveway approach to divide the entrance and exit lane(s). The minimum width of a one-way driveway shall be sixteen (16) feet.

b. Industrial Driveway Approach. The width of industrial driveway approaches shall not exceed sixty-five (65) feet or be less than twenty-five (25) feet measured parallel to the center line of the street at the property lines for two-way driveway approaches; provided that the minimum width for one-way driveway shall be sixteen (16) feet.

2. Corner of Adjacent Property Line Offset.

a. Commercial or Industrial Driveway Approaches. When commercial or industrial driveway approaches are located at or near a street intersection, in no case shall the distance from the intersection property corner be less than fifty (50) feet to the near line of the nearest driveway approach, as extended to the street curb or pavement edge.

No commercial or industrial driveway approach shall be constructed having a



PAVEMENT TYPES

STREET CLASSIFICATIONS

OPTION 1

OPTION 2

LOCAL

6" min. portland cement
concrete pavement.

1 1/2" type 3 asphaltic
concrete surface.

6" min. compacted subgrade
95% of standard max. density.

6 1/2" min. asphaltic
concrete base course (type 1 or 2)

COLLECTOR / COMMERCIAL

7" min. portland cement
concrete pavement

1 1/2" type 3 asphaltic concrete
surface

6" min. compacted subgrade
95% of standard max. density

8 1/2" min. asphaltic concrete
base course (type 1 or 2)

6" min. compacted subgrade
95% of standard max. density

MINOR ARTERIAL

9" min. portland cement
concrete pavement

1 1/2" type 3 asphaltic concrete
surface

6" min. compacted subgrade
95% of standard max. density

10 1/2" min. asphaltic concrete
base course (type 1 or 2)

6" min. compacted subgrade
95% of standard max. density

MAJOR ARTERIAL

9" min. portland cement
concrete pavement

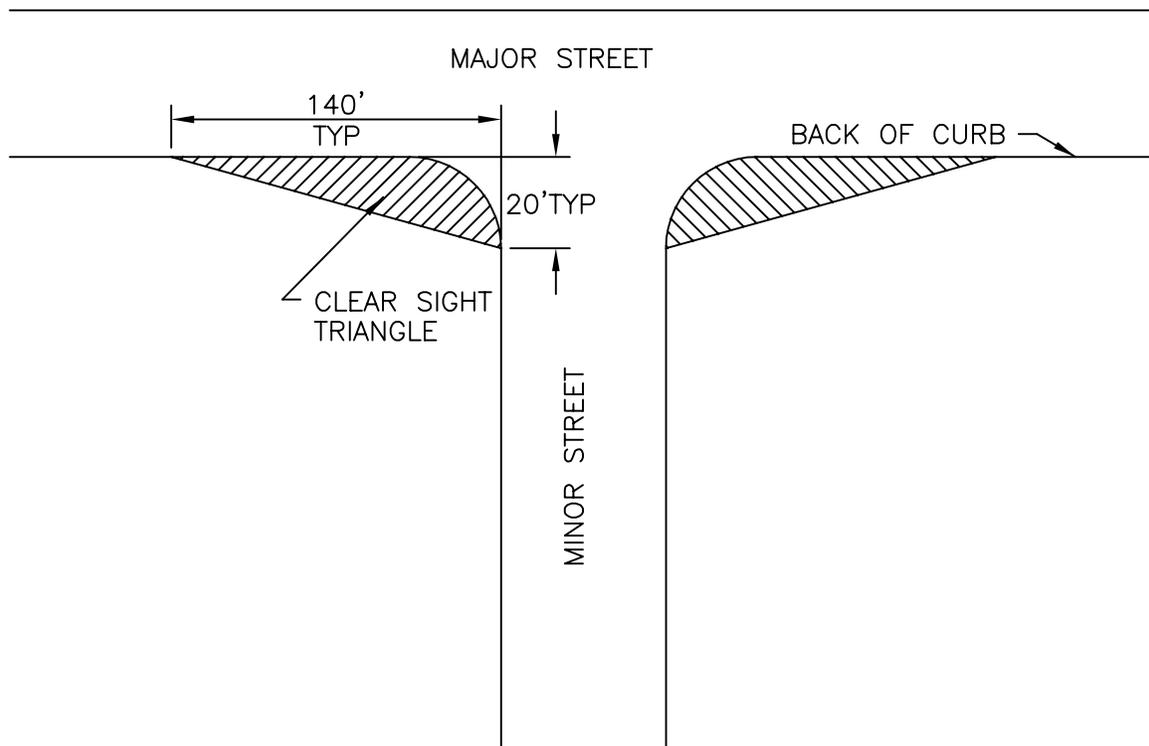
1 1/2" type 3 asphaltic concrete
surface

6" min. compacted subgrade
95% of standard max. density

10 1/2" min. asphaltic concrete
base course (type 1 or 2)

6" min. compacted subgrade
95% of standard max. density

NOTE: Pavement type options to be
considered shall be submitted
to the City Engineer for approval.



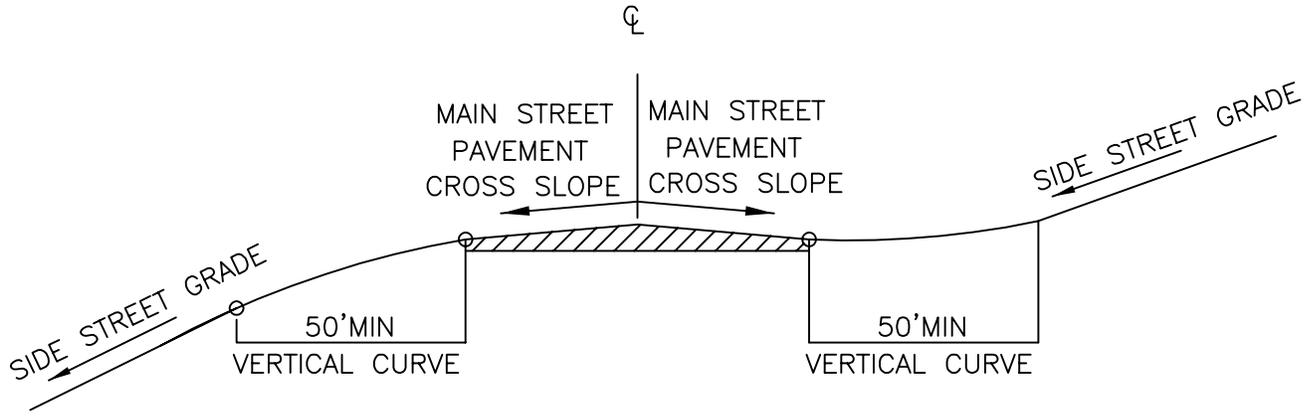
REV 97



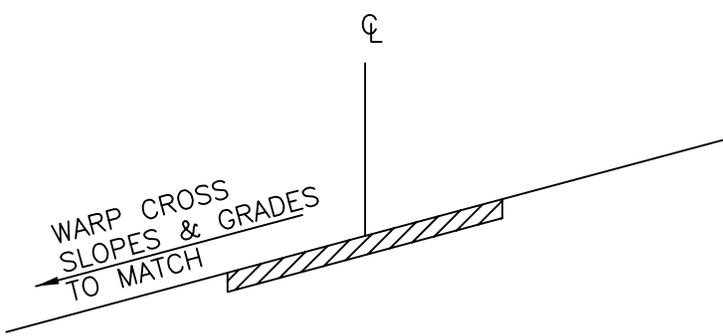
CITY OF LIBERTY, MO
DEPARTMENT OF
PUBLIC WORKS

INTERSECTION CLEAR
SIGHT TRIANGLE
Design Aid No.4

38



MAIN STREET SECTION & SIDE STREET PROFILE
 INTERSECTION OF LESSER WITH A GREATER FUNCTION STREET



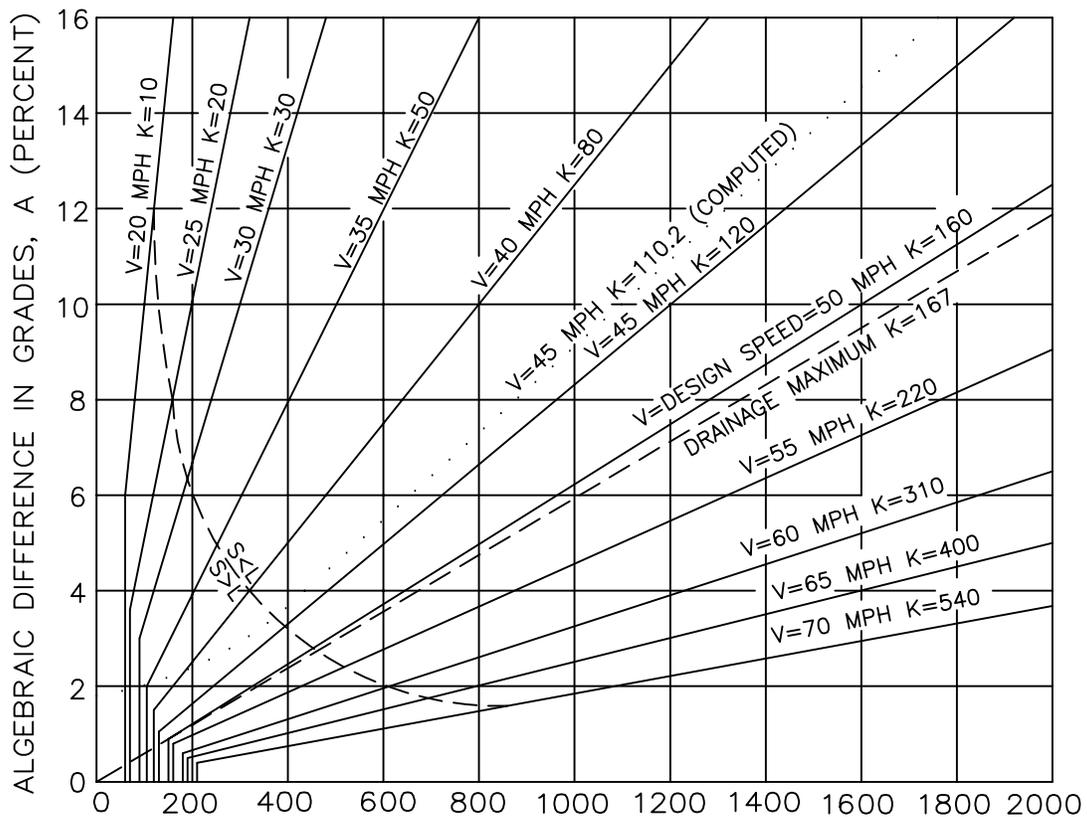
THRU STREET SECTION AND PERPENDICULAR STREET PROFILE
 INTERSECTION OF EQUAL FUNCTION STREETS. NCTION STREET

REV 97



CITY OF LIBERTY, MO
 DEPARTMENT OF
 PUBLIC WORKS

INTERSECTION
 VERTICAL ALIGNMENT
 Design Aid No.5



DESIGN SPEED (MPH)	STOPPING SIGHT DISTANCE (FT.)	K VALUE
20	125	10
25	150	20
30	200	30
35	250	50
40	325	80
45	400	120
50	475	160
55	550	220
60	650	310
65	725	400
70	850	540

$$S < L : L = \frac{AS^2}{1398}$$

L=LENGTH OF VERTICAL CURVE

A=ALGEBRAIC DIFFERENCE IN GRADES

$$S > L : L = 2S - \frac{1398}{A}$$

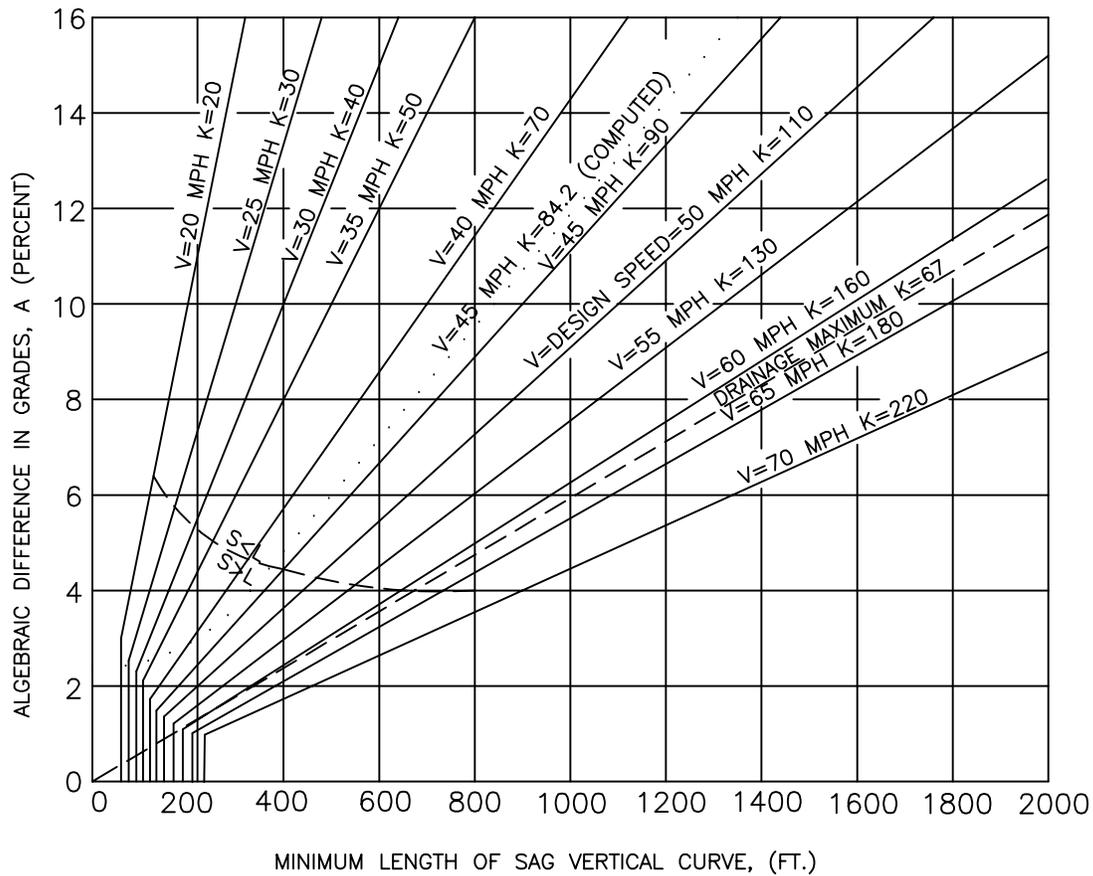
S=STOPPING SIGHT DISTANCE

DESIGN CONTROLS FOR CREST VERTICAL CURVES

STOPPING SIGHT DISTANCE

FIGURE III-39





DESIGN SPEED (MPH)	STOPPING SIGHT DISTANCE (FT.)	K VALUE
20	125	20
25	150	30
30	200	40
35	250	50
40	325	70
45	400	90
50	475	110
55	550	130
60	650	160
65	725	180
70	850	220

$$S < L : L = \frac{AS^2}{1398}$$

$$S > L : L = 2S - \frac{1398}{A}$$

L=LENGTH OF VERTICAL CURVE

A=ALGEBRAIC DIFFERENCE IN GRADES

S=STOPPING SIGHT DISTANCE

DESIGN CONTROL FOR SAG VERTICAL CURVES

STOPPING SIGHT DISTANCE

FIGURE III-40

SOURCE: 1984 AASHTO, PAGE 314

DESIGN AID NO.7

REV 97



CITY OF LIBERTY, MO
DEPARTMENT OF
PUBLIC WORKS

MINIMUM STOPPING
SIGHT DISTANCE FOR

41

SECTION 3000 MATERIALS AND CONSTRUCTION - SANITARY SEWERS

3001 GENERAL: This section governs materials that may be required to complete pipeline construction, exclusive of structures, as shown on the Plans and/or as provided in the Special Provisions.

3002 SPECIFICATION MODIFICATIONS: It is understood that throughout this section these specifications may be modified or deleted by appropriate items in the contract drawings or Special Conditions.

3003 REVISIONS OF STANDARDS: When reference is made to a Standard Specification, i.e. ASTM, ANSI, AWWA, MCIB, the specification referred to shall be understood to mean the latest revision of said specification as amended at the time of the Notice to Bidders, except as noted on the Plans or in the Special Provisions.

3004 MATERIALS AND TESTING. Furnish pipe of materials, joint types, sizes, and strength classes indicated and specified. Higher strengths may be furnished at the Contractor's option and at no additional cost to the Owner.

The manufacturer shall be experienced in the design, manufacture and commercial supplying of the specific material.

Testing is to be performed by the Manufacturer's quality control personnel in conformance with applicable standards. Testing may be witnessed by Owner, or approved independent testing laboratory. The Contractor shall provide three (3) copies of certified test reports indicating that the material does conform to the specifications.

Handling: The manufacturer and contractor shall use equipment and methods adequate to protect pipe, joint elements and prevent shock contact of adjacent units during moving or storage. Damaged sections that cause reasonable doubt as to their structural strength or water tightness will be rejected. No pipe or fitting shall be delivered until approved by the said Materials Laboratory and are so marked.

3005 HIGH DENSITY POLYETHYLENE PIPE (HDPE):

General: High Density Polyethylene Pipe (HDPE) and fittings shall conform to ASTM F714, ASTM D-1248, ASTM D-3550, except as otherwise noted herein. Furnish maximum lengths manufactured by supplier, except for fittings, closures and specials. All HDPE pipe shall be marked with a green stripe to signify its use for sanitary sewer facilities.

3006 DUCTILE-IRON PIPE. Ductile Iron Pipe shall be used only where structural concerns are paramount and corrosive conditions do not exist. Material shall conform to ANSI A21.51; ASTM A536, Grade 60-42-10, except as otherwise noted herein.

- A. Design. Design of pipe shall be in accordance with ANSI A21.50 laying conditions S, Type 2 or 3. Minimum wall thickness shall be Class 50. Polyethylene Encasement is not permitted.

- B. Joints. Mechanical and push-on joints for ductile-iron pipe and fittings shall conform to the requirements of ANSI A21.11. Gaskets shall be neoprene or other synthetic rubber material. Natural rubber gaskets will not be acceptable.
- C. Fittings. Fittings shall be in accordance with ANSI A21.10/AWWA C 110 and shall have a pressure rating of not less than that specified for pipe. Fittings used with ductile-iron pipe shall be ductile-iron or cast iron. Fittings for pipe with mechanical joints shall have mechanical joints. Fittings for pipe with push-on joints shall be either mechanical joint or push-on joint.
- D. Lining & Coating. All ductile-iron pipe, fittings and specials shall be cement mortar lined in accordance with ANSI A21.51. Coat all pipe, fittings and specials with manufacturer's standard coal tar coating.

3007 POLY VINYL CHLORIDE (PVC) SEWER PIPE. Conform to ASTM D3034, except as otherwise specified herein.

- A. General. Furnish maximum pipe lengths manufactured by the supplier, except for fitting, closures and specials.
- B. Design. The minimum wall thickness for PVC Pipe shall conform to SDR-35 (SDR-26 for stub lines). PVC Material shall conform to ASTM D1784 and shall have a cell classification of 12454-B, 12454-C, 12364-C, or 13364-B.
- C. Joints. Flexible gasketed joints shall be compression type with a gasket confined in a machined groove in the spigot end of the pipe. Oil resistant rubber gasket rings shall conform to the requirements of ASTM D 1869. Gaskets shall be neoprene or other synthetic material. Natural rubber gaskets will not be acceptable.
- D. Fittings. Fittings defined as tee or wye connections suitable for assembly to 4-inch or 6-inch house or building sewers shall be saddle-type fittings molded of PVC plastic.

3008 CONCRETE. Concrete, whether reinforced or non-reinforced, shall conform to MCIB Specifications and to the requirements set forth in Section 2000 "Concrete".

3009 REINFORCING STEEL. Reinforcing steel shall be placed as shown on the plans and shall conform to ASTM Specifications as follows:

- A. Bars and rods shall be deformed billet-steel conforming to ASTM A 615, Grade 40.
- B. Welded wire fabric shall conform to ASTM A 185, Grade 40.
- C. Fabricated steel bar and rod mats shall conform to ASTM A 184. Bar material shall conform to ASTM A 615, Grade 40.
- D. Smooth bars shall be round carbon steel bars conforming to ASTM A 306, Grade 60.

3010 MANHOLE MATERIALS.

- A. General. Manholes shall conform to the Standard Drawings included in these specifications.
- B. Pre-cast Concrete. Pre-cast concrete manholes shall conform to ASTM C 478. Joints shall be of material as specified for reinforced concrete pipe joints or a bitumastic material or preformed flexible joint sealants applied in accordance with manufacturer's recommendations.
- C. Waterproofing. Waterproofing will be required on all manholes. The bitumen shall consist of two coats of Koppers Bitumastic No. 50 or approved equal. Pre-cast manholes shall be shop coated.
- D. Sealed Joints: All manholes shall be sealed at the joints. The casting shall be sealed to the structure with an external sealing system as manufactured by Sealing Systems, Inc. or approved equal. The seal shall be a continuous band made of high quality EPDM (Ethylene Propylene Diene Monomer) rubber with a minimum thickness of 65 mils. Each unit shall have a 2" wide mastic strip on the top and bottom of the band. The mastic shall be non-hardening butyl rubber sealant, with a minimum thickness of 3/16", and shall seal to the cone/top of the manhole section and over the flange of the casting. The external sealing system shall be installed according to the manufacturer's recommendations.

3011 MANHOLE CASTINGS.

- A. General: Cast-iron rings, covers, and steps shall conform to City Standard Drawing. Manhole rings and covers shall be Clay and Bailey No. 2008BV, Deeter No. 1315, or approved equal. The exception shall be for use on shallow manholes where manhole covers shall be Clay & Bailey No. 2020, Deeter No. 2016 or approved equal.

When bolt-down type manhole rings and covers are required and specified, Clay and Bailey No. 2014, Deeter 1310 or approved equal, with rubber gaskets and stainless steel cover bolts 5/8-inch diameter with hexagonal-head bolts shall be furnished. Bolt-down type manhole rings shall be anchored to the manhole with not less than four (4) 3/4-inch diameter anchor bolts having a minimum of fourteen (14) inches of embedment, (excluding adjustment rings) except in concrete manholes in which the ring is embedded in concrete.

All covers shall have Liberty - Sewer cast onto the top surface. No other wording shall be visible on the surface of the manhole castings.

Frame and grade adjustments on all manholes or manholes in paved surfaces shall be sealed with an internal or external rubber chimney seal as manufactured by Cretex Specialty Products, or approved equal.

All manhole covers shall be solid and sealed. Rehabilitated manholes shall include a manhole insert per section 3304.

Cast iron manhole steps shall be Clay and Bailey, or approved equal, No. 2102 for precast concrete manholes and No. 2104 for concrete manholes.

Polypropylene coated steel reinforced "plastic steps" shall be M.A. Industries, Inc. model PS-2-PF or approved equal manhole step for precast concrete manholes.

The castings shall meet or exceed the following minimum requirements:

1. Iron castings shall conform to the requirements of ASTM A 48, Class 25.
2. Castings shall be clean and whole, and without blow or sand holes or any other surface defects which would impair serviceability. Plugging or filling of holes or other defects will not be permitted.
3. Parting fins and pouring gates shall be removed.

3012 BEDDING AGGREGATE. All crushed stone materials used for pipe bedding shall conform to the requirements of Class I, II, or III and installed as required in ASTM D2321, latest edition. Bedding material shall be placed as indicated in Detail D30-1.

3013 CONSTRUCTION REQUIREMENTS.

A. Grading and Excavation.

1. Scope. Excavation and trenching work shall include the necessary clearing, grubbing, and preparation of the site; removal and disposal of all debris; excavation and trenching as required; the handling, storage, transportation and disposal of all excavated material; all necessary sheeting, shoring and protection work; preparation of subgrades; pumping and dewatering as necessary or required; protection of adjacent property; and other appurtenant work.
2. General. Excavation and trenching work shall be performed in a safe and proper manner with suitable precautions being taken against all hazards. The Contractor shall explore and expose any and all obstructions in advance of excavation so that minor changes in grade and alignment may be made.

In paralleling present water and gas mains, the Contractor shall protect all service connections and shall arrange to furnish service to the consumers with minimum interruption. Door hanger notifications will be furnished by the City and the Contractor shall inform consumers 24 hours in advance of any interrupted service.

All excavated material shall be piled in a manner that will not endanger the work and that will avoid obstructing sidewalks and driveways. Gutters shall be kept clear or other satisfactory provisions made for street drainage.

Siltation and erosion. Construction methods that will minimize siltation and erosion shall be employed. 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 siltladen water into the stream. Specifications shall require that clean-up, grading, seeding, planting, or restoration of all work areas shall begin immediately. Exposed areas shall not remain unprotected for more than seven (7) days.

3. Classification of Excavated Material. When specifically indicated in the proposal and contract, classification of excavated materials will be made as follows:
 - a. Rock. Rock excavation will be so classified when sandstone, limestone, blue shale or other similar material is encountered and, in the opinion of the Engineer, requires drilling or blasting to remove the material.
 - b. Earth. All material not classified as rock.
4. Clearing. The Contractor shall do all clearing necessary for access, stringing of pipeline materials, and construction of the pipeline and appurtenant structures.
5. Unauthorized Excavation. Any part of the trench excavated below grade shall be corrected with material approved by the Engineer placed and compacted by the Contractor.
6. Dewatering. The Contractor shall provide and maintain adequate dewatering equipment to remove and dispose of all surface and groundwater entering excavations, trenches, or other parts of the work. Each excavation shall be kept dry during sub-grade preparation and continually thereafter until the structure to be built, or the pipe to be installed therein, is completed to the extent that no damage from hydrostatic pressure, flotation or other cause will result.

All excavations for concrete structures or trenches which extend down to or below static groundwater elevations shall be dewatered by lowering and maintaining the groundwater surface beneath such excavations a distance of not less than 12 inches below the bottom of the excavation.

Surface water shall be diverted or otherwise prevented from entering excavated areas or trenches to the greatest extent practicable without causing damage to adjacent property.

The Contractor will be held responsible for the condition of any pipe or

conduit which he may use for drainage purposes, and all such pipes or conduit shall be left clean and free of sediment.

7. Sheeting and Shoring. Except where banks are cut back on a stable slope, excavation for structures and trenches shall be properly and substantially sheeted, braced, or shored as necessary to prevent caving or sliding, to provide protection for workmen and the work, and to provide protection for existing structures and facilities. Sheeting, bracing and shoring shall be designed and built to withstand all loads that might be caused by earth movement of pressure and shall be rigid, maintaining shape and position under all circumstances.

Trench sheeting shall not be pulled unless pipe strength is sufficient to carry trench loads based on trench width to the back of sheeting. Sheeting shall not be pulled after backfilling.

Where trench sheeting is left in place, such sheeting shall not be braced against the pipe, but shall be supported in a manner which will preclude concentrated loads or horizontal thrusts on the pipe. Cross braces installed above the pipe to support sheeting may be removed after pipe embedment has been completed.

8. Stabilization. Trench bottoms shall be firm, dense, and thoroughly compacted and consolidated; shall be free from mud and muck; and shall be sufficiently stable to remain firm and intact under the feet of the workmen.

Trench bottoms which are otherwise solid but which become mucky on top due to construction operations shall be reinforced with one or more layers of crushed stone or gravel. Not more than 1/2 inch depth of mud or muck shall be allowed to remain on stabilized trench bottoms when the pipe bedding material is placed thereon

9. Trench Excavation. The Contractor shall not open more trenching advance of pipe laying than is necessary to expedite the work. One block or 300 feet whichever is the shorter, shall be the maximum length of open trench ahead of pipe laying unless by written permission of the Engineer.

Except where tunneling or boring and jacking is specified and shown on the plan by the Engineer, all trench excavations shall be open cut.

10. Alignment and Grade. The alignment and grade or elevation of the pipeline shall be as shown on the plans.

The Contractor must maintain a constant check of the pipe alignment and trench depth and will be held responsible for any deviations there-from. Sewers twenty-four inches (24") (61 cm) or less shall be laid with straight alignment between manholes. Straight alignment shall be checked by either

using a laser beam or lamping.

11. Limiting Trench Width. Trenches shall be excavated to a width which will provide adequate working space and pipe clearances for proper pipe installation, jointing, and embedment. Ledge rock, boulders, and large stones shall be removed to provide a clearance of six (6) inches below and on each side of all pipe. These distances are minimum clear distances which will be permitted between any part of the pipe and appurtenances being laid on any part, projection, or point of such rock, boulder, or stone.

Cutting trench banks on slopes to reduce earth load to prevent sliding and caving will be permitted only in areas where the increased trench width will not interfere with surface features or encroach on right-of-way limits. Slopes shall not extend lower than one (1) foot above the top of the pipe.

Limiting trench widths below an elevation of one (1) foot above the exterior top of the installed pipe shall be not less than fifteen (15) inches nor more than twenty-four (24) inches greater than the nominal outside diameter of the pipe.

12. Unauthorized Trench Widths. When, for any reason, the width of the lower portion of the trench as excavated at any point exceeds the maximum permitted in the foregoing, either pipe of adequate strength, special pipe embedment, or arch concrete encasement, as required by loading conditions and as determined by the Engineer, shall be furnished and installed by and at the Contractor's expense.
13. Trench Bottom in Earth. The trench in earth shall have a flat bottom the full width of the trench and shall be excavated to grade 4-inches below bottom of the pipe to be laid. Granular pipe embedment material shall be used to restore the trench bottom to the desired elevation and grade and to provide a uniform bearing and continuous support for the pipe along its entire length
14. Rock Exploration. Unless shown otherwise on the plans or noted in the Special Provisions, no rock exploration has been made. On those projects where rock exploration has been made, test holes have been drilled at locations and intervals as shown on the plans or subsurface information report to determine the approximate location and depth of rock. Resistance to penetration was assumed to be "solid rock". This information is furnished for general reference purposes only.
15. Trench Bottoms in Rock. All rock excavation shall be carried to a minimum of 6 inches below the bottom of the pipe. Granular pipe embedment material shall be used to restore the trench bottom to the desired elevation and grade and to provide a uniform bearing and continuous support for the pipe along its entire length. Care shall be exercised to prevent any portion of the pipe from coming to bear on solid rock or boulders.
16. Mechanical Excavation. The use of mechanical equipment will not be

permitted in locations where its operations would cause damage to trees, buildings, culverts, or other existing property, utilities, or structures above or below ground. In all such locations, hand-excavating methods shall be used.

Mechanical equipment used for trench excavation shall be of the type, design and construction and shall be so operated that the rough trench excavation bottom elevation can be controlled, that uniform trench widths and vertical sidewalls are obtained at least from the bottom of the trench, and that trench alignment will be centered in the trench with adequate clearance between the pipe and sidewalls of the trench. Undercutting the trench sidewall to obtain clearance will not be permitted.

All mechanical trenching equipment, its operating conditions, and the manner of its operations shall be subject at all times to the approval of the Engineer.

17. Stream Crossings. Stream crossings shall be made in accordance with these specifications and as shown on the plans.

The trench width shall be as required for proper pipe installation and the trench depth shall be as required to give minimum cover shown on the plans, Pipe encasement, where required, shall be in accordance with the specifications and placed as indicated on the plans.

18. Highway and Railroad Crossings. The Contractor shall make highway and railroad crossing in accordance with these specifications, the Special Provisions and as shown on the plans.

All construction or work performed and all operations of the Contractor, his employees, or his subcontractors within the limits of highway or railroad right-of-ways shall be in conformity with all the requirements, regulations and be under the control of the authority owning or having jurisdiction over and control of the right-of-way. All notifications of the owning authority shall be through the Engineer

The Contractor shall pay fees and obtain permits to make the crossings unless otherwise directed.

3014 HANDLING. Handle pipe materials and fittings in a manner to insure installation in sound and undamaged condition. Do not drop or bump. Use slings, lifting lugs, hooks and other devices designed to protect pipe, joint elements and coatings. In handling plastic pipe of ten (10) feet in length or greater, a double sling will be required unless otherwise approved by the Engineer.

Materials shall be shipped, moved and stored with provisions to prevent movement or shock contact with adjacent units.

3015 INSTALLATION.

- A. All work shall be in accordance with the following standards:

Flexible Thermoplastic Pipe; ASTM C600

Ductile Iron Water Mains; AWWA C600

B. Utilize equipment, methods and materials insuring installation to lines and grades indicated.

1. Maintain the following tolerances from true alignment and grade between manholes:

Alignment	3 inches
Grade	+ - 1 inch

Joint deflection shall not exceed the maximum allowable deflection per joint according to ASTM C 425, ASTM C 594 and AWWA C 600. Only one correction for alignment and/or grade shall be made between adjacent manholes.

2. Except where pipe sections are being encased in concrete, no pipe is to be supported by blocks.

C. Install pipe of size, material, strength class, and joint type with embedment as shown on the Plans.

D. Insofar as possible, commence laying at downstream end of line and install pipe with spigot or tongue end downstream.

E. Clean interior of all pipe, fittings, and joints prior to installation. Exclude entrance of foreign matter during discontinuance of installation. Close open ends of pipe with snug fitting closures. Do not let water fill trench. Include provisions to prevent flotation should water control measures prove inadequate. Remove water, sand, mud and other undesirable materials from trench before removal of end cap.

F. Install pipe only when weather and trench conditions are suitable. Do not lay pipe in water. Brace or anchor pipe as required preventing displacement after establishing final position.

G. Ledge rock, boulders, and large stones shall be removed to provide a minimum clearance of four inches (4") (10 cm) below and on each side of all pipe(s).

3016 PIPE BEDDING. The sewer trench shall be carried to a point not less than two (2) inches below bottom of pipe bell, or less than four (4) inches below bottom of pipe barrel, whichever is greater. Crushed stone pipe bedding, compacted to full width of trench, shall then be placed and compacted to bottom of pipe with proper allowance for bell joints or couplings. After each length of pipe being laid has been shoved "home" and placed in proper alignment, it shall be securely anchored and held in position by crushed stone backfill extending to a point not less than six (6) inches above the top of the pipe bell or coupling. If unstable subgrade conditions are encountered and it is determined by the Engineer that the bedding specified will not provide suitable support for the pipe, additional excavation to the limits determined by the Engineer will be required. This additional

excavation shall be backfilled with crushed stone material approved by the Engineer.

Rigid pipe. Bedding Classes A, B, C, or crushed stone, as described in ASTM C12, shall be used and carefully compacted for all rigid pipe provided the proper strength pipe is used with the specified bedding to support the anticipated load based on the type of soil encountered and potential groundwater conditions.

Composite pipe. Except as described in ASTM D2680, the bedding, haunching, and initial backfill requirements for composite pipe shall be the same as for plastic pipe.

3017 JOINTING.

A. General Requirements.

1. Locate joints to provide for differential movement at changes in type of pipe embedment, concrete collars, and structures. Support pipe from wall of manhole at first joint in normal sewer trench with concrete cradle structurally continuous with base slab or footing.
2. Clean and lubricate all joint and gasket surfaces with lubricant recommended by pipe manufacturer.
3. Utilize methods and equipment capable of fully homing or making up joints without damage.
4. Check joint opening and deflection for specification limits.
5. Examine each piece of pipe prior to installation for soundness and specification compliance.

B. Provisions for Jointing Ductile Iron Pipe.

1. Conform with AWWA C 600.
2. Paint suspected damaged portions with turpentine and dust with cement to check for cracks. Remove turpentine and cement by washing when crack test is satisfactorily completed. If cracks are found, the pipe shall be rejected.
3. Check gasket position and condition after assembly prior to installation of next pipe section.

C. Provisions for Jointing PVC Pipe. Check gasket for position and condition after assembly prior to installation of next pipe section.

D. Provisions for Jointing HDPE Pipe. Connection shall be made in conformance with manufacturer's recommendations.

3018 CUTTING. Cut in neat workmanlike manner without damage to pipe. Observe specification regarding joint locations. Smooth cut by power grinding to remove burrs and sharp edges. Repair

lining as required and approved.

3019 TEMPORARY PLUGS.

- A. Plugs. Provide and install plugs as manufactured by pipe supplier or as fabricated by Contractor if approved. Plugs shall be water-tight against heads up to 20 feet of water. Secure plugs in place in a manner to facilitate removal when required to connect pipe.
- B. Location. Plugs shall be installed as specified or where shown on Plans. Also the open end of the sewer shall be plugged at the end of the work day with a suitable mechanical plug to prevent entry of foreign material until work is resumed.

3020 CONNECTIONS TO EXISTING PIPELINES AND STRUCTURES.

- A. Connect pipe to existing structures and pipelines where indicated. Observe pertinent articles of specifications pertaining to joint locations.
- B. Openings in manhole sections for sewer connections shall be core-drilled and shall be done to produce a smooth, uniform, cylindrical hole of proper size to accommodate a resilient connector meeting requirements of ASTM C 923. The resilient connectors shall be either Fernco or PSX Gasket or approved equals. Any additional holes cut in the field shall be drilled with a core-drill or in a manner approved by the Engineer.
- C. Manholes to be built on an existing sewer shall be constructed in such a manner as will not disrupt service of the existing sewer. The manhole base, walls and invert shall be completed before the top half of the sewer pipe is cut or broken away. Rough edges of the pipe thus exposed shall be covered with expansive grout, in such a manner as to produce a smooth and acceptable finish. Any portion of the existing sewer damaged by the Contractor shall be repaired or replaced at no expense to the City.
- D. Connections between pipes shall be made using a proprietary transition coupling or stainless steel Fernco gasket or approved equal, unless otherwise specified on the Plans.

Service connections. Service connections to the sewer main shall be watertight and not protrude into the sewer. If a saddle type connection is used, it shall be a device designed to join with the types of pipe which are to be connected. All materials used to make service connections shall be compatible with each other and with the pipe materials to be joined and shall be corrosion proof.

3021 TRENCH BACKFILL. Compacted backfill shall be required for the full depth of the trench above the embedment where beneath structures, street, road, or highway right-of-way, driveways, walks, parking areas, and at all locations shown on the plans or as directed by the Engineer during the progress of the work.

Final backfill shall be of a suitable material removed from excavation except where other material is

specified. Debris, frozen material, large clods, stones, organic matter, or other unstable materials shall not be used for final backfill within two feet (2') (0.6 m) of the top of the pipe.

The top portion of the backfill beneath established sod areas shall be finished with at least twelve (12) inches of topsoil corresponding to, or better than, that underlying adjoining sodded areas. Topsoil shall be approved by the Engineer prior to placement, and unless otherwise directed, shall be material previously excavated and stockpiled for the purpose during excavating and grading operations. Grades on areas to receive topsoil shall be established and maintained as a part of the grading operations. Immediately prior to dumping and spreading topsoil, the surface shall be loosened by disking or scarifying to a depth of two (2) inches to permit bonding of the topsoil to the underlying surface.

At the option of the Contractor, compacted backfill may be job-excavated material or material obtained off site, except that all street crossings shall be backfilled with MoDOT Type I rock, four (4) feet back of curb to four (4) feet back of curb, unless authorized by the City Engineer. Job-excavated material may be used for compacted backfill (outside of Street Right of Ways) when the job-excavated material is finely divided and free from debris, organic material, cinders, or other corrosive material, and stones larger than three (3) inches in greatest dimension. Large masses of moist, stiff clay shall not be used. Job-excavated material shall be compacted to ninety-five (95) percent of maximum density at optimum moisture content as determined by ASTM D698 when the test is appropriate, or to seventy (70) percent relative density as determined by ASTM D2049 when that test is appropriate.

The method of compaction and the equipment used shall be appropriate for the material to be compacted and shall not transmit damaging shocks to the pipe.

The combination of the thickness of the layer, the method of compaction and the type of compaction equipment used shall be at the discretion of the Contractor subject to obtaining the densities as specified above.

Backfill shall not be placed when material contains frost, is frozen, or a blanket or snow prevents proper compaction. Backfill shall not contain waste material, organic material, or debris of any kind.

Trench backfill above pipe embedment in locations other than those specified shall be compacted to ninety (90) percent of maximum density at optimum moisture content as determined by ASTM D698, unless otherwise permitted by the Engineer.

Uncompacted earth backfill material to be placed above embedments shall be free of brush, roots, rocks more than two (2) inches in diameter, debris, cinders, or other corrosive material, and junk, but may contain rubble and debris from rock excavation, stones, and boulders in certain portions of the trench depth. Uncompacted backfill material above embedments may be placed by any method acceptable to the Engineer which will not impose excessive concentrated or unbalanced loads, shock, or impact on and which will not result in displacement of installed pipe. Uncompacted backfill shall be placed to the extent necessary to prevent excessive future settlement.

Compact masses of stiff clay or other consolidated material more than one (1) cubic foot in volume shall not be permitted to fall more than five (5) feet into the trench unless cushioned by at least two (2) feet of loose backfill above pipe embedment.

No un-compacted trench backfill material containing rocks, or rock excavation detritus, shall be placed in the upper eighteen (18) inches of the trench except with specific permission of the Engineer, nor shall any stone larger than eight (8) inches in its greatest dimension be placed within three (3) feet of the top of pipe. Large stones may be placed in the remainder of the trench backfill only if well separated and so arranged that no interference with backfill settlement will result.

All excess bedding rock and other excavation debris shall be removed from surface before final grading can be accepted for seeding or sodding.

3022 STRUCTURE BACKFILL. Backfill around structures shall be compacted to the extent necessary to prevent future settlement by tamping or other means acceptable to the Engineer.

Material for backfill shall be composed of earth only and shall contain no wood, grass, roots, broken concrete, stones, trash, or debris of any kind. No tamped or otherwise mechanically-compacted backfill shall be deposited or compacted in water.

No backfill shall be placed over or around any structure until the concrete or mortar therein has attained a minimum strength of 2000 psi and can sufficiently support the loads imposed by the backfill without damage.

The Contractor shall use utmost care to avoid any wedging action between the side of the excavation and structure that would cause any movement of the structure. Any damage caused by premature backfill or by the use of equipment on or near a structure will be the responsibility of the Contractor.

Backfill shall be placed and compacted on all sides of the structure simultaneously, and operations shall be so conducted that the backfill is approximately the same elevation on all sides of the structure.

No excavated rock larger than four (4) inches maximum dimension shall be placed within one (1) foot of the exterior surface of any structure.

3023 DENSITY TESTING. At the option of the Engineer, in-place field density testing to determine compliance with specified compaction requirements may be performed using a nuclear moisture-density measuring device. Such testing shall be performed in trenches with no more than one (1) foot lifts. The field testing results shall be immediately available to the inspector. If, as a result of this field testing, the engineer determines that further compaction is required, the Contractor shall revise his compaction procedures to obtain the results specified.

3024 DRAINAGE MAINTENANCE. Trenches across roadways, driveways, walks, or other trafficways adjacent to drainage ditches or water courses shall not be backfilled prior to completion of backfilling the trench on the upstream side of the trafficway, to prevent impounding water after the pipe has been laid. Bridges and other temporary structures required to maintain traffic across such unfilled trenches shall be constructed and maintained by the Contractor. Backfilling shall be done so that water will not accumulate in unfilled or partially-filled trenches. All material deposited in roadway ditches or other water courses crossed by the line of trench shall be removed immediately after backfilling is completed and the original section, grades, and contours of ditches or water courses shall be restored. Surface drainage shall not be obstructed longer than necessary.

3025 PROTECTION OF TRENCH BACKFILL IN DRAINAGE COURSES. Where trenches are

constructed in ditches or other water courses, backfill shall be protected from surface erosion. When the grade of the ditch exceeds one (1) percent, ditch checks shall be installed. Unless otherwise shown on the drawings or directed by the Engineer, ditch checks shall be concrete. Ditch checks shall extend not less than two (2) feet below the original ditch or water course bottom for the full bottom width and at least eighteen (18) inches into the side slopes and shall be at least twelve (12) inches thick.

3026 DISPOSAL OF EXCESS EXCAVATED MATERIALS. Except as otherwise permitted, all excess excavated materials shall be disposed of away from the site or work.

Broken concrete and other debris resulting from pavement or sidewalk removal, excavated rock in excess of the amount permitted to be and actually installed in trench backfill, junk, and debris encountered in excavation work and other similar waste materials shall be disposed of away from the site of the work.

Excess earth from excavation located in unimproved property shall be distributed directly over the pipe trench and within the pipeline right-of-way to a maximum depth of six (6) inches above the original ground surface elevation at and across the trench and sloping uniformly. Drag with blade machine or other suitable tool to a smooth, uniform surface without obstructing drainage at any point. Wasting of excess excavated material in the above manner will not be permitted where the line of trench crosses or is within a railroad, public road, or highway right-of-way. The disposal of waste and excess excavated materials, including hauling, handling, grading, and surfacing shall be a subsidiary obligation of the contractor.

3027 SETTLEMENT. The Engineer may perform periodic inspections to insure that no settlement has occurred. The Contractor shall be responsible for all settlement of backfill, fills and embankments which may occur within two (2) years of time after final acceptance of the contract under which the work was performed.

The Contractor shall make, or cause to be made, all repairs or replacements made necessary by settlement within thirty (30) days after notice from the Engineer. Should the Contractor fail to make such repairs the City Engineer may cause repairs to be made and the cost of these repairs shall be the responsibility of the Contractor. Within sixty (60) days of the expiration of the Warranty period, an inspection will be held by the Owner. The Contractor is invited to attend the Inspection

3028 PROTECTION OF DRINKING WATER SUPPLIES.

A. Cross Connections Prohibited. There shall be no physical connections 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 supply. No water pipe shall pass through or come in contact with any part of a sewer manhole.

B. Relation to Water Works Structures.

1. While no general statement can be made to cover all conditions, it is recognized that sewers shall meet the requirements of 10 CSR 23-3.010, Rules of the Missouri Department of Natural Resources, with respect to minimum distances from public water supply wells or other water supply sources and structures.
2. All existing water works units, such as basins, wells, or other treatment units, within

two hundred feet (200') (60 m) of the proposed sewer shall be shown on the engineering plans.

C. Relation to Water Mains.

1. Horizontal and vertical separation.

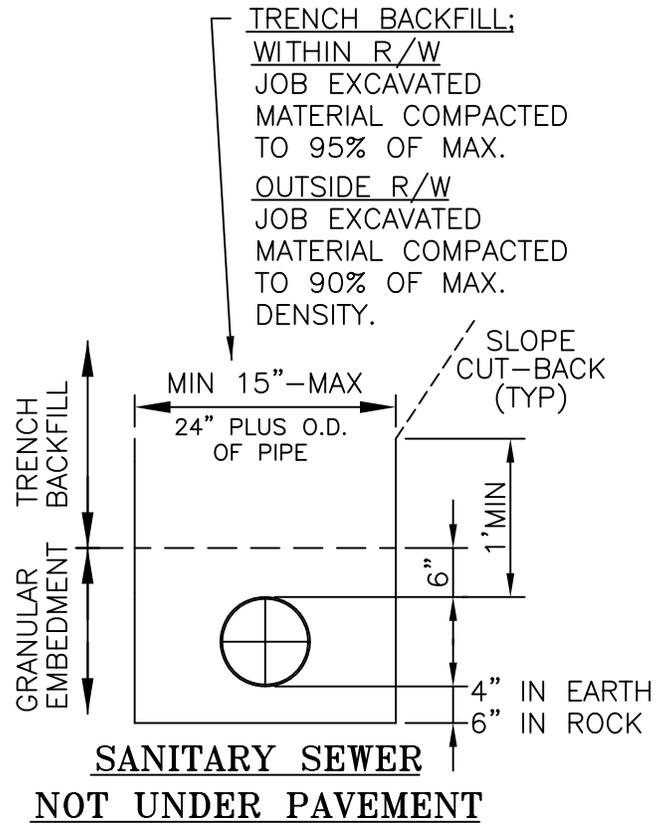
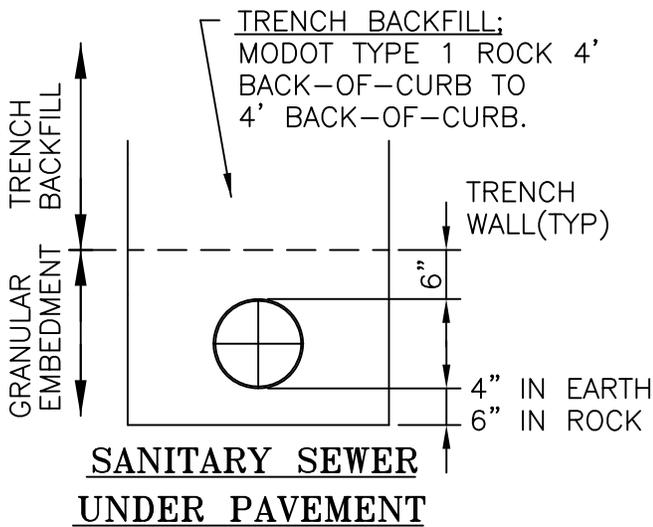
- A. Sewer mains shall be laid at least ten feet (10') (3.0 m) horizontally from any existing or proposed water main. The distances shall be measured edge-to-edge. In cases where it is not practical to maintain a ten-foot (10') (3.0 m) separation, the department may allow deviation on a case-by-case 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 (1) side of the sewer and at an elevation so the bottom of the water main is at least eighteen inches (18") (46 cm) above the top of the sewer.
- B. If it is impossible to obtain proper horizontal and vertical separation as described above for sewers, the sewer must be constructed of slip-on or mechanical joint pipe or continuously encased and be pressure tested to one hundred fifty pounds per square inch (150 psi) (1,034 kPa) to assure watertightness.
- C. Manholes should be located at least ten feet (10') (3.0 m) horizontally from any existing or proposed water main.

2. Crossings.

- A. Sewers crossing water mains shall be laid to provide a minimum vertical distance of eighteen inches (18") (46 cm) between the outside of the water main and the outside of the sewer. This shall be the case where the water main is either above or below the sewer. The crossing shall be arranged so that the sewer joints will be equidistant and as far as possible from the water main joints. Where a water main crosses under a sewer, adequate structural support shall be provided for the sewer to maintain line and grade.
- B. When it is impossible to obtain proper vertical separation as stipulated above, one (1) of the following methods must be specified:
 - (I) The sewer shall be designed and constructed equal to water pipe and shall be pressure tested to assure watertightness prior to backfilling; or
 - (II) Either the water main or sewer line may be continuously encased or enclosed in a watertight carrier pipe which extends ten feet (10') (3.0 m) on both sides of the crossing, measured perpendicular to the water main. The carrier pipe shall be of materials approved by the department for use in water main construction.

shall be installed on all service lines between the mainline and two-way cleanout within the public right-of-way per Section 9100 Tracer Wire Pipe Detection System.

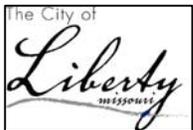
3030 CLEANOUTS. A two-way cleanout shall be installed on proposed service lines near the edge of the right-of-way. The service line shall be stubbed approximately 5 feet beyond the cleanout from the main. The riser pipe and threaded cleanout adapter fitting shall match service line pipe size and material. Cleanout cover and frame shall be Neenah R-1976, or approved equal, color coded green, and shall rest on a 4" thick concrete support pad, top of pad being 8" from the surface grade. Tracer wire shall be terminated within the cleanout frame per detail D30-6.



NOTES:

1. GRANULAR EMBEDMENT PER SECTION 3012 AND 3016.
2. TRENCH BACKFILL PER SECTION 3021.

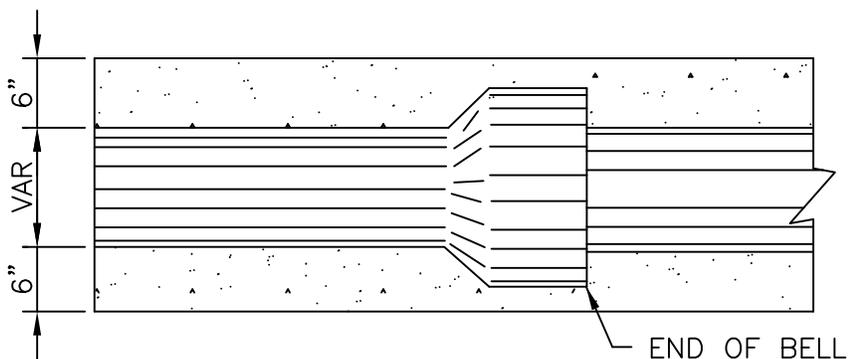
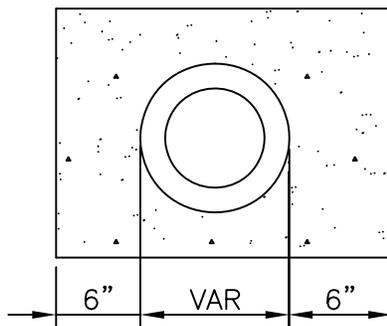
REV 2016



CITY OF LIBERTY, MO
DEPARTMENT OF
PUBLIC WORKS

**EMBEDMENT &
BACKFILL FOR
SANITARY SEWERS**

D30-1



FOR USE ONLY WHERE INDICATED ON PLANS THE CONCRETE ENCASEMENT SHALL BE OF MCIB 548 CONCRETE WITH A MINIMUM THICKNESS ON ALL SIDES OF 6".

1. 8" DIA = .11 C.Y. OF CONCRETE PER LINEAL FT
2. 10" DIA = .12 C.Y. OF CONCRETE PER LINEAL FT
3. 12" DIA = .14 C.Y. OF CONCRETE PER LINEAL FT
4. 15" DIA = .15 C.Y. OF CONCRETE PER LINEAL FT

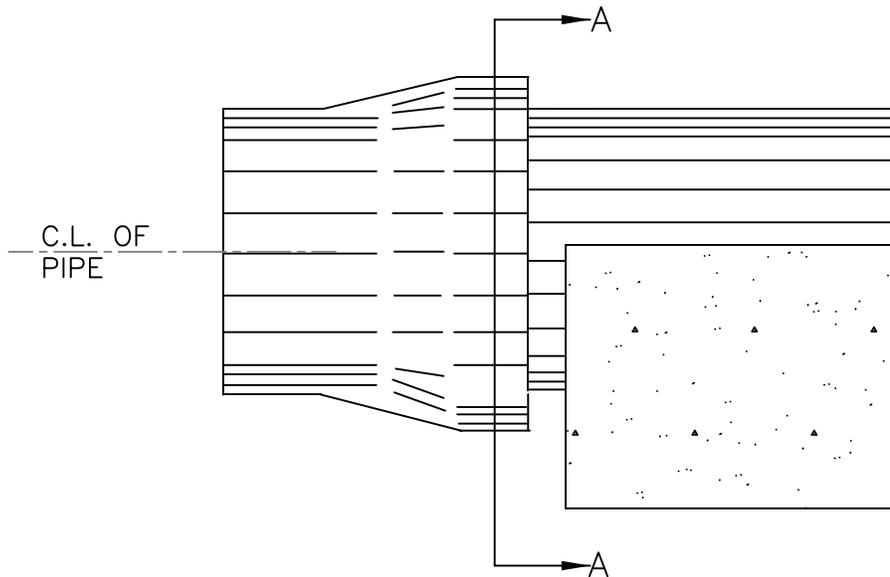
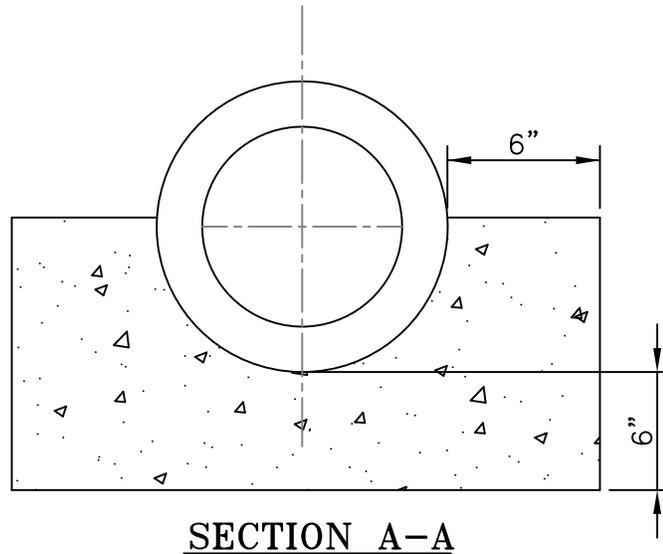
REV 2009



CITY OF LIBERTY, MO
DEPARTMENT OF
PUBLIC WORKS

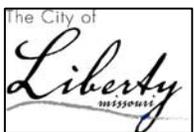
CONCRETE
ENCASEMENT DETAIL

D30-2



FOR USE ONLY WHERE INDICATED ON PLANS.
 THE CONCRETE SHALL BE 3000 PSI CONCRETE.
 THE MIN THICKNESS, ON THE SIDES AND BOTTOM
 SHALL BE 6" THE TOP OF THE CONCRETE SHALL
 BE AT LEAST TO THE CENTER OF THE PIPE.

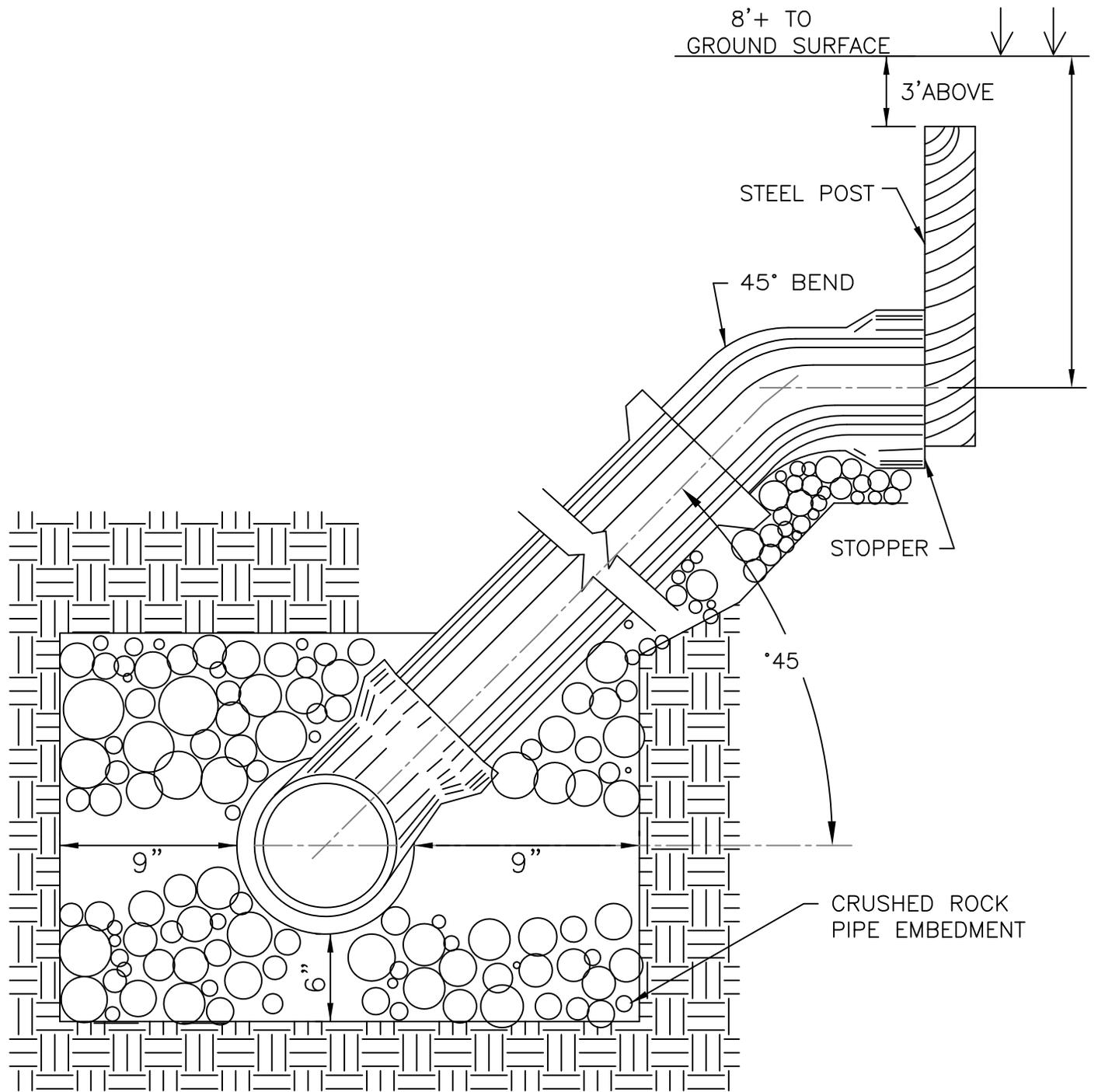
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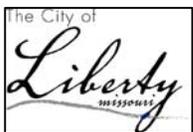
CITY OF LIBERTY, MO
 DEPARTMENT OF
 PUBLIC WORKS

CONCRETE
 CRADLE DETAIL

D30-3



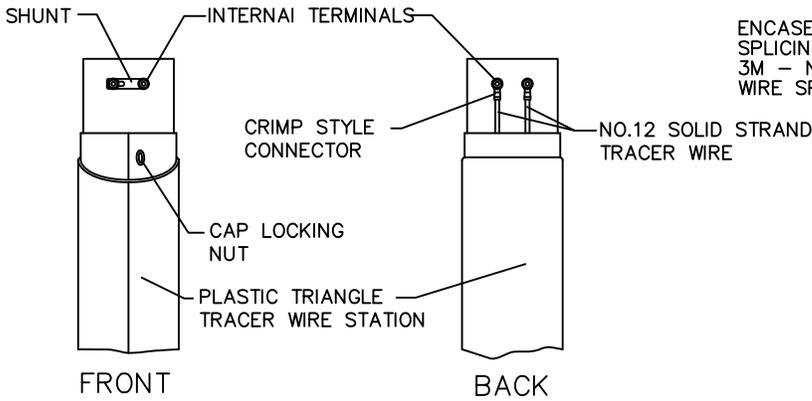
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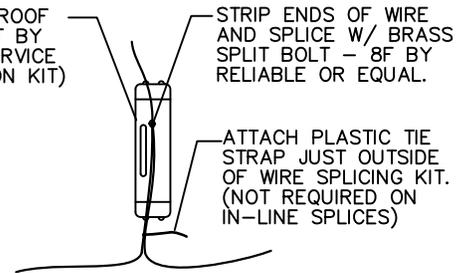
STANDARD
SERVICE
RISER

D30-4



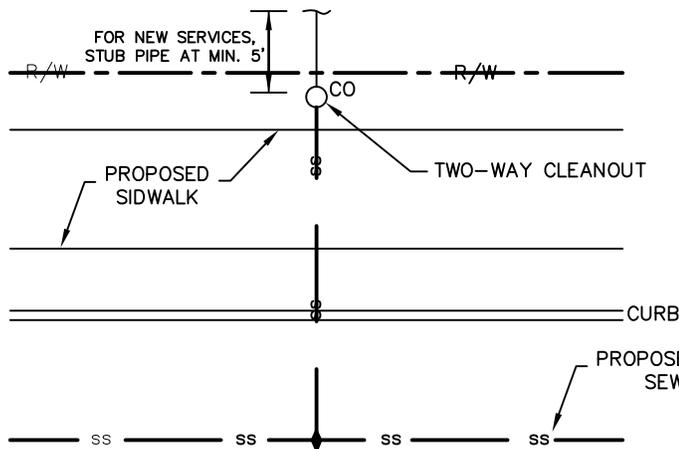
TRACER WIRE RECEPTACLE DETAIL
Not to Scale

ENCASE SPLICE IN WATERPROOF SPLICING KIT. (SCOTCHCAST BY 3M - No. 3832 BURIED SERVICE WIRE SPLICE ENCAPSULATION KIT)

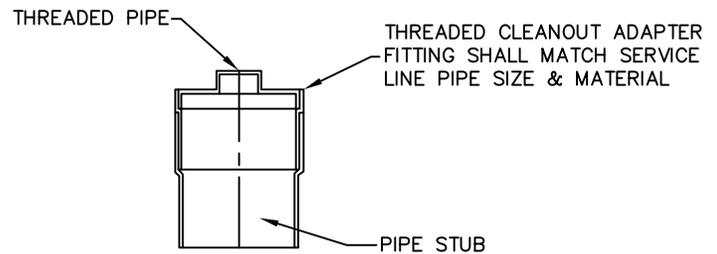


***SPLICES PERMITTED ONLY WITH APPROVAL OF ENGINEER**
TRACER WIRE SPLICE DETAIL
Not to Scale

NOTE:
SET STEEL POST 3'-0" ABOVE GRADE NEXT TO RISER PIPE LOCATION.
POST TO REMAIN UNTIL FINAL GRADING AND SEEDING OR SOD IS IN PLACE.

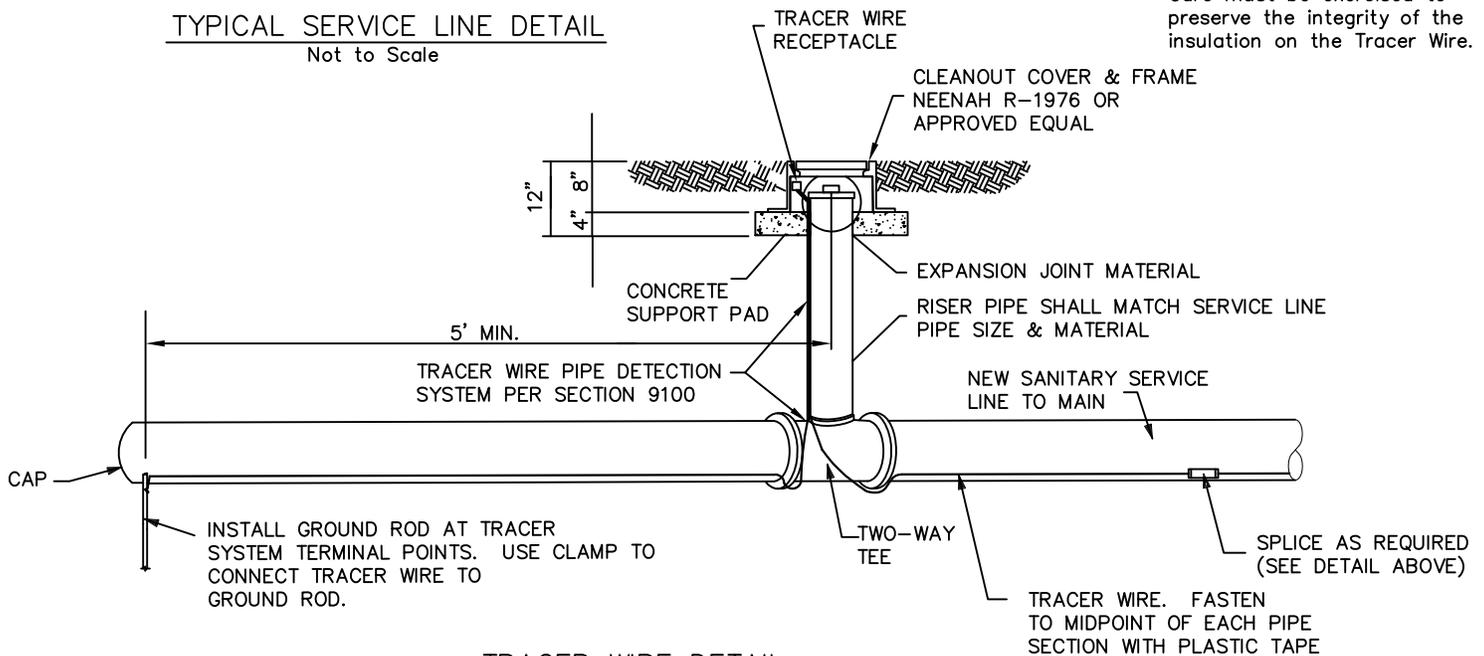


TYPICAL SERVICE LINE DETAIL
Not to Scale



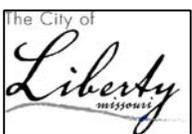
SECTION DETAIL
Not to Scale

Note:
Care must be exercised to preserve the integrity of the insulation on the Tracer Wire.



TRACER WIRE DETAIL
Not to Scale

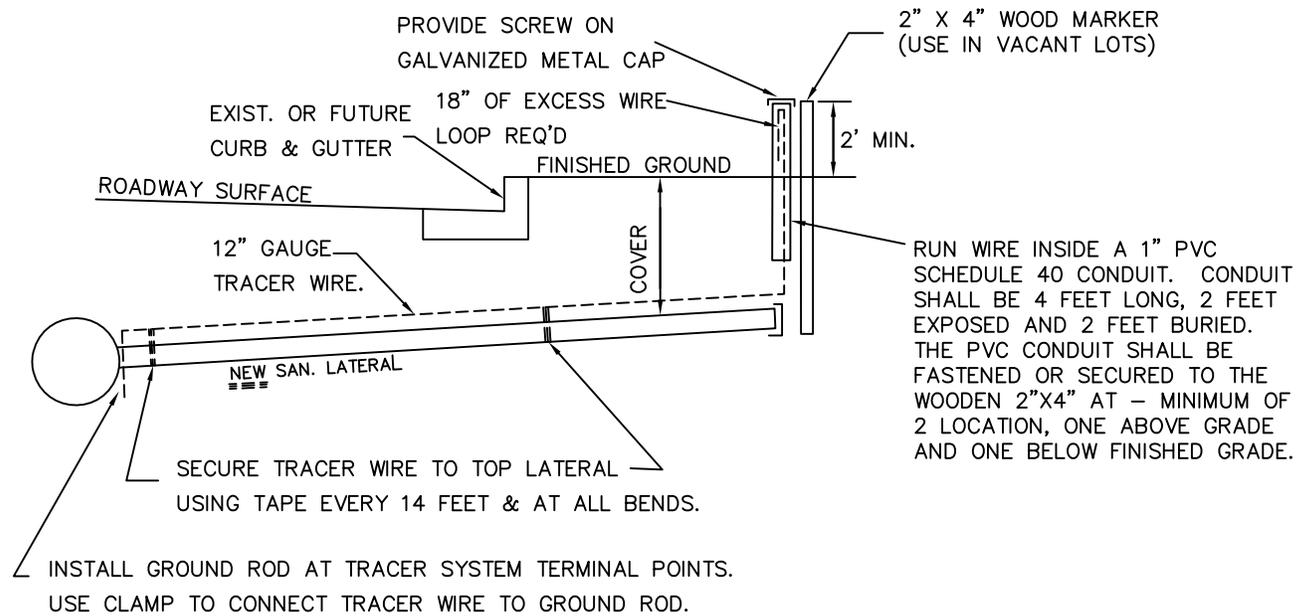
REV 2015



CITY OF LIBERTY, MO
DEPARTMENT OF
PUBLIC WORKS

**TWO-WAY
CLEANOUT
DETAIL**

D30-6

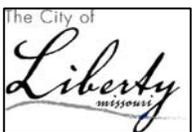


TRACER WIRE PIPE DETECTION SYSTEM PER SECTION 9100.

NOTES:

1. WHEN NEW PRIVATE SERVICE LINE TIES INTO STUB, INSTALL A PERMANENT TWO-WAY CLEANOUT WITH TRACER WIRE TERMINAL IN CLEANOUT FRAME PER DETAIL D30-6.

REV 2015



CITY OF LIBERTY, MO
DEPARTMENT OF
PUBLIC WORKS

TEMPORARY STUB
TRACER WIRE
DETAIL

D30-7

SECTION 3100 MANHOLE AND SPECIAL STRUCTURES - SANITARY SEWERS

3101 SCOPE. This section governs the furnishing of all labor, equipment, tools, and materials, and the performance of all work incidental to the construction of manholes, drop manholes and special sewer structures complete with covers, steps, fittings and appurtenances as required for sanitary sewer construction.

3102 GENERAL. As used herein special structures refers to manholes on large sewers, special junction structures, metering stations, siphons and similar structures constructed on the pipeline.

Manholes and special structures may be constructed of precast concrete sections or cast-in-place concrete. Construction of brick or concrete/hydite block masonry will not be allowed.

Outside manhole drops are not allowed. If a drop manhole is necessary, an inside drop shall be installed, and the minimum inside diameter of the manhole shall be five (5) feet.

3103 CONSTRUCTION.

- A. General. Manholes and special structures shall be constructed at locations indicated and in accordance with details as shown on the plans or City Standard Drawings. Manholes will be constructed with eccentric cones unless otherwise approved by the City Engineer.
- B. Precast Wall and Reducing Cone Sections. Handle with care to avoid damage to joint ends of each section. Damaged sections may be subject to rejection at the discretion of the Engineer.

When using bitumastic joints, both spigot and bell end shall be primed with solvent material compatible to the adhesive in the mastic. Approved bitumastic material shall completely fill the joints so that a minimum of one-fourth (1/4) inch bead of material is visible after jointing, to be smoothed off after completion of the jointing operation.

When a flexible preformed butyl rubber or bituminous polymer compounded with modifiers is used to seal jointed sections of manholes, the extrusion of sealant from the joint is not required. The vertical spacing between manhole section shall not exceed one-fourth (1/4) inch. Preformed joint sealers shall remain flexible at temperatures as low as 0 deg. F.

All bitumastic materials or preformed flexible joint sealants shall not be applied to wet or damp surfaces.

When using precast manholes, drop connections must not enter the manhole at a joint.

- C. Cast-in-Place. Consolidate concrete with mechanical vibrators to eliminate entrapped air voids and rock pockets. Forms shall be supported in such a manner as to prevent any movement of the forms while concrete is being cured. Any movement of the forms may be cause for rejection.

- D. Invert Channels. Alignment of the invert channels shall be as shown on the Contract Drawings. When no specific details and dimensions are given, changes in flow direction shall be smooth, uniform and made with the longest radius possible. The cross sectional shape of invert channels shall match the lower halves of the entering and exiting pipes. The surfaces of the channels shall be troweled to produce a dense, smooth surface.

Bench. A bench shall be provided on each side of any manhole channel when the pipe diameter(s) are less than the manhole diameter. The bench should be sloped no less than a one-half inch per foot (0.5 in/ft) (12.7 mm/m). No pipe shall discharge onto the surface of the bench.

- E. Manhole Penetrations. All manhole penetrations shall have waterstop gaskets as shown in exhibit D31-4.

3104 CURING. All masonry, plaster coating and cast-in-place concrete shall be adequately protected from freezing and loss of moisture for the first 24 hours. The curing methods and materials to be used shall be approved by the Engineer.

3105 MANHOLE RINGS. All rings for manhole covers shall be set to match elevations indicated on the City approved plans. Each ring shall be set on one 4-inch and one 6-inch adjusting ring as indicated on the Standard Details. Mastic sealant shall be provided between all joints.

Recycled rubber grade adjustment rings (flat or tapered), as manufactured by Sealing Systems Inc. or approved equal, may be used.

A minimum access diameter of twenty-two inches (22") (56 cm) shall be provided.

3106 WATER-PROOFING. Waterproofing will be required on the exterior surface of manhole structures from base to manhole rings. Precast manholes will be shop coated. The waterproof coating shall be Koppers Company, Inc. Bitumastic No. 50 or Tnemec Company, Inc. asphalt base foundation coat and shall consist of two coats wet thickness of 22-26 mils with a combined dry thickness of 31 mils. The coating shall be applied in sufficient quantity so that no bare or thin spots show. The coating shall be applied in sufficient time to permit proper curing prior to backfilling the excavation. Proper methods and material shall be used during backfilling to prevent damage to the coating. Any damage to the coating which does occur shall be immediately repaired.

3107 INTERNAL OR EXTERNAL RUBBER CHIMNEY SEAL. An internal rubber chimney seal as manufactured by Cretex Specialty Products or approved equal shall be installed, sealing all joints from the manhole frame to the corbel cone. Internal rubber chimney seal extension shall be used if necessary.

3108 EXTERIOR MANHOLE JOINT SEAL. Each manhole shall be sealed with an external rubber sleeve, Infi-Shield Gator Wrap as manufactured by Sealing Systems, Inc. or approved equal, to form a continuous rubber seal on the manhole joint preventing water and soil from infiltrating through the manhole. The seal shall be made of a stretchable, self-shrinking, intra-curing halogenated base rubber with a minimum thickness of 30 mils. The back side each unit shall be coated with a cross-linked re-inforced butyl adhesive. The butyl adhesive shall be non-hardening sealant with a

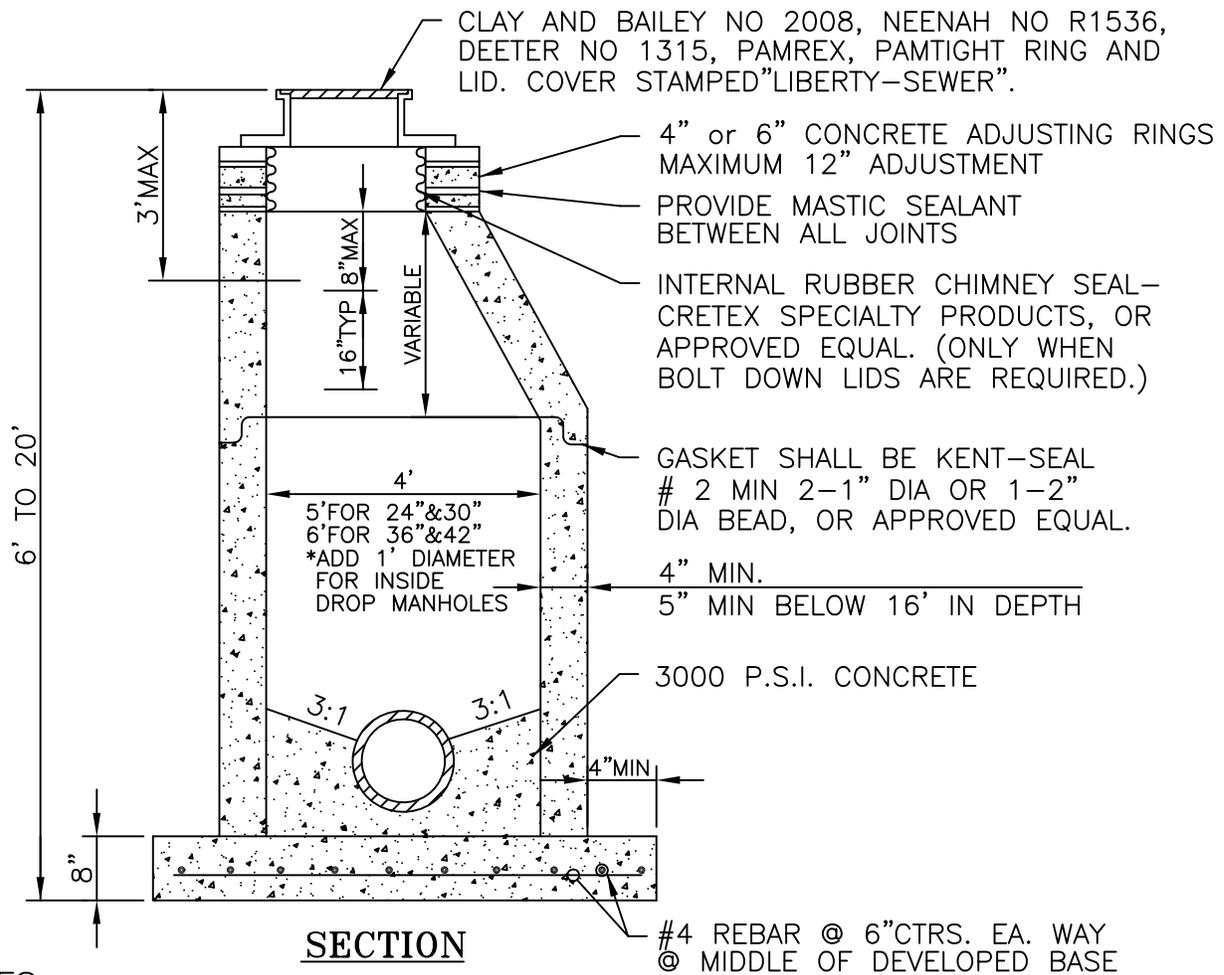
minimum thickness of 30 mils. The seal shall be designed to stretch around the joint and then overlapped creating a cross-link and fused bond between the rubber and butyl adhesive.

A. Rubber Specifications:

Physical Properties	ASTM Test Method	Typical Value
Sheer Strength	D816	20 lb. PSI min
Tesile, PSI	D412	50 PSI
Elongation %	D412	500%
Penetration	D217	60/140 MM
Low Temperature	D746	Minus 49 degrees F flexibility
Heat Aging	D573 7 days @ 90 degrees C	
Tensile Strength	Minimum, PSI (MPa) > 100 PSI	Pass
Fusion	5/64" (0.2) max	Pass
Elongation %	Minimum 300% at break	Pass
Ozone Resistance	No visible signs of cracking	Pass
Aging and Storage	300% elongation applied (10 years)	Pass
UV Resistance	No visible signs of cracking	Pass

B. Installation:

1. Expose the area that is to be sealed. Clean the entire area around the joint with a wire brush and whisk broom. Remove any sharp protruding edges around the joint with an abrasive tool. When finished cleaning, the entire area must be dry and free of any dirt.
2. Remove the first foot of paper backing from the mastic. Center and place the wrap around the joint. Continue to remove the paper backing as you apply the wrap around the entire structure.
3. Seal the overlapping area with a 6" overlap. Be sure to stretch material at the overlap area.
4. Cut excess material using a utility knife. Using a rubber mallet or hand held roller, firmly flatten the wrap 360 degrees around the joint.



NOTES:

1. PRECAST CONCRETE MANHOLES SHALL CONFORM TO ASTM C478 EXCEPT AS MODIFIED BY THE SPECIFICATIONS.
2. BASES NOT BUILT MONOLITHIC WITH BOTTOM SECTION SHALL BE POURED OF 3000 PSI CONCRETE.
3. MANHOLE MAY BE TRANSITIONED TO 4' DIA., 8' ABOVE F.L. OF OUTFALL FOR 5' & 6' MANHOLES.
4. THE BOTTOM SECTION OF ALL PRECAST MANHOLES NOT BUILT MONOLITHIC WITH THE BASE SHALL BE SET INTO A STEEL REINFORCED POURED CONCRETE BASE A MIN OF 4". (#4 @ 6" E.W.)
5. WATERPROOFING WILL BE REQUIRED ON THE EXTERIOR SURFACE OF MANHOLE STRUCTURES FROM BASE TO MANHOLE RINGS. PRECAST MANHOLES WILL BE SHOP COATED. THE WATERPROOF COATING SHALL BE KOPPERS COMPANY, INC. BITUMASTIC NO. 50 OR TNE MEC COMPANY, INC. ASPHALT BASE FOUNDATION COAT AND SHALL CONSIST OF TWO COATS WET THICKNESS OF 22-26 MILS WITH A COMBINED DRY THICKNESS OF 31 MILS.
6. THE COMPRESSIVE STRENGTH OF CONCRETE USED IN THE CONSTRUCTION OR PRECAST REINFORCED CONCRETE MANHOLES SHALL NOT BE LESS THAN 4000 PSI.
7. ONLY ECCENTRIC MANHOLE CONES WILL BE ALLOWED UNLESS OTHERWISE APPROVED BY THE CITY ENGINEER.
8. ADDITIONAL BASE THICKNESS FOR MANHOLES GREATER THAN 20' DEEP SHALL BE APPROVED BY CITY ENGINEER WITH SUBMITTAL OR APPROPRIATE CALCULATIONS.
9. ALL MANHOLE JOINTS SHALL BE SEALED WITH AN EXTERNAL RUBBER SLEEVE, INFI-SHIELD GATOR WRAP AS MANUFACTURED BY SEALING SYSTEMS, INC., OR APPROVED EQUAL.

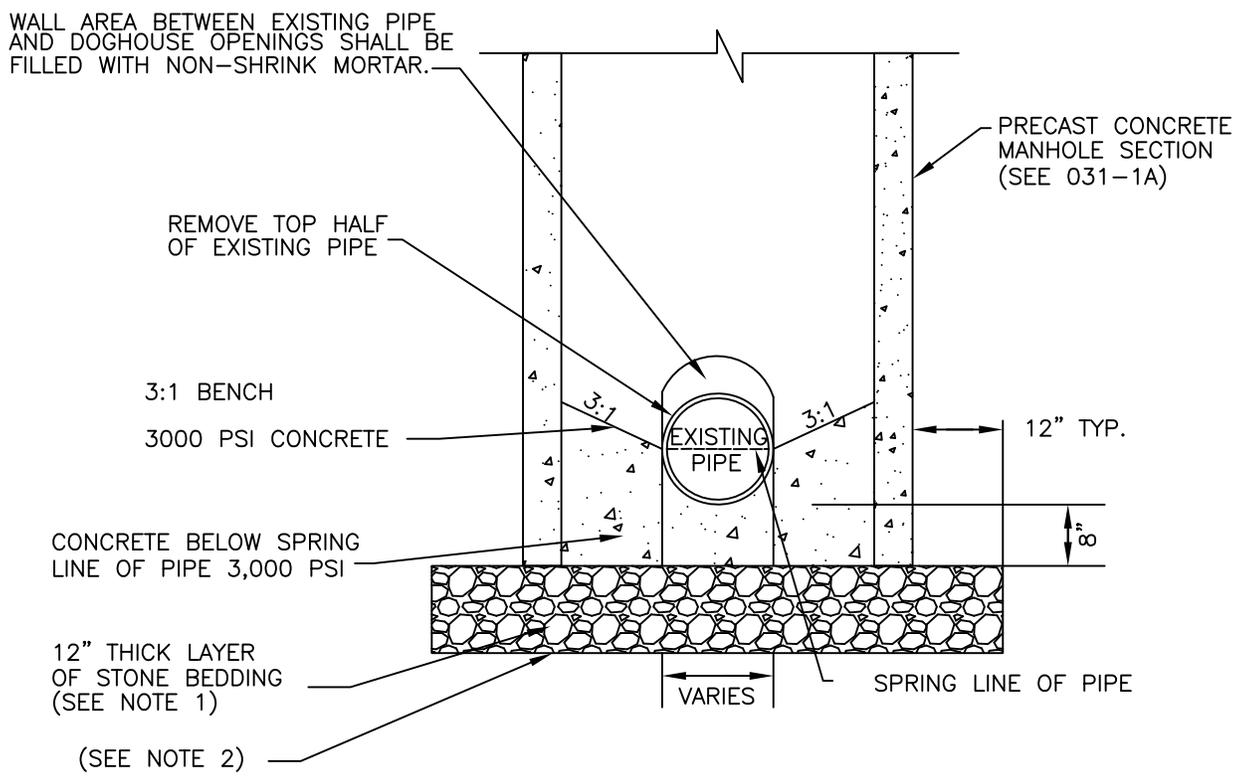
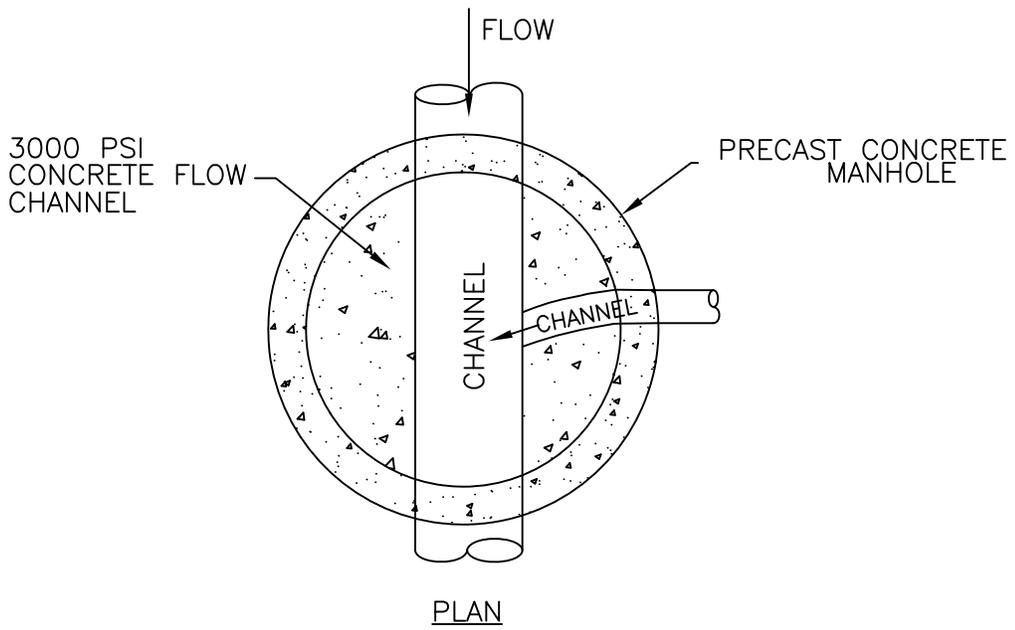
REV 2016



CITY OF LIBERTY, MO
DEPARTMENT OF
PUBLIC WORKS

STANDARD
PRECAST MANHOLE
DETAIL

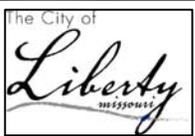
D31-1A



TYPICAL CROSS SECTION

1. STONE BEDDING SHALL CONFORM TO SECTIONS 3012 AND 3016.
2. IF MANHOLE EXCAVATION BOTTOM IS IN UNSUITABLE MATERIAL, SUITABLE FILL MATERIAL AND MIRAFI 140N OR APPROVED EQUAL FILTER FABRIC WILL BE REQUIRED PRIOR TO PLACEMENT OF BEDDING.

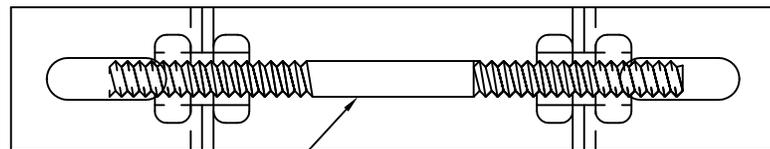
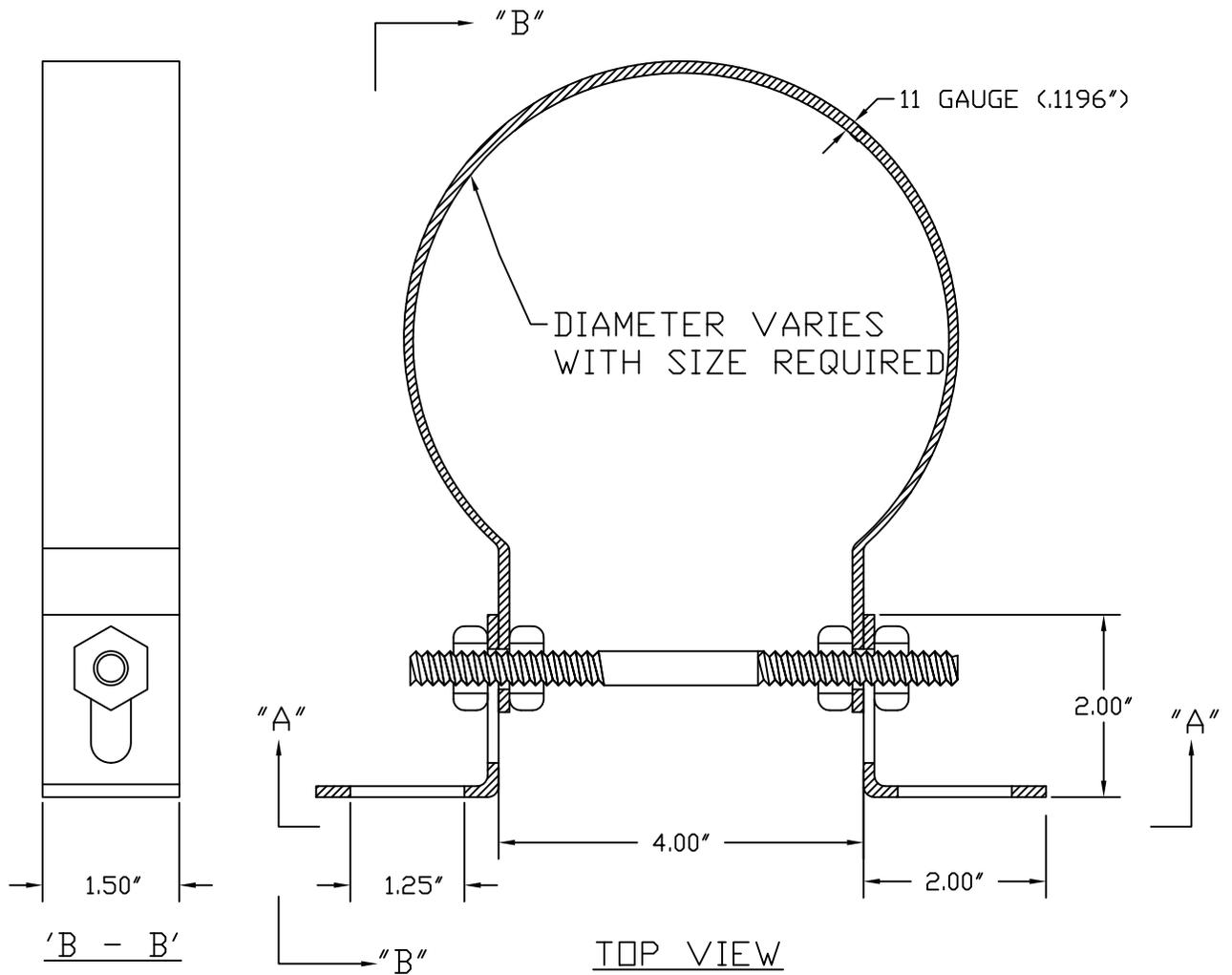
REV 2016



CITY OF LIBERTY, MO
**DEPARTMENT OF
 PUBLIC WORKS**

**SANITARY SEWER
 DOGHOUSE MANHOLE
 DETAIL**

D31-1B



3/8" DIAMETER STAINLESS STEEL PINCH BOLT

SPECIFICATIONS:

- 1) CLAMP AND BRACKETS IS TYPE 304 STAINLESS STEEL, 11 GAUGE (.1196").
 - 2) 3/8" Ø PINCH BOLT AND NUTS IS TYPE 18-8 STAINLESS STEEL.
 - 3) WIDE RANGE OF SIZES FOR SDR35, SCH40, C100-C900 STOCKED FOR 4" - 30"
- OTHER SIZES AVAILABLE.

'A - A'

REV 2009

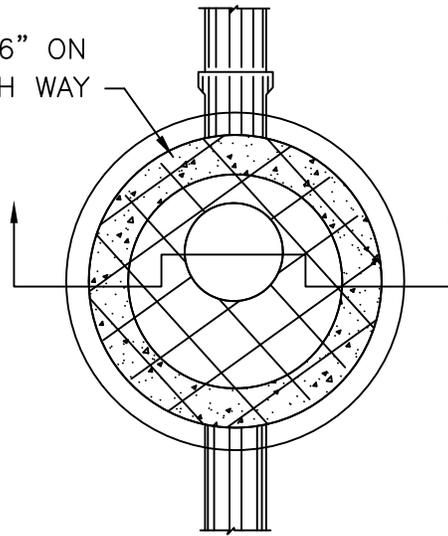


CITY OF LIBERTY, MO
DEPARTMENT OF
PUBLIC WORKS

STAINLESS STEEL
ADJUSTABLE
CLAMPING
BRACKETS

D31-2B

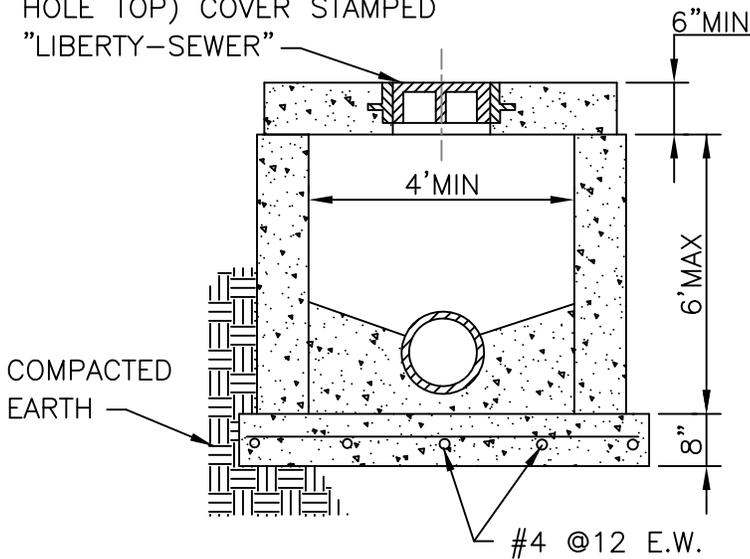
#5 BARS AT 6" ON CENTERS EACH WAY



USE OF A STANDARD LID AND RING WILL BE ALLOWED WHERE GRADE PERMITS (SEE SPEC. FOR APPROVED TYPES)

PLAN

CLAY & BAILEY NO.2020 DEETER NO.2016 OR APPROVED EQUAL. RING AND LID (CAST IN MAN-HOLE TOP) COVER STAMPED "LIBERTY-SEWER"

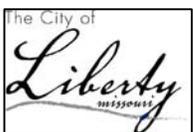


SECTION

NOTE:

1. WATERPROOFING WILL BE REQUIRED ON THE EXTERIOR SURFACE OF MANHOLE STRUCTURES FROM BASE TO MANHOLE RINGS. PRECAST MANHOLES WILL BE SHOP COATED. THE WATERPROOF COATING SHALL BE KOPPERS COMPANY, INC. BITUMASTIC NO. 50 OR TNE MEC CO., INC. ASPHALT BASE FOUNDATION COAT AND SHALL CONSIST OF TWO COATS WET THICKNESS OF 22-26 MILS WITH A COMBINED DRY THICKNESS OF 31 MILS.
2. FOR ALL DIMENSIONS NOT SHOWN, SEE STANDARD MANHOLE DETAIL.
3. ALL MANHOLE JOINTS SHALL BE SEALED WITH AN EXTERNAL RUBBER SLEEVE, INFI-SHIELD GATOR WRAP AS MANUFACTURED BY SEALING SYSTEMS INC. OR APPROVED EQUAL.

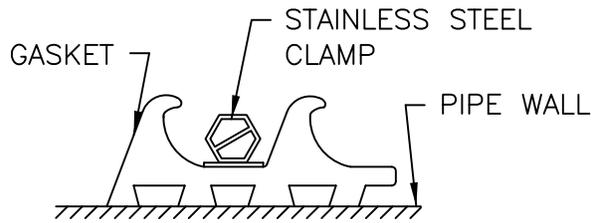
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CITY OF LIBERTY, MO
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STANDARD SHALLOW
MANHOLE DETAIL

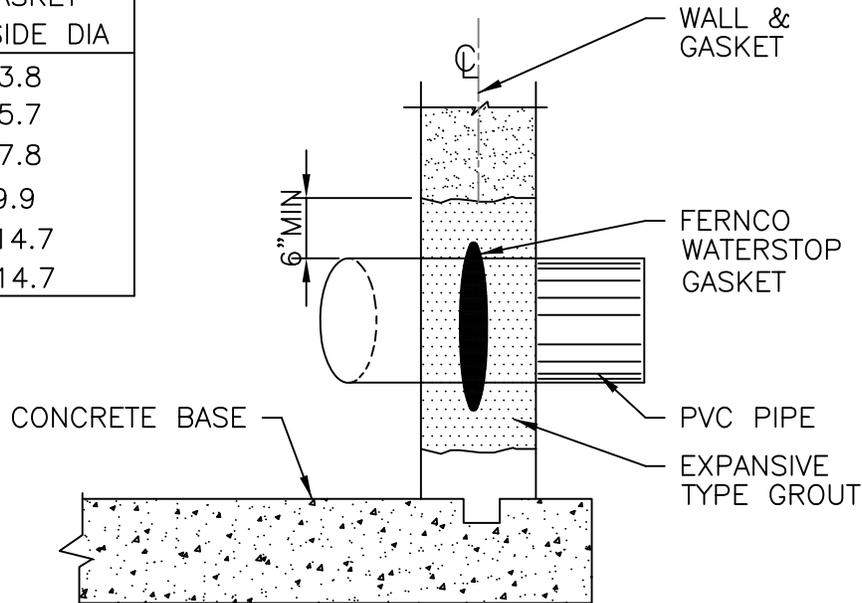
D31-3



WATERSTOP GASKET

DIMENSION TABLE FOR WATERSTOP GASKET

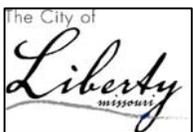
NOMINAL PIPE SIZE	GASKET INSIDE DIA
4	3.8
6	5.7
8	7.8
10	9.9
12	14.7
15	14.7



NOTES:

1. WATERSTOP GASKET – GASKET CROSS SECTION SHALL BE EQUAL TO HAMILTON KENT DIE NO 2347.
2. CLAMP – CLAMPS SHALL BE WORM DRIVE WITH 3/8” HEX HEAD SLOTTED SCREW WITH 9/16” WIDE BAND WHICH IS CONTINUOUSLY GEAR SLOTTED ALL AROUND. CLAMPS SHALL BE ALL STAINLESS STEEL—BAND AND A HOUSING OF 300 SERIES AND WORM SCREW OF 400 SERIES S.S. CLAMPS SHALL BE EQUAL TO IDEAL, 64 SERIES OR 68 SERIES, 0.024” THICK.
3. INSTALLATION – STRETCH GASKET AND SLIP OVER PIPE INTO POSITION. PLACE CLAMP OVER GASKET AS SHOWN ABOVE AND TIGHTEN WORM DRIVE TO 10’LBS TORQUE. ENCASE IN EXPANSIVE TYPE CEMENT GROUT FOR 4”MIN COVER ALL AROUND. GROUT SHALL BE A METALLIC ADDITIVE NON—SHRINK TYPE EQUAL TO MASTER BUILDERS ”EMBECO”.
4. ALL PIPE CONNECTIONS TO EXISITING MANHOLES SHALL BE CORE—DRILLED.

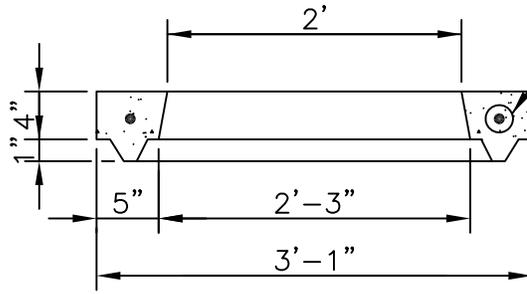
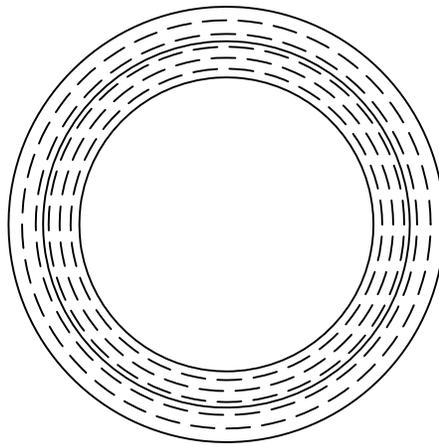
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PUBLIC WORKS

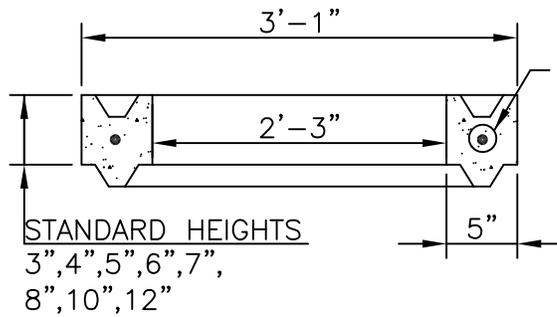
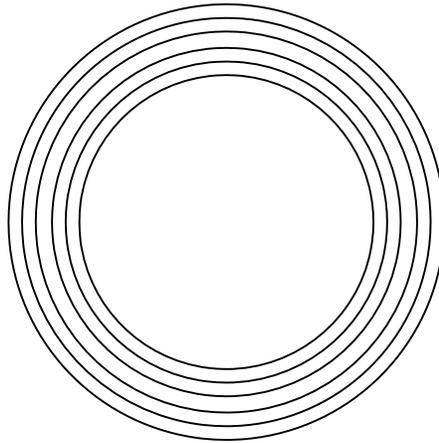
MANHOLE
CONNECTIONS
W/PVC SEWER PIPE

D31-4



#4 WIRE
CENTERED

**REDUCER
GRADE RING**
WEIGHT: 165 LB.



#4 WIRE
CENTERED

GRADE RING
WEIGHT: 41 LB./V IN.

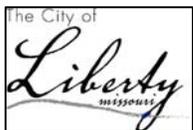
NOTES:

GRADE RINGS SHALL MEET REQUIREMENTS OF
ASTM DESIGNATION C-478-80 STANDARD
SPECIFICATION FOR PRECAST REINFORCED
CONCRETE MANHOLE SECTIONS.

CONCRETE: 4000 P.S.I.

REINFORCEMENT: #4 WIRE, ASTMA-82

REV 2009



CITY OF LIBERTY, MO
DEPARTMENT OF
PUBLIC WORKS

GRADE RINGS

D31-5

SECTION 3200 ACCEPTANCE TESTS FOR SANITARY SEWERS

3201 SCOPE. This section governs the furnishing of all labor, equipment, tools and materials, and the performance of any or all acceptance tests as required by the Plans, Special Provisions, and these specifications.

3202 ACCEPTANCE TESTS FOR GRAVITY SEWERS.

A. Visual Inspection

1. Contractor shall clean pipe of excess mortar, joint sealant and other dirt and debris prior to inspection.
2. Sewer shall be inspected by running a T.V. camera the full length of the line and recording on audio/visual media compatible with WinCan software or approved equal, recording shall be retained by the City. Correct defects as determined by T.V. inspection including the presence of any misaligned, displaced, or broken pipe and the presence of visible infiltration or other defects. Sewer lateral locations shall be identified on the recording by distance from a manhole.
3. Correct defects as required. Any section with defects shall be re-inspected as set forth in paragraph 2.

B. Leakage Tests. A leakage test shall be performed on the full length of all sewer lines prior to acceptance.

1. Exfiltration Leakage Test.

- a. Contractor may perform leakage testing by exfiltration on sewer pipe larger than eighteen (18) inches I.D.
- b. Furnish all labor, equipment, tools and materials required including bulkheads, water and all miscellaneous items required to perform the tests.
- c. Test all sewer pipe over eighteen (18) inches I.D. after either the completed backfill or partial backfill sufficient to stabilize the position of the pipe in both alignment and grade is accomplished. Contractor may select section of the project for testing at any time by notifying the Engineer in advance.
- d. Perform at depths of ground water of not less than two (2) feet nor more than ten (10) feet as measured above center line of pipe or adjacent water table, whichever is higher.
- e. Maintain test as necessary to locate all leaks, but not less than two hours.

- f. Repeat as necessary after repair of leaks and defects until leakage, as measured, does not exceed 0.80 gallons per inch of internal diameter per hour per 1000 feet of pipe length (100 gal/inch of I.D./day/mile).
- g. Protect manholes and other structures by means of bulkheads to prevent bursting pressures from being applied inside the structure.
- h. De-water pipe upon completion of testing.

2. Air Leakage Testing.

- a. Contractor shall perform air tests on all pipe 18” and smaller, and may perform air tests for all pipe sizes larger than 18”.
- b. Furnish all facilities required including necessary piping connections, test pumping equipment, pressure gauges, bulkheads, regulator to avoid over pressurization, and all miscellaneous items required.

(1) The pipe plug for introducing air to the sewer line shall be equipped with two taps. One tap will be used to introduce air into the line being tested, through suitable valves and fittings, so that the input air may be regulated. The second tap will be fitted with valve and fittings to accept a pressure test gauge indicating internal pressure in the sewer pipe. An additional valve and fitting will be incorporated on the tap used to check internal pressure so that a second test gauge may be attached to the internal pressure tap. The pressure test gauge will also be used to indicate loss of air pressure due to leaks in the sewer line.

(2) The pressure test gauge shall meet the following minimum specifications:

Size (diameter)	4-1/2 inches
Pressure Range	0-15 P.S.I.
Figure Intervals	1 P.S.I. Increments
Minor Subdivisions	0.05 P.S.I.
Pressure Tube	Bourdon Tube or Diaphragm
Accuracy	+/- 0.25% of maximum scale reading
Dial	White coated aluminum with black lettering, 270 deg. Arc and mirror edge.
Pipe Connection	Low Male 1.2" N.P.T.

Calibration data will be supplied with all pressure test gauges. Certification of pressure test gauge will be required from the gauge manufacturer. This certification data shall be up to date (within 1 year from test) will be available when tests are performed

- c. Test each reach of sewer pipe between manholes after completion of the installation of pipe and appurtenances and the backfill of sewer trench.
- d. Plug ends of line and cap or plug all connections to withstand internal pressure. One of the plugs provided must have two taps for connecting equipment. After connecting air control equipment to the air hose, monitor air pressure so that internal pressure does not exceed 5.0 psig. After reaching 4.0 psig throttle the air supply to maintain between 4.0 and 3.5 psig for at least two (2) minutes in order to allow equilibrium between air temperature and pipe walls. During this time, check all plugs to detect any leakage. If plugs are found to leak, bleed off air, tighten plugs, and again begin supplying air. After temperature has stabilized, the pressured is allowed to decrease to 3.5 psig. At 3.5 psig, begin timing to determine the time required for pressure to drop from 3.5 psig to 2.5 psig. If the time, in seconds, for the air pressure to decrease from 3.5 psig to 2.5 psig is greater than that shown in the table below, the pipe shall be presumed free of defects.

<u>Pipe size</u>	<u>Required Time per 100 LF</u>	<u>Maximum Required Time</u>
8"	70 sec	227 sec
10"	110 sec	283 sec
12"	158 sec	340 sec
15"	248 sec	425 sec
18"	356 sec	510 sec
21"	485 sec	595 sec
24"	634 sec	680 sec
27"	765 sec	765 sec
30"	851 sec	851 sec
33"	935 sec	935 sec
42"	1050 sec	1050 sec
48"	1100 sec	1100 sec

Sizes above 48" I.D. shall not be tested by air

If air test fails to meet above requirements, repeat test as necessary after all leaks and defects have been repaired. Prior to acceptance all constructed sewer lines shall satisfactorily pass the low pressure air test.

- e. The height of groundwater above pipe in feet shall be divided by 2.3 to establish the pounds of pressure that will be added to all readings.

C. Deflection Tests. A deflection test shall be required on all installations after pipe has been laid and backfilled. The deflection test shall take place no sooner than 30 days after said pipe has been laid and backfilled. The maximum allowable deflection shall

not exceed 5.0% of the pipe's internal diameter.

The rigid ball or mandrel used for the deflection test shall have a diameter not less than ninety-five percent (95%) of the base inside diameter or average inside diameter of the pipe depending on which is specified in the ASTM specification, including the appendix, to which the pipe is manufactured. The test shall be performed without mechanical pulling devices. A mandrel must have nine (9) or more odd number of flutes or points. The deflection test shall consist of guiding such a device of the appropriate size for the pipe involved to accurately measure any deflection in the pipe. The device to be used shall be approved by the City Engineer prior to its use. Attention is directed to the fact that the pipe's nominal diameter is greater than the actual internal diameter of the pipe.

Upon completion of the testing, all piping showing a deflection greater than 5.0% shall be excavated, replaced, backfilled, and retested to the satisfaction of the Engineer.

3203 ACCEPTANCE TESTS FOR PRESSURE SEWAGE FORCE MAINS.

- A. Perform hydrostatic pressure and leakage tests. Conform to AWWA C 600 procedures as modified herein. Test shall apply to all pressure sewers. Perform after backfilling.
- B. Test separately in segments between sectionalizing valves, between a sectionalizing valve and a test plug, or between test plugs. Select test segments such that adjustable seated valves are isolated for individual checking. Contractor shall furnish and install test plugs at no additional cost to the Owner, including all anchors, braces, and other devices to withstand hydrostatic pressure on plugs. Contractor shall be responsible for any damage to public or private property caused by failure of plugs. Limit fill rate of line to available venting capacity.
- C. Pressure Test. Conduct at 1.5 time maximum operating pressure determined by the following formula:

$$P_{pt} = 0.650 (OP-GE), \text{ in which}$$

P_{pt} = test pressure in psi at gauge elevation

OP = the highest elevation of each section of the line in feet

GE = elevation of the gauge in feet.

3204 ACCEPTANCE TEST FOR MANHOLES:

- A. Visual Inspection.

All precast concrete manholes shall be visually inspected to determine the presence of misaligned, displaced, broken manhole sections or other physical defects. All defects shall be satisfactorily corrected prior to conducting vacuum leakage tests.

- B. Vacuum testing procedure: Vacuum testing, if specified for concrete sewer manholes, shall conform to the test procedures in ASTM C1244 or the

manufacturer's recommendation.

All vacuum tests on concrete sewer manholes shall be performed according to ASTM C1244 procedures, as modified herein. All pipes entering the manhole shall be plugged, taking care to securely brace the plugs from being drawn into the manhole. The test head shall be placed at the inside of the top of the cone section and the seal inflated in accordance with the manufacturer's recommendation. A vacuum of at least ten and one half (10 1/2) inches of mercury shall be drawn and the vacuum pump shut off. With the valves closed, the time shall be measured for the vacuum drop from ten (10) inches to nine (9) inches.

The manhole shall pass if the time is greater than one and one half (1 1/2) minutes for a forty eight (48) inch diameter manhole, two (2) minutes for sixty (60) inch manholes and two and one half (2 1/2) minutes for seventy two (72) inch manholes.

If the manhole fails the initial test, necessary repairs shall be made with a non-shrink grout while the vacuum is still being drawn. Retesting shall proceed until a satisfactory test is obtained. If the joint mastic or gasket is displaced during the vacuum testing, the manhole shall be disassembled, the seal replaced and the manhole retested.

SECTION 3300 SANITARY SEWER SYSTEM REHABILITATION

3301 SCOPE: This section governs the furnishing of all labor, equipment, tools, materials, testing and the performance of all work to rehabilitate the sanitary sewer system.

3302 REFERENCES: Referenced manuals or Specifications for testing shall refer to the latest adopted standards at the time of receiving the Notice to Bidders from:

ASTM	American Society of Testing materials
APWA	American Public Works Association
MCIB	MidWest Concrete Industry Board

3303 MATERIALS: Except as modified herein, all materials used for rehabilitation of the Sanitary Sewer System shall conform to the requirements stipulated in applicable sections of these specifications.

- A. Sewer pipe: The pipe for replacement shall conform to Section 3000 except as follows:
 - 1. Pipe liners: The material for lining the pipe for trenchless replacement shall be high density polyethylene pipe (HDPE) meeting the requirements of ASTM F714 PE SDR-PR based on outside diameter, and shall conform to the following:
 - 1. Pipe shall have a cell classification of 345434B in accordance with ASTM D3350.
 - 2. Polyethylene base resin shall conform to the requirements of ASTM D1248, Type III, Class B, Grade P34, category 5. The resins shall contain antioxidants and be stabilized, for protection against ultra-violet degradation.
 - 3. Wall thickness: The minimum wall thickness of the polyethylene pipe shall meet the following:

Depth of cover (feet)	Minimum SDR of Pipe
0-16	19
>16.1	17
 - 4. Color: Pipe shall be standard carbon black with no internal coatings. Light gray pigment throughout will be acceptable.
 - 5. Pipe shall be homogenous throughout and be free from cracks, holes, foreign matter, blisters, or other irregularities.
 - 6. Joints: Butt fusion joints in accordance with ASTM D2657. No gasketed joints shall be allowed without prior approval of the Engineer. Threaded or solvent welded joints will not be permitted.
 - 2. Service connections: The sewer main shall be connected and sealed to service laterals with one of the following:

1. A field assembled adapter tee consisting of a compression fit gasket and seal clamp and adapter pipe stub selected to match the existing service pipe. Adapter tees shall be "Inserta Tee" or equal.
 2. A heat fusion saddle made of polyethylene pipe compound that meets the requirements of ASTM D1248, Class C for fusion welding to polyethylene pipe. Fusion saddles shall be as manufactured by Driscopipe, Miller, Dupont, or Central Plastics.
 3. Connections shall be watertight and shall not permit infiltration between the pipe and the liner.
3. Cured-in-place pipe materials:
- a. The sewn tube shall meet the requirements of ASTM F1216, Section 3.1 and shall not contain fiberglass continuous strand matt. The tube shall be constructed to withstand inversion pressures, have sufficient strength to bridge missing pipe, stretch to fit irregular pipe sections, and shall invert smoothly around bends.
 - b. The wetout tubes shall have a uniform thickness that when compressed at installation pressures will meet or exceed the design thickness.
 - c. The tube shall be a size that when installed will tightly fit the internal circumference and length of the original pipe. Allowance should be made for circumferential stretching during inversion.
 - d. The outside layer of the tube (before wetout) shall be polyethylene coated, a translucent flexible material that clearly allows inspection of the resin impregnation (wetout) procedure. The plastic coating shall hold the resin inside the tube without leakage, accommodate inversion, stretch to size and shall not delaminate before, during or after curing of the CIPP.
 - e. The tube shall be homogeneous across the entire wall thickness containing no intermediate or encapsulated elastomeric layers. No material shall be included in the tube that may cause delamination in the cured CIPP. No dry or unsaturated layers shall be evident.
 - f. The wall color of the interior pipe surface of the CIPP after installation shall be alight reflective color so that a clear detail examination with closed circuit television inspection equipment may be made.
 - g. Seams in the tube shall be stronger than the unseamed felt. Where the length requires joining, the sewn joint shall not be perpendicular to the long axis but spirally formed and sewn.
 - h. The outside of the tube shall be marked for distance at regular intervals along its entire length, not to exceed five (5) feet. Such Markings shall include the Manufacturers name or identifying symbol.
 - i. The minimum length shall be that deemed necessary by the contractor to effectively span the distance from the inlet to the outlet of the respective manholes unless otherwise specified. The contractor shall verify the lengths in the field before impregnation. Individual inversion runs can be made over one (1) or more manhole sections as determined in the field by the contractor and approved by the owner.

- i. A cementitious grout shall be used for stopping very active infiltration and filling voids and shall be mixed and applied according to manufacturer’s recommendations. The grout shall be volume stable, and have a minimum 28 day compressive strength of 250 psi and a one day compressive strength of 50 psi. *Strong-Seal “grout 250” or Engineer approved equal.*
 - ii. A cementitious grout shall be used for same application as Grout 25, but is designed for special soil conditions, and shall be used per manufacturer’s recommendations. This grout shall be volume stable and have a minimum twenty-eight (28) day compressive strength of 1,000 psi. *Strong-Seal “Grout 1000” or Engineer approved equal*
 - iii. Chemical Grouts may be used for stopping very active infiltration and shall be mixed and applied per manufacturer’s recommendations.
- e. Liner Materials: A cementitious product shall be used to form a structural/structurally enhanced monolithic liner covering all interior substrate surfaces. The liner material shall be applied with machinery specially designed for the application, and shall have the following minimum requirements at 28 days.

Compressive strength	ASTM C495	>3000 psi
Tensile strength	ASTM C496	>300 psi
Flexural Strength	ASTM C293	>600 psi
Shrinkage@90% RH	ASTM C596	0%
Bond	ASTM C321	>130 psi
Density, when applied		105 pcf

- f. Liner material shall be one of the following products:
- i. Strong-Seal MS-2A or Permacast MS-10,000 shall be made with Type I or Type III Portland Cement and shall be used according to manufacturer’s recommendations in applications where there is no or very mild sulfide conditions (pH 3.0 or higher).
 - ii. Strong-Seal MS-2C or permacast CR-5,000 with Calcium Aluminate Cement and shall be used according to manufacturer’s recommendations in applications where there is evidence of severe sulfide conditions (pH 2.0 or higher)
 - iii. Strong-Seal Sewpercoat PG or Permacast MS-10,000 with ConShield, shall be made with calcium aluminate cement and calcium aluminate aggregate and shall be used per manufacturer’s recommendations in any harsh hydrogen sulfide conditions regardless of surface pH as long as environment is in a municipal sanitary system. Refer to Sewpercoat PG specifications for physical properties and application procedures.

2. WATER: Water used to mix product shall be clean and potable. Questionable water shall be tested by laboratory in accordance with ASTM C-94 procedure. Potable water need not be tested.
3. OTHER MATERIALS: No other material shall be used with the mixes described above without prior approval or recommendation of the Engineer.

3304 CONSTRUCTION DETAILS:

A. Trenchless Replacement - Pipe Bursting Tools:

1. Static Pull method (TRS Process): The process involves the use of a static “moling” device suitable sized to break out the old pipe with a flared plug that bursts the existing pipe.
 - a. The maximum outside diameter of the pipe bursting tool shall be greater than the maximum inside diameter of the existing sewer pipe.
 - b. The tool shall be pulled along the inside of the existing sewer pipe.
 - c. The pipe bursting tool shall be of such dimension that the maximum diameter of the tunnel created shall not exceed the maximum outside diameter of the new pip, plus 1 INCH.
 - d. The existing sewer pipe shall be broken up into small fragments and these fragments driven into the surrounding pipe zone. The tool shall make a tunnel along the space formerly occupied by the existing sewer pipe and shall place the new pipe by pulling it into place in the tunnel. This process continues until the new pipe reaches the machine pit.
2. Pneumatic Method (TT Technologies process): The pipe bursting tool shall be designed and manufactured to force its way through existing pipe materials by fragmenting the pipe and compressing the old pipe sections into the surrounding soil as it progresses. Only pneumatically operated equipment with either front or rear expanders for the proper connection to the polyethylene will be allowed for use.
 - a. The bursting unit shall be pneumatic and shall generate sufficient force to burst and compact the existing pipe line.
 - b. The bursting head shall incorporate a shield/expander to prevent collapse of the hole ahead of the pipe insertion.
 - c. The pipe bursting unit shall be remotely controlled.
 - d. The pipe burster shall have its own forward momentum while being assisted by winching. A hydraulic winch shall give the burster friction by which it can be moved forward. To form a complete operating system, the burster must be matched to a constant tension hydraulic winching system.
 - e. Winch Unit: The pneumatic pipe bursting tool must be used in conjunction with a constant tension hydraulic twin Capstan Winch of either 20, 10, or

5 tons, the size of the winch depends on the diameter of the pipe to be replaced. In no case is the constant tension on the winch to exceed 20 tons.

B. Pipe reaming tools: The operation shall be conducted with a directional drilling machine and a reamer that grinds and pulverizes the pipe, the excess peripheral material flushed and removed with the drilling fluids and the HDPE pipe of the required size pulled into place simultaneously.

C. Manhole Lining:

1. Equipment: Application equipment shall be as recommended by the materials manufacturer.

2. Application:

a. Preparation: Place covers over invert to prevent extraneous material from entering the sewer lines.

i. All foreign material shall be removed from the manhole wall and bench using a high pressure water spray (minimum 2,500 psi). Loose and protruding brick, mortar, and concrete shall be removed using a mason's hammer and chisel and/or scraper. Fill any large voids with patching material as specified herein. The surface to be repaired must be clean and free of any loose materials with walls totally saturated with water.

ii. Active leaks shall be stopped using infiltration control material according to manufacturer's recommendations. Some leaks may require weep holes to localize the infiltration during application. After Application the weep holes shall be plugged with infiltration control material prior to the application of the final coat. When severe infiltration exists, drilling may be required in order to pressure grout using a cementitious grout or chemical grout, as specified herein for grouting material. Manufacturer's recommendations shall be followed when pressure grouting is required.

iii. All manhole steps shall be removed and the wall repaired prior to lining.

b. Invert, pipe seal and bench repair:

i. After all preparations have been completed, remove all loose material and wash the wall again.

ii. Any bench, invert, pipe seal and/or service line repairs shall be made at this time using patching material and shall be used per manufacturer's recommendations.

iii. Invert repair shall be performed on all inverts with visible damage or where infiltration is present or when vacuum testing is specified. After blocking flow through the manhole, and thoroughly cleaning

invert, the patching material shall be applied to the invert in an expeditious manner. The material shall be troweled uniformly onto the damaged invert at a minimum thickness of ½ inch at the invert extending out onto the bench of the manhole sufficiently to tie into the structural/ structurally enhanced monolithic liner to be applied. The finished invert surfaces shall be smooth and free of ridges. The flow may be reestablished in the manhole within thirty (30) minutes after placement of the material.

- iv. Mixing: Mixing shall be done in strict accordance with the material manufacturer's instructions.
- v. Spraying: On all manholes, a single application of the liner mix shall be spray applied to a total thickness of 1 inch in one application.

D. Manhole Cover Insert: Should prevention of groundwater inflow through the manhole cover be required, a PARSON MANHOLE INSERT, or approved equal, shall be installed under the cover. The insert shall be manufactured to exact measurements and made of High Density Polyethylene Copolymer or Stainless Steel material.

The manhole insert shall vent the sewer system by means of two ventilation holes or valve(s) (1 or 2) manufactured of an Ethylene Propylene compound. An adhesive backed, closed cell neoprene or cross linked polyethylene gasket may be applied as required on the underside of the rim of the insert by the manufacturer. A corrosion resistant nylon lifting strap shall also be included and installed by the manufacturer.

HDPE Plastic (ASTM D-1248, Class A, Cat. 5 Type III)
Impact brittleness -105 deg. F ASTM D-746-70
Softening Temperature 254 deg. F ASTM D-1525-70
Tensile Strength 700 psi ASTM D-638-71A
Thickness Uniform 1/8 in.

STAINLESS STEEL
Corrosion Resistance Excellent
Tensile Strength 600 MPa ASTM A-240M
Density 8,000 kg/m³
Endurance Limit 240 MPa

The manhole frame rim shall be cleaned of all dirt and debris prior to measuring. The manhole insert shall be manufactured per exact measurements. Measurements must be done in strict accordance with manufacturer's instructions.

SECTION 6000 TUNNELING, BORING AND JACKING (PIPELINES)

6001 SCOPE. This section governs construction of steel casings, complete with bulkheads and sand fill, by boring and/or jacking at the locations and to the lines and grades indicated on the drawings directed by the Engineer, or where constructed at the contractor's option, when approved, to bypass obstructions without open cutting.

6002 MATERIALS.

A. Steel Liner Plate. Steel tunnel liner plates shall be Armco "Standard", Commercial Shearing and Stamping Company "Commercial", Republic "Truscon Paneled Out", or equal and shall be galvanized in accordance with ASTM A 123. The design and shape of the liner plates shall be such that assembly can take place entirely from within the tunnel liner. Sufficient sections shall be provided with one and one-half (1 1/2) inch or larger grouting holes, located near the centers, so that when the plates are installed there will be one line of holes on either side of the tunnel and one at the crown. The holes in each line shall not be more than nine (9) feet apart and, unless otherwise approved, shall be staggered. Bolts and nuts shall conform to ASTM A 153, A 307, A 325 and A 449 as applicable.

B. Steel Casing.

1. Steel casing for bored or jacked construction shall conform to ASTM A-139.
2. Steel shall be grade B under railroads and grade A for all other uses.
3. Minimum wall thickness for steel casing shall be in accordance with the following table:

<u>Diameter of Casing</u>	<u>Under Railroads</u>	<u>All Other Uses</u>
24"	0.406"	0.281"
26"	0.438"	0.281"
28"	0.469"	0.312"
30"	0.469"	0.312"
32"	0.500"	0.312"
34"	0.500"	0.312"
36"	0.500"	0.312"

4. Casing joints shall be welded by a certified welder in accordance with AWWA C-206.

C. End Seals. Ends of each casing pipe or tunnel liner shall be closed with a minimum 1/8-inch neoprene rubber end seal (CCI Pipeline Products, Advance Products & Systems, or approved equal) with stainless steel bands or as shown on the plans. The closure for each casing pipe or tunnel line shall not be constructed until all testing of the line has been completed and accepted.

D. Casing Spacers. Projection-type casing spacers shall be constructed of stainless

steel with glass filled polymer runners of type CCI Pipeline Products model CSS, or approved equal. Casing spacers shall be fastened tightly onto the carrier pipe so that when the carrier pipe is being installed the spacers will not move along the pipeline. Casing spacers shall be no more than 10 feet apart and doubled on each end of the encasement.

- E. Sand Fill. Sand fill shall comply with ASTM C-33 or MCIB Section 4, Fine Aggregate. Moisture content of the sand shall not exceed. 0.5%.

6003 CONSTRUCTION DETAILS.

A. General.

- 1. Prior to starting work, complete details of the method of operation and liner materials to be used shall be submitted to the Engineer. The pipe line, in the area to be tunneled, bored or jacked, shall be completed before the construction of adjacent portions of the same pipe line. The purpose of this requirement is to allow for slight discrepancies in alignment and grade which may occur in the tunneled, bored or jacked installation, so minor adjustments in the adjacent pipe can be made.
- 2. The maximum allowable deviation from plan alignment and grade shall be as follows:
 - a. Alignment 1.0%
 - b. Grade 1.0%

B. Casing Installation.

- 1. The steel casing shall be advanced in a continuous operation without interruption. Sections of the casing pipe shall be welded together to form a continuous conduit capable of resisting all stresses, including jacking stresses. The casing in its final position shall be within alignment and grade tolerances specified in Section 6003 (A2). There shall be no space between the earth and the outside of the casing. Any voids which do occur shall be filled by pressure grouting.
- 2. Boring operations shall be performed by experienced crews using a rotary type boring machine designed especially for this purpose. Boring shall be performed in a manner to prevent disturbing the overlying and adjacent materials.
- 3. Jacking.
 - a. Jacking frame, guides, blocking, head and reaction devices shall be arranged to apply uniform pressure about the casing circumference without damage to the casing material, and to maintain alignment within specified tolerances.

- b. Jacking reaction device shall provide adequate resistance to withstand 200 percent of the maximum jacking pressure.
 - c. Provide jacks of adequate number and size for the required jacking pressure; but not less than two jacks.
 - d. Maintain jacking pit and pipe installation in such condition that drainage does not accumulate. Control and disposition of surface and subsurface water at the site of jacking operations shall be the Contractor's responsibility subject to the approval of the Engineer.
 - e. Excavation of the heading shall not be extended more than 1 inch outside the top and sides (upper 300-degree sector) of the casing and shall be true to grade at the invert (lower 60-degree sector).
 - f. Once jacking begins, it shall proceed without interruption until installation of the entire length of the jacked line is complete.
4. Excavation in Jacked Casings. Perform excavation within jacked casings by hand or machine methods as necessary to remove the materials encountered without disturbing the overlying material. The jacked casing shall be advanced a sufficient distance ahead of the excavation face and/or shield used as necessary to protect the workman and the work, and to prevent the uncontrolled entry of unstable materials into the casing.
 5. Unstable Materials. If materials are encountered during casing installation that cannot be excavated safely or without creating voids around the exterior of the casing, the Contractor shall discontinue casing installation and stabilize such materials by dewatering, chemical soil stabilization, grouting, or other methods, and/or modify equipment and procedures as necessary to complete the casing installation.

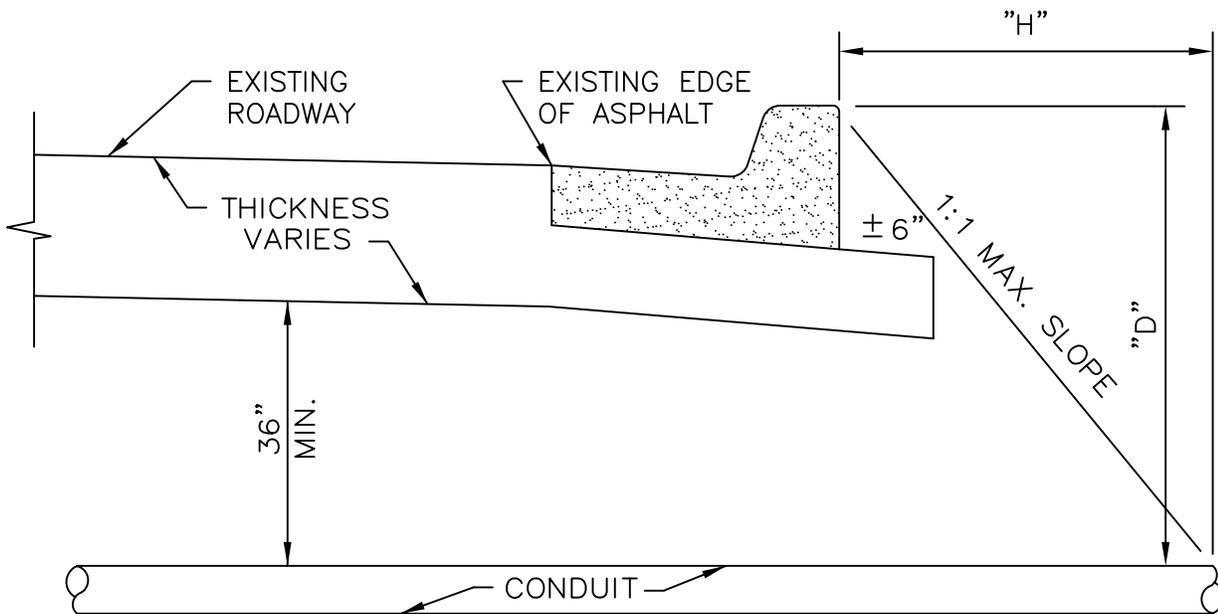
C. Lining Installation.

1. Excavation. Excavate by approved methods applicable to materials encountered. Boring operations shall be performed by experienced crews using a rotary type boring machine designed especially for this purpose. Include dewatering and chemical soil stabilization or grouting when necessary due to existing field conditions. Conduct excavation in a manner to prevent disturbing the overlaying and adjacent material.
2. Lining. Assemble liner plates immediately following the excavation. Advance casing continuously with excavation. When liner plates are being installed, care shall be taken to maintain alignment, grade and circular shape of the tunnel. All voids between liner and surrounding earth shall be filled with grout forced in under pressure. The grout shall consist of two parts of sand to one part of portland cement, mixed with sufficient water to maintain a freely pouring consistency. As the pumping

through any hole is stopped, it shall be plugged to prevent the backflow of grout. After lining installation is complete it shall be cleaned of all debris and all leaks which allow flowing or seeping water into tunnel, shall be stopped.

D. Pipe Installation.

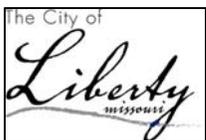
1. Pipe shall be placed inside the casing to the plan line and grade by the use of projection type spacers. Projection type spacers shall be RACI or approved equal per Section 6002(D). The casing spacers shall be installed according to the manufacturer's guidelines and recommendations. Wooden skids are not acceptable.
2. End seals shall be constructed per Section 6002(C) after the pipe is installed and approved.
3. No interruption of traffic will be permitted at any location where a tunnel or casing is required.
4. All boring or jacking under Railroads shall conform to the specifications of that specific Railway.



"H" MIN. DISTANCE BEHIND CURB
TO START PUNCH OR BORE
"D"=TOTAL DEPTH FROM TOP OF
CURB TO TOP OF CONDUIT.
"H"="D"

(BY PUNCH OR BORE METHOD)

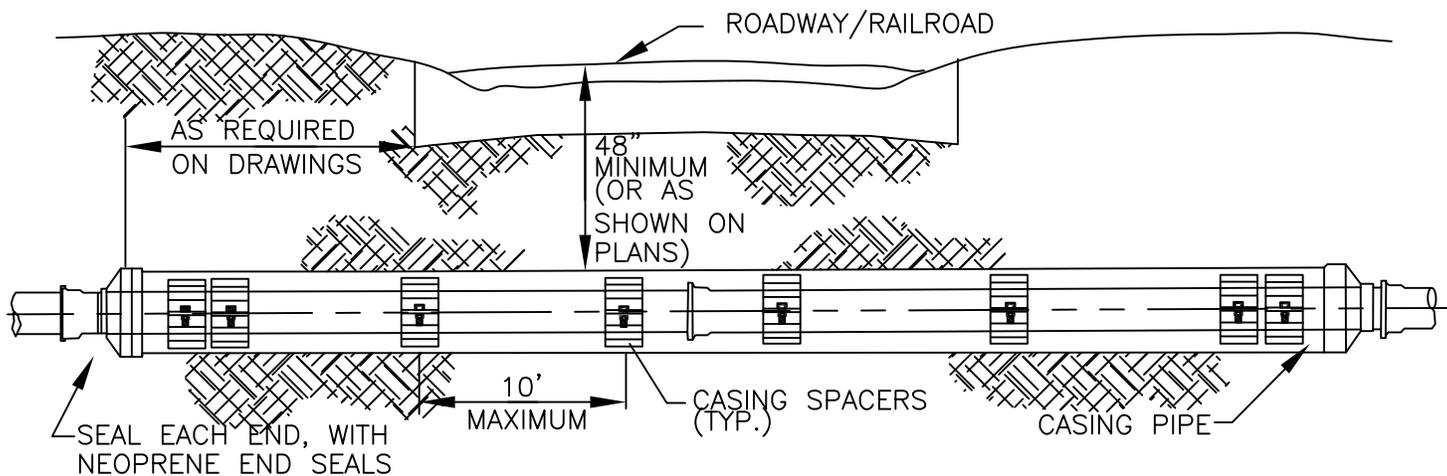
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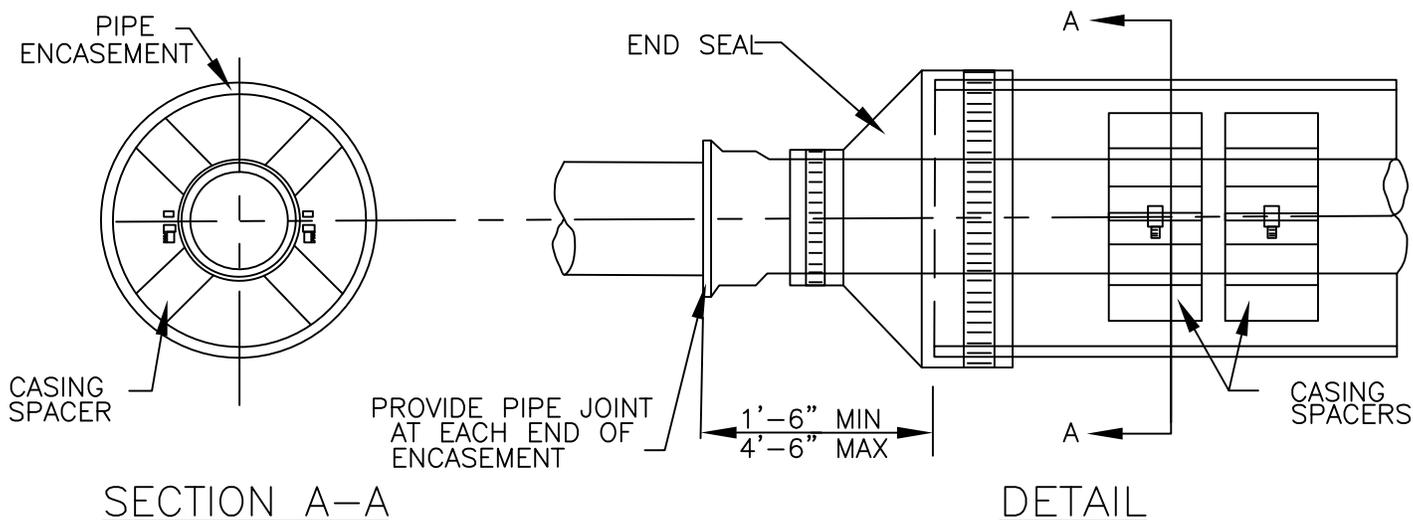
CITY OF LIBERTY, MO
DEPARTMENT OF
PUBLIC WORKS

ROADWAY CONDUIT
CROSSING DETAIL

D60-1



WALL THICKNESS OF ENCASEMENT PIPE TO BE SPECIFIED IN SECTION 6002(B)



STAINLESS STEEL CASING SPACERS

CASING SPACERS SHALL BE USED TO INSTALL THE CARRIER PIPE INSIDE THE ENCASEMENT PIPE.

CASING SPACERS SHALL FASTEN TIGHTLY ONTO THE CARRIER PIPE SO THAT WHEN THE CARRIER PIPE IS BEING INSTALLED THE SPACERS WILL NOT MOVE ALONG THE PIPELINE.

CASING SPACERS SHALL BE DOUBLED ON EACH END OF THE ENCASEMENT.

PROJECTION-TYPE CASING SPACERS SHALL BE CONSTRUCTED OF STAINLESS STEEL WITH GLASS FILLED POLYMER RUNNERS.

PROJECTION-TYPE CASING SPACERS SHALL BE CCI PIPELINE PRODUCTS MODEL CSS OR ENGINEER PRE-APPROVED EQUAL.

REV 2013



CITY OF LIBERTY, MO
DEPARTMENT OF
PUBLIC WORKS

PIPE ENCASEMENT
DETAIL

D60-2

SECTION 9100 TRACER WIRE PIPE DETECTION SYSTEM

9101 GENERAL. Install electrically continuous tracer wire with access points as described herein to be used for locating pipe with an electronic pipe locator after installation. Tracer wire shall be installed on all plastic water mains and services and sanitary sewer mains and services.

Tracer wire system and detection marking tape shall be included in the unit price bid for the installation of the pipe. Submit shop drawings and manufacturer's literature to the Engineer for approval in accordance with this Section.

9102 MATERIALS.

- A. Tracer Wire. Tracer wire shall be a minimum 12 gauge solid copper with thermoplastic insulation recommended for direct burial on top of plastic pipe and connected to valve boxes and existing iron piping as shown on the Standard Drawing.
- B. Detection Marking Tape. Detection marking tape shall be solid aluminum foil core tape completely encased in polyethylene jacket, 5.5 mils thick minimum, 6 inches (15cm) wide; Allen Systems, Inc. "Detectatape" or Reef Industries, Inc. "Terra Tape D" or approved equal.

For water lines, the detection marking tape shall be blue in color and have "Buried Water Line Below" printed on the tape at 20 to 30 inch (50 to 75 cm) intervals. For sanitary sewer lines, the detection marking tape shall be green in color and have "Buried Sanitary Sewer Line Below" printed on the tape at 20 to 30 inch (50 to 75 cm) intervals. The detection and marking tape shall be installed directly above the centerline of the pipe and 18 to 24 inches (45 to 60 cm) below finish grade.

- C. Connectors. All mainline trace wires must be interconnected in intersections, at mainline tees and mainline crosses. At tees, the three wires shall be joined using a single 3-way lockable connector. At Crosses, the four wires shall be joined using a 4-way connector. Use of two 3-way connectors with a short jumper wire between them is an acceptable alternative.

Direct bury wire connectors – shall include 3-way lockable connectors and mainline to lateral lug connectors specifically manufactured for use in underground trace wire installation. Connectors shall be dielectric silicon filled to seal out moisture and corrosion, and shall be installed in a manner so as to prevent any uninsulated wire exposure.

Non locking friction fit, twist on or taped connectors are prohibited.

- D. Termination. All trace wire termination points must utilize an approved trace wire access box (above ground access box or grade level/in-ground access box as applicable), specifically manufactured for this purpose. Test stations shall be

Handley Industries (T2PS3B) 2 inch test stations or approved equal. Lids shall be cast iron and color coded blue for water, or green for sanitary sewer.

Service Laterals on public property - Trace wire must terminate at an approved grade level/in- ground trace wire access box, located at the edge of the road right-of-way, and out of the roadway.

All grade level/in-ground access boxes shall be 15 inch ABS plastic boxes with flanged top. Terminals shall be solid brass. Lids shall be cast iron and appropriately identified with "sewer" or "water" cast into the cap and be color coded blue for water, or green for sanitary sewer. A minimum of 2 ft. of excess/slack wire is required in all trace wire access boxes after meeting final elevation.

All trace wire access boxes must include a manually interruptible conductive/connective link between the terminal(s) for the trace wire connection and the terminal for the grounding anode wire connection. Grounding anode wire shall be connected to the identified (or bottom) terminal on all access boxes.

9103 INSTALLATION. Tracer wire shall be installed on all plastic water mains, and on sanitary sewer service lines within the public right-of-way. The wire shall be installed in such a manner as to properly trace the pipe without loss or detection of signal or without the transmitted signal migrating off the tracer wire.

A. Sanitary Sewer System:

1. Trace wire installed on all sanitary service laterals within the public right-of-way must terminate at an approved trace wire access box color coded green and located directly above the service lateral adjacent to the two-way cleanout at the edge of road right-of-way per detail D30-6.
2. Trace wire will be required to be installed on the private sanitary sewer service line only, within public right-of-way only, from the mainline sanitary sewer main to the edge of the roadway right-of-way.
3. Trace wire will not be required to be installed on the public mainline sanitary sewer main.

B. Water System:

1. A mainline trace wire must be installed, with all service lateral trace wires properly connected to the mainline trace wire, to ensure full tracing/locating capabilities from a single connection point.
2. Lay mainline trace wire continuously, by-passing around the outside of valves and fittings on the North or East side.
3. Trace wire on all water service laterals must terminate at an approved trace wire access box color coded blue and located directly above the service lateral at the edge of road right of way.
4. Above-ground tracer wire access boxes will be installed at all fire hydrant valves.

5. All conductive and non-conductive service lines shall include tracer wire.
- C. Trace wire shall be installed in the same trench and inside bored holes and casing with pipe during pipe installation. It shall be secured to the pipe as required to insure that the wire remains adjacent to the pipe. The trace wire shall be securely bonded together at all wire joints with an approved watertight connector to provide electrical continuity, and it shall be accessible at all trace wire access points.
 - D. Trace wire access points shall in general be no more than five-hundred (500) feet and at every proposed 24" x 24" x 6" concrete valve box collar. Concentrations of multiple proposed valves near pipe intersections, i.e. tees or crosses, may require more than one access point assembly in each concrete valve box collar. Trace wire access points shall be within public right-of-way or public utility easements.
 - E. At the point of connection between cast or ductile iron water mains, with any non iron water main, the tracer wire shall be properly connected to the iron pipe with a cad weld or approved equivalent. Tracer wire welds shall be completely sealed with the use of an approved mastic type sealer specifically manufactured for underground use. Mastic shall be applied in a thick coat a minimum of 2 inches thick and shall be protected from contamination by the backfill material with the use of a plastic membrane.
 - F. Tracer wire shall be laid flat and securely affixed to the pipe at 10 foot intervals. The wire shall be protected from damage during the execution of the work. No breaks or cuts in the tracer wire or tracer wire insulation shall be permitted. At water service saddles, the tracer wire shall not be allowed to be placed between the saddle and the water main.
 - G. Except for approved spliced-in connections, tracer wire shall be continuous and without splices from each trace wire access point. Where any approved spliced-in connections occur, 3M DBR water tight connectors, or approved equal, shall be used to provide electrical continuity.
 - H. At all water main end caps, a minimum of 6 feet of tracer wire shall be extended beyond the end of the pipe, coiled and secured for future connections. The end of the tracer wire shall be spliced to the wire of a six pound zinc anode and is to be buried at the same elevations as the water main.
 - I. For directional drilling, auguring or boring installations, four #12 tracer wires shall be installed with the pipe and connected to the tracer wire at both ends, or cad welded to the existing iron pipe at both ends.
 - J. Spliced connections between the main line tracer wire and branch connection tracer wire shall only be allowed at water main tees, crosses or at iron or copper water services where a portion of the branch connection water main or water service is replaced with a non iron or non copper material. The branch connection tracer wire

shall be a single tracer wire properly spliced to the main line tracer wire. Where the existing branch connection is neither iron nor copper, then the new branch connection tracer wire shall be properly spliced to the existing tracer wire on the branch connection.

- K. At all repair locations where there is existing tracer wire, the tracer wire shall be properly reconnected and spliced as outlined above.

9104 TESTING. All new trace wire installations shall be located using typical low frequency line tracing equipment, witnessed by the contractor, engineer and facility owner as applicable, prior to acceptance of ownership. This verification shall be performed upon completion of rough grading and again prior to final acceptance of the project. Continuity testing in lieu of actual line tracing shall not be accepted.