

CITY OF REDLANDS

MUNICIPAL UTILITIES & ENGINEERING DEPARTMENT



SANITARY SEWER SYSTEMS STANDARD SPECIFICATIONS

January 2023 Edition

CITY OF REDLANDS
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SECTION A

GENERAL REQUIREMENTS

These instructions set forth the standards for the preparation and processing of plans and all documents supplemental thereto for sanitary sewers and related structures intended to connect to or become part of the collection and trunk system of the City of Redlands.

Your cooperation in preparing plans in conformity with these standards will expedite the work of checking the plans and will consequently lessen the time needed to process these plans.

The City requires that plans and profiles be prepared and signed by a Civil Engineer, registered in the State of California. Plans must be submitted for checking and approval before any sewer construction is commenced either in public streets, alleys or easements.

The plans and construction shall comply with all standard specifications and ordinances of the City of Redlands and those of any other governing body or jurisdiction as may apply. Any questions you may have on matters not covered herein will be answered by the City Engineer.

1. DEFINITIONS:

The word “City” shall mean the City of Redlands Municipal Utilities & Engineering Department.

The words “Municipal Utilities & Engineering Department” or “Engineer” shall mean the Municipal Utilities & Engineering Department Director/City Engineer acting directly or such individuals acting in his/her behalf as properly authorized agents, assistants, inspectors, and superintendents.

The words “City Engineer” used in this standard shall mean the Municipal Utilities & Engineering Department Director/City Engineer or his/her properly authorized agents, engineers, assistants, inspectors and superintendents acting in his/her behalf.

The words “Engineer” or “Design Engineer” used in this standard shall mean a Civil Engineer registered as such in the State of California and the duly authorized representative of the party or parties requesting an extension of or addition to the City’s sewer system.

The word “Contractor” shall mean the person, persons, partnership, or corporation duly licensed as such in the State of California to enter into a contract for the performance of the work required.

The word “Standard Specifications” shall refer to Standard Specification for Public Works Construction (SSPWC), the “Greenbook”.

The word “Design Standards” shall refer to this standard.

The word "Drawings" shall mean collectively all of the drawings attached to and accompanying this specification and made a part thereof.

2. CONDITIONS:

On all matters relating to the acceptability of the materials, machinery or plant equipment, classifications of material or work, the proper execution, progress or sequence of the work, quantities, and the interpretation of the specifications or drawings, the decision of the City Engineer shall be final and binding.

The contractor shall obtain copies of, and comply with, all applicable current statutes, laws, ordinances, rules, regulations, and specifications of the United States Government, State of California, County of San Bernardino, City of Redlands, and any other governmental agencies having jurisdiction and shall make application for all required permits and bear the cost of same.

Any contractor installing a sanitary sewer within public right-of-way, or within a City easement, or a sewer which will be ultimately maintained by the City, shall, prior to starting work, obtain an encroachment permit from the One Stop Permit Center (OSPC). This permit shall be kept on the job site and shall be available for review by any City representative. Failure to present a valid permit when requested by the City will be cause to issue a notice to stop work and all work shall remain stopped until a valid permit is produced.

Any contractor making an excavation over five feet deep shall have a valid Cal-OSHA permit on file with the OSPC. The contractor shall furnish to the City, copies of all required permits and licenses prior to initiation of the work.

3. SUPERVISION AND INSPECTION:

The City Engineer shall decide within the provisions of the specifications all questions that may arise concerning the quality or acceptance of materials furnished and work performed, and all questions concerning the acceptable fulfillment of the work by the Contractor.

4. DEFECTIVE WORK OR MATERIALS:

No work which is defective in its construction or deficient in any of the requirements of this specification will be considered as accepted even in consequence of the failure of any inspector connected with the work to point out said defects or deficiency during construction. The Contractor shall correct any imperfect work, without compensation from the City before final acceptance of the work by the City.

All materials not conforming to the requirements of this specification shall be considered as defective. They shall be rejected whether in place or not, and shall be removed immediately from the site of the work by the Contractor at his expense. No

rejected material, the defects of which have been subsequently corrected, shall be used until approval in writing, has been given by the City Engineer.

5. MAINTENANCE OF EXISTING IMPROVEMENTS:

Unless otherwise indicated on the plans or in this specification, or unless otherwise cared for by the owner of a public utility or franchise, all water, gas, oil, or irrigation lines; lighting, power, telephone conduits or communication wires; sewer lines, structures or house laterals in place and other surface or sub-surface structures or lines, shall be maintained by the Contractor and shall not be disturbed, disconnected or damaged by the Contractor during the progress of the work. Should the contractor in the performance of the work, disturb, disconnect or damage any of the above, all expenses, of whatever nature arising from such disturbance or in the replacement or repair thereof, shall be borne by the Contractor.

6. PROXIMITY TO WELLS:

Where sanitary sewers and house connections are to be constructed within a 100-foot radius of a water well, types of pipe and joints shall be reviewed with the State Health Department for their recommendation and approval. In accordance with the City of Redlands Municipal Code, every well shall be located no closer than fifty feet (50') from sewers, watertight septic tank, or any potential sources of contamination and pollution. Minimum distances from other sources of pollution or contamination shall be determined by Division of Environmental Health Services (DEHS) upon investigation and analyses of the probable risks involved. No impoundment of recycled water shall be located within one hundred feet (100') of any domestic water well, unless it can be demonstrated that special circumstances justify lesser distances to be acceptable.

7. CONSTRUCTION WATER:

All water taken from the City fire hydrants shall be by a special permit or through a Redlands fire hydrant meter. Arrangements for a permit or meter may be made through the Municipal Utilities & Engineering Department. City ordinance No. 1441 provides that using hydrants is a privilege, which, if abused, will be revoked.

8. GENERAL NOTES (SEWER):

1. SEWER INSTALLATION IS TO BE IN ACCORDANCE WITH THESE PLANS AND THE STANDARD SPECIFICATIONS AND DETAIL DRAWINGS OF THE CITY OF REDLANDS LATEST REVISION THEREOF.
2. ALL SEWER PIPE ELEVATIONS GIVEN REFER TO THE FLOW LINE INVERT ELEVATIONS.
3. THE APPROXIMATE LOCATIONS OF KNOWN EXISTING UNDERGROUND UTILITY LINES ARE SHOWN ON THESE PLANS. THE LINES ARE PLOTTED

FROM A COMBINATION OF RECORD AND FIELD DATA. THE CITY HAS TRIED WITHIN ITS AVAILABLE RESOURCES TO LOCATE ALL SUCH FACILITIES WITH REASONABLE ACCURACY. BY ENTERING INTO A CONTRACT FOR THIS WORK THE CONTRACTOR AGREES, PRIOR TO ANY EXCAVATION TO NOTIFY ALL UTILITY AND IRRIGATION COMPANIES OPERATING IN THE AREA OF THE WORK AND TO DETERMINE WITH AS MUCH ACCURACY AS IS NEEDED TO PERFORM THIS WORK, THE EXACT LOCATIONS OF ALL UNDERGROUND MAIN OR SERVICE UTILITY FACILITIES.

4. SAND BEDDING AND BACKFILL TO A DEPTH OF 12" ABOVE PIPE IS REQUIRED FOR ALL SEWER PIPE MAY BE REQUIRED IF IN THE OPINION OF THE CITY, THE NATIVE BACKFILL MATERIAL IS DEEMED UNSUITABLE.
5. VCP AND PVC SEWER PERMITTED ON HORIZONTAL OR VERTICAL CURVES SUBJECT TO DESIGN.
6. THE CONTRACTOR SHALL AIR TEST THE SEWER SYSTEM IN ACCORDANCE WITH CITY STANDARDS AFTER ALL OTHER UTILITIES HAVE BEEN INSTALLED AND COMPLETED WITHIN THE TRACT OR DEVELOPMENT. IN ADDITION, AFTER FINAL AIR TEST, THE CONTRACTOR SHALL CONNECT THE SEWER LATERALS TO THE HOUSE LATERALS AT THE PROPERTY.
7. SEWER LATERALS SHALL BE CLEARLY MARKED WITH AN "L" CHISELED IN CURB FACE.
8. REQUIRED SEPARATION OF THE WATER AND SEWER MAINS AND LATERALS SHALL BE STRICTLY ADHERED TO. INSTALLATION SHALL COMPLY WITH THE STATE DEPARTMENT OF HEALTH REGULATIONS AND BE A MINIMUM OF 10 FEET SEPARATION.
9. SEWER LATERAL LOCATIONS SHALL NOT BE CHANGED MORE THAN 3 FEET (HORIZONTAL) WITHOUT AUTHORIZATION FROM THE CITY.
10. IF PLASTIC SEWER PIPE IS USED, A MANDREL TEST SHALL BE PERFORMED BY THE CONTRACTOR IN THE PRESENCE OF THE CITY INSPECTOR IN ACCORDANCE WITH THE STANDARD SPECIFICATIONS OF THE MUNICIPAL UTILITIES DEPARTMENT. LATEST REVISIONS EXCEPT THE MANDREL SHALL BE SUPPLIED BY THE PIPE MANUFACTURER APPROVED BY CITY OF REDLANDS AND SHALL BE PULLED THROUGH THE PIPE BY HAND. PVC PIPE-MAXIMUM 15" DIAMETER ALLOWABLE.
11. PRIOR TO PAVING OF STREETS OVER A NEW SEWER MAIN ALL COMPACTION TESTS, AIR TESTS, BALLING AND MANDREL TESTS SHALL BE COMPLETED AND APPROVED BY THE CITY AND A COMPLETE SET OF AS-BUILT DRAWINGS SUBMITTED TO THE MUNICIPAL UTILITIES DEPARTMENT. THE CONTRACTOR SHALL BE RESPONSIBLE FOR THE PREPARATION OF AS-BUILT DRAWINGS.
12. PRIOR TO ACCEPTANCE BY THE CITY. NEW SEWER LINE SHALL REMAIN PLUGGED AT OR PHYSICALLY SEPARATED FROM THE DOWNSTREAM MANHOLE AND STREETS SHALL BE PAVED.

13. THE CONTRACTOR SHALL REPLACE EXISTING STRIPING AS NECESSARY.
14. THE CONTRACTOR SHALL OBTAIN AN ENCROACHMENT PERMIT FOR SEWER CONSTRUCTION FROM THE CITY OF REDLANDS PUBLIC WORKS DEPARTMENT PRIOR TO COMMENCEMENT OF WORK.
15. PVC SEWER PIPE AND FITTINGS SHALL CONFORM TO AMERICAN SOCIETY FOR TESTING AND MATERIALS (A.S.T.M.) DESIGNATION D-3034, 15" MAXIMUM SIZE, SDR 35 LATEST REVISION.
16. THE JOINTING OF PVC SEWER PIPE SHALL BE BY USING ELASTOMERIC GASKET JOINTS. THE CRITICAL SEALING DIMENSIONS OF THE BELL, SPIGOT, AND GASKET SHALL BE IN ACCORDANCE WITH THE MANUFACTURER'S STANDARD DIMENSIONS AND TOLERANCES.
17. MANHOLE RIM ELEVATIONS INDICATED HEREON ARE APPROXIMATE. THE CONTRACTOR SHALL BE RESPONSIBLE FOR ADJUSTING ALL RIMS TO FINAL FINISH GRADE, IN COORDINATION WITH STREET IMPROVEMENTS.
18. ALL SEWER STATIONS ARE CENTERLINE SEWER MAIN UNLESS OTHERWISE INDICATED.
19. DURING THE PERIOD OF CONSTRUCTION THE CONTRACTOR SHALL FURNISH, ERECT, AND MAINTAIN ALL WARNINGS, SIGNS, BARRICADES, AND OTHER SAFETY MEASURES IN CONFORMANCE WITH THE STATE MANUAL OF TRAFFIC CONTROLS FOR CONSTRUCTION AND MAINTENANCE WORK ZONES, LATEST EDITION. THE CONTRACTOR SHALL PROVIDE SAFE AND CONTINUOUS PASSAGE FOR PEDESTRIAN AND VEHICULAR TRAFFIC AT ALL TIMES.

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SECTION B

MATERIALS

1. GENERAL:

Vitrified Clay Pipe (VCP) or Polyvinyl Chloride (PVC) pipe shall be used for sewer mains, except where cast iron pipe is required for special conditions.

Vitrified Clay Pipe (VCP) or Polyvinyl Chloride (PVC) pipe shall be used for house connection laterals from the sewer main to the property line.

Manholes shall be the pre-cast reinforced concrete type described herein.

2. VITRIFIED CLAY PIPE:

Pipe shall conform to American Society for Testing and Materials (ASTM) Standards C-700, latest revision, entitled "Standard Specifications for Vitrified Clay Pipe, Extra Strength, Standard Strength, and Perforated". For either plain end or bell and spigot, type extra strength vitrified clay pipe shall be used.

Jointing of vitrified clay pipe shall conform to ASTM Designation C-425, latest revision, entitled "Standard Specifications for Compression Joints for Vitrified Clay Pipe and Fittings", for either plain end or bell and spigot type extra strength vitrified clay pipe.

3. POLYVINYL CHLORIDE (PVC) SEWER PIPE:

Type PSM Polyvinyl Chloride (PVC) sewer pipe fittings shall conform to ASTM Designation D-3034, 15" maximum size, SDR 35 (latest revision).

PVC plastic pipe and fittings shall be made of PVC plastic having a cell classification of 12454-B or 12454-C as defined in ASTM Designation D-1784 (latest revision).

The jointing of PVC sewer pipe shall be accomplished by using elastomeric gasket joints. The critical sealing dimensions of the bell, spigot and gasket shall be in accordance with the manufacturer's standard dimensions and tolerances. The elastomeric compound shall comply with the physical properties specified in ASTM Designation D-1869 (latest revision). The gasket shall provide an adequate compressive force against the sealing surfaces of the bell and spigot so as to affect a positive seal under all combinations of the joint tolerances. The gasket shall be the only element dependent upon to make the joint flexible and watertight.

Whenever possible, the manufacturer's maximum standard length of pipe shall be used.

Solvent cement joints shall be allowed only when installing saddles and lateral caps. The solvent cement shall be in accordance with ATSM Designation D-2564 (latest revision).

All fittings and accessories shall be as manufactured by the pipe supplier and be of equal material of the pipe suppliers and have bell and spigot configurations identical to that of the pipe. Pipe of the same manufacturer shall be joined together.

4. CAST IRON PIPE:

Cast iron pipe shall be “pipe centrifugally cast in metal molds” conforming to the requirements of the American National Standards Institute (ANSI) Specification A21.6 (latest revision), Class 150 Minimum American Water Works Association (AWWA) Standard C-106 (latest revision). Pipe shall be furnished with mechanical bolted joints conforming to ANSI Specification A21.11 (latest revisions) and AWWA Standard C-111 (latest revision).

5. STEEL CASING FOR BORED CROSSING:

Steel pipe shall be a minimum one-quarter (1/4) inch thick wall for 12 inch to 20 inch nominal diameter and a minimum three-eighths (3/8) inch thick wall for pipe sizes up to 36 inch nominal diameter or in accordance with the requirements of the governing agency, whichever is greater; and shall be manufactured in accordance with AWWA Standard C202-64, (latest revision), entitled “AWWA Standard for Mill-Type Steel Water Pipes”, Grade “B”. The casing shall be round and straight, free from protruding bolts, rivets or welds and shall have a inside diameter of not less than the maximum outside diameter of the sewer plus six (6) inches. The steel casing pipe shall be jacked or bored into place and shall be designed to withstand stresses created by jacking the pipe into place. The carrier pipe shall be installed on redwood skids banded to the pipe, and the annular space between the casing and carrier pipe shall be filled with sand slurry and approved and seals shall be provided.

6. CONCRETE:

All concrete shall be 560-C-3250 as per SSPWC Section 201-1 (latest revision).

Mortar and Grout – Cement Mortar shall be Class “A” per SSPWC Section 201-5 (latest revision). Mortar for plastering shall be composed of one part of cement to one part of sand. Cement mortar shall consist of Portland cement, sand, and water. Cement and sand shall be combined in the proper proportions, and then thoroughly mixed with the required amount of water. The quantity of water to be used in the preparation of mortar shall be only that required to produce a mixtures sufficiently workable for the purpose intended. Mortar shall be used as soon as possible after mixing and shall show no visible signs of setting prior to use. No mortar or grout that has begun to set shall be used and no re-tempering will be permitted.

7. MANHOLES, FRAMES & COVERS:

Frames and covers shall be Alhambra Foundry No. A-1170 or equal as approved by the City Engineer.

Precast manholes shall be of reinforced concrete manufactured to meet ASTM Specification C-478 (latest revision) entitled "Standard Specifications for Precast Reinforced Concrete Manhole Sections", and shall be 48 inches in diameter for sewers 15 inches and smaller. Manholes for sewers 18 inches through 24 inches shall be 60 inches in diameter or as shown on the plans (see Standard Drawing No. A-101).

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SECTION C

METHODS OF CONSTRUCTION

1. EXCAVATION, TRENCHING AND BACKFILL:

a. General

The work covered by this portion of the specifications consists of the furnishing of all plant, labor, equipment, appliances, and materials and the performance of all operations in connection with excavation, trenching, back-filling and testing for sanitary sewers and appurtenant structures, in strict accordance with the specifications and the applicable drawings.

In case of conflict in requirements for excavation, trenching and backfilling between this specification and any statutes, laws, ordinances, rules, regulations and specifications of any political subdivision or agency having jurisdiction, it shall be understood that the more exacting requirement shall govern. In general, this specification will apply in City right-of-ways and easements and the aforementioned statutes, laws, ordinances, rules, regulations and specifications of any political subdivision or agency having jurisdiction will apply within the political boundaries or public right-of-ways to which they apply.

The Contractor shall perform all excavation of every description and of whatever substances encountered, to the depths and alignment indicated on the construction drawings or as otherwise specified. During excavation, material suitable for backfilling shall be piled in an orderly manner, a sufficient distance from the banks of the trench to avoid overloading and to prevent slides or cave-ins. All excavated materials not required or suitable for backfill shall be removed and wasted by the Contractor at the direction of the City Engineer.

Such grading shall be done as may be necessary to prevent surface water from flowing into trenches or other excavation. The Contractor shall remove, by pumping or other means approved by the City, any water accumulated in the trench from any source.

Suitable shoring, timbering or sheeting shall be provided by the Contractor where necessary to support the sides of the trench prior to and during the installation of the pipe. The shoring methods and procedure shall be consistent with safety. The shoring shall be removed as the trench is being backfilled. All such shoring, timbering or sheeting shall meet or exceed the standards of Cal-OSHA.

Unless otherwise indicated, excavation shall be by open cut except that short sections of a trench may be tunneled if, in the opinion of the City Engineer, the pipe can be safely and properly installed and backfill can be properly tamped in such tunnel sections.

All spoil shall be thrown on one side of the trench only to facilitate distribution and installation of pipe in such a manner that it will not endanger the work and will not obstruct roads and driveways. Adequate provisions shall be made for maintaining the flow of water courses, drains, sewers or ditches crossing the trench, and upon completion of the work they shall be restored to their original condition.

When trenching is necessary across street intersections, the work shall be done in such a manner as to maintain two-way traffic on the cross-street without undue interruption. Vehicular access to residences shall be interrupted only when absolutely necessary to expedite construction. Where any crosswalk is cut by the trench, suitable bridging shall be constructed. Such bridging shall be at least four (4) feet in width, shall have suitable hand railing, and shall be adequately guarded and lighted.

The use of trench digging machinery will be permitted except where its operations will cause damage to trees, buildings or existing structures above or below the ground. At such locations, hand methods shall be employed to avoid such damage. Trees, fences, poles and other property shall be protected unless their removal is authorized. Any property damaged shall be satisfactorily restored by the Contractor.

The Contractor shall provide his own access and proper clearances for installation of pipe in easements. Removal and disposal of all trees, stumps, roots, brush and other objectionable material shall be performed by the Contractor, all in accordance with the approval of the City.

b. Trench Excavations

The width of the trench at and below the top of the pipe shall be such that the clear space between the barrel of the pipe and the trench wall shall not be less than 5 inches nor exceed 8 inches on either side of the pipe. No narrow trenches will be permitted (SSPWC 306-1.2.1.2). The width of the trench above that level may be as wide as necessary for sheeting and bracing and the proper performance of the work and the banks shall be as near vertical possible. The bottom of the trench shall be rounded so that at least the bottom quadrant of the pipe shall rest firmly on undisturbed soil for the full length of the barrel except where it is necessary to excavate the bell holes and proper joint operations. This part of the excavation shall be done manually, only a few feet in advance of the pipe laying, by workers skilled in this type of work. Bell holes and depressions for joints shall be dug after the trench bottom has been graded and shall be only of such length, depth and width as necessary for properly aiming the particular type of joint. Except where rock or unsuitable materials are encountered, care shall be taken not to excavate below the depth indicated on the construction drawings.

Where the bottom of the trench is in rock or hard materials, the trench shall be excavated six (6) inches below grade as directed by the City Engineer. Where the trench bottom requires the use of imported material under the pipe because of soft, wet, spongy or unstable condition in the trench, a minimum thickness of twelve (12) inches crushed rock bedding shall be placed below grade of pipe invert of the full width of the trench.

c. Excavation for Appurtenances

Excavation for manholes and similar structures shall be sufficient to leave at least twelve (12) inches clear between their outer surfaces and the embankment of timber which may be used to hold and protect the banks. Excavation for other structures shall be made to the grade shown on the construction drawings and all work shall be done in a workmanlike manner.

d. Backfill

Backfill of the trench around the pipe and around appurtenances shall follow the installation as closely as possible. Backfill shall be accomplished in two stages:

- (1) Initial backfill from proper trench grade to twelve (12) inches over the pipe;
- (2) Final backfill from twelve (12) inches over the pipe to the surface.

i. Initial Backfill - Vitrified Clay Pipe and Cast Iron Pipe

Initial backfill should be accomplished as soon as possible after the pipe has been laid. The backfill material shall be approved by the City Engineer and shall contain no particles larger than one (1) inch or other objectionable material. The material shall be sufficiently damp to permit thorough compaction free of voids on all sides of the pipe. Initial backfill shall consist of placing the backfill from proper trench grade to an elevation of twelve (12) inches over the top of pipe by the following procedure:

The first lift of material shall be uniformly placed on both sides of the pipeline for the full width of the trench and have a maximum loose depth of not more than six (6) inches as measured from the trench bottom. This material shall then be tamped under and around the pipe and joints until all voids underneath and around the pipe and joints have been filled.

After the voids beneath the pipe have been filled, the material between the trench walls and the pipe shall be compacted, with each layer firmly compacted prior to placing the subsequent material. Maximum depth of the horizontal layers shall not exceed eight (8) inches in depth.

Flooding of the initial backfill may be permitted with prior approval of the City Engineer. Flooding of the initial backfill will be permitted when the

material has a sand equivalent value of not less than 30 as determined by California Test No. 217 of the California Divisions of Highways.

ii. Initial Backfill Polyvinyl Chloride (PVC)

The initial backfill procedures for PVC sewer pipe shall be in accordance with ASTM Designation D-2321, (latest revision) entitled "Standard Practice for Underground Installation of Thermoplastic Pipe for Sewers and Other Gravity-Flow Applications", except as amended herein. Only Class 1 or Class 2 embedment materials shall be used. Class 1 materials are crushed rock bedding, graded stone, or slag. Class 2 materials are coarse sands and gravels containing small percentages of fines, and the fines shall be granular and non-cohesive. No particles greater than 1-½ inch in the greatest dimension will be permitted. The same class of bedding material shall be used for the bedding, haunching and initial backfill. The bedding material shall have a minimum thickness of 4 inches. PVC PIPE WILL NOT BE ALLOWED WHEN THERE IS LESS THAN 60 INCHES OF COVER OVER THE PIPE. The bedding, haunching, and initial backfill shall be mechanically compacted to bring the relative compaction of the material up to 90 percent of the maximum dry density as determined by ASTM D-1556.

Care shall be taken to insure that material is properly worked under the pipe and that the pipe is not moved or deflected during the haunching and initial backfill procedure. By the nature of the material being used for the initial backfill, little compactive effort will be required to obtain the specified density. FLOODING THE INITIAL BACKFILL WILL NOT BE PERMITTED.

iii. Final Backfill-General

The balance of backfill shall contain no particles larger than six (6) inches in its greatest dimension or such small dimensions as specified by the governing body having jurisdiction and shall be free from brush or any other perishable or objectionable matter that would prevent proper compaction, consolidation or that might cause subsequent settlement. Relative compaction of 95% minimum shall be required for asphalt pavement, paving base material and backfill material within top two (2) feet from the surface. All of the backfill placed within the bedding zone shall be compacted to a minimum dry density of ninety (90) percent of its maximum dry density as determined by ASTM D-1556, (latest revision). Flooding and/or jetting of the material to accomplish compaction will not be permitted without prior authorization by the City Engineer. For trenches eight (8) feet in depth or less, the final backfill may be placed in compacted lifts of twenty-four (24) inches or one-half (1/2) of the trench depth, whichever is greater. For trenches greater than eight (8) feet in

depth, the material shall be placed in maximum compacted lifts of four (4) feet. The depth of fill lifts for trenches on slopes may be reduced by the City Engineer to facilitate compaction.

The Contractor shall provide the City with compaction test results as determined by an approved and licenses soiled laboratory at intervals of not less than one test per 300 feet or as required by the City Inspector. The Contractor shall pay all costs of compaction tests.

In lieu of the above, the Contractor may elect to backfill completely with sand and jet thoroughly to the satisfaction of the City Inspector.

Any deficiency in the quantity of material for backfilling the trenches or for filling depressions caused by settlement shall be supplied by the Contractor. Surplus soils shall be crowned over the trench, spread or hauled away as directed by the City Engineer.

Backfill within traveled streets or highways existing or proposed shall meet the standards and approval of the City or proper authority having jurisdiction over same.

Trenches improperly backfilled, or where settlement occurs, shall be re-opened to the depth required for proper compaction, then backfilled and compacted, with the surface restored to the required grade.

Where flooding and/or jetting have been approved by the City Engineer, backfill shall be thoroughly consolidated by use of the water jets. The Contactor shall use water jets of adequate diameter and of sufficient length to extend to within one foot of the top of the pipe. A City approved back flow assembly is required when connecting to a fire hydrant meter.

Where water is not readily available in sufficient quantity and pressure, the backfill may be flooded by the following method: The water shall be allowed to flow slowly into the trench from the upper end, and shall be worked down to the bottom of the trench by “poling”. Care shall be taken to insure that water does not flow through the trench before it has penetrated down to the pipe line.

iv. Final Backfill PVC Pipe

PVC Pipe shall be backfilled as described in Section g. “Final Backfill” except as amended in this section. Thirty-six (36) inches of cover shall be provided over the pipe before wheel rolling the trench is permitted. Forty-eight (48) inches of cover shall be provided before using a hydrohammer to compact the backfill. Where the Contractor can demonstrate that a four (4) foot lift can be thoroughly compacted without deflecting the pipe, he may

place the first lift four (4) foot thick. When in the opinion of the City Engineer a four (4) foot lift cannot be adequately compacted, he may require a thinner lift and an alternate method of compaction or require that the first four (4) feet of final backfill be filled with clean sand and be jetted or flooded with water to achieve the required compaction.

e. Pavement Replacement

When it is necessary to break pavement in order to lay the pipe lines shown on the construction drawings, the Contractor shall comply with all the requirements of the City Engineer.

The existing pavement shall be saw cut vertically as near as possible to a straight line by a City approved method. The pavement removed shall be hauled away as directed by the City and shall be replaced as herein specified. Base material shall be replaced with materials and methods which will give a sub-base at least equal to that adjacent.

The Contractor shall install a temporary patch of not less than two (2) inches thick of a City approved asphaltic material over the backfilled trench and shall maintain said trench in a smooth readable condition for a period of thirty (30) days. Where the trench has been completely backfilled with sand, the pavement may be replaced initially with a permanent patch as specified below:

Asphaltic surfaces or oiled surfaces shall be replaced with a City approved plant-mix surfacing material to a thickness equal to the original thickness, or to a thickness of two and one-half (2-½) inches, whichever is greater. The paving asphalt to be used in the plant mix shall be steam refined, grad as specified by the City Engineer. At the Contractor's option, where the area to be resurfaced is less than 650 square feet, the City may resurface the area with a permanent patch to be paid for by the Contractor at City resurfacing rates in effect at that time. In any case, the Contractor shall be responsible for replacing all necessary pavements.

2. PIPE LAYING:

a. Vitrified Clay Pipe (VCP)

The bottom of the trench shall be shaped to give uniform circumferential support to the lower fourth of each pipe. Pipe laying shall proceed upgrade with the spigot ends of bell-and-spigot pipe pointing in the direction of the flow. Each pipe shall be laid true to line and grade in such a manner as to form a close concentric joint with the adjoining pipe and to prevent sudden offsets of the flow line. As the work progresses, the interior of the sewer line shall be cleared of all dirt and superfluous materials of every description.

Where cleaning after laying is difficult because of small pipe size, suitable swab or drag shall be kept in the pipe and pulled forward past each joint immediately after the jointing has been completed. If the maximum width of the trench at the tip of the pipe, specified in EXCAVATION, TRENCHING AND BACKFILLING is exceeded for any other reason than by order of the City Engineer, the Contractor shall install at his own expense, such concrete, cradling, pipe encasement, or other bedding as may be required by the City Engineer to support the added load of the backfill. Trenches shall be kept free from water until the pipe jointing has been completed. Pipe shall not be laid when the condition of the trench or the weather is unsuitable for such work. At times when work is not in progress, open ends of pipe and fittings shall be securely closed to the satisfaction of the City Engineer so that no trench water, earth, or other substances will enter the pipe or fittings.

b. Polyvinyl Chloride (PVC) Pipe

The pipe shall be laid directly on the grade of the bedding material. Pipe laying shall proceed upgrade with spigot ends of the pipe pointing in the direction of the flow. Each pipe shall be laid true to line and grade in such manner as to form a close concentric joint with the adjoining pipe to prevent sudden offset of the flow line. As the work progresses the interior of the sewer line shall be cleared of all direct and superfluous materials of every description.

Where cleaning after laying is difficult because of the small pipe diameter, a suitable swab or drag shall be kept in the pipe and pulled forward past each joint immediately after the jointing has been completed. If the maximum width of the trench at the top of the pipe, specified in EXCAVATION, TRENCHING AND BACKFILLING is exceeded for any other reasons than by orders of the City Engineer, the Contractor shall install at his own expense, such concrete, cradling, pipe encasement, or other beddings as may be required by the City Engineer to support the added load of the backfill. Trenches shall be kept free from water until the pipe jointing has been completed and pipe shall not be laid when the condition of the trench or the weather is unsuitable for such work. At times when work is not in progress, open ends of the pipe and fittings shall be securely closed to the satisfaction of the City Engineer so that no trench water, earth, or other substances will enter the pipe or fittings.

Whenever pipe is required to be cut, it shall be done in a neat and workmanlike manner and the cut shall be made at a right angle to the longitudinal axis of the pipe. All burrs shall be removed prior to the assembly of the pipe.

Connections to manholes or other rigid structures shall be accomplished by installing a manhole water stop, corresponding to the size of the sewer pipe directly into the rigid structure such as a manhole or manhole base. The coupling shall be placed in the structure whereby the outer side of the coupling is flush with the outside of the structure. (See Standard Drawing No. A-101).

c. Cast Iron Pipe

Defective, damaged or unsound pipe will be rejected. The cutting of pipe, where necessary, shall be done in a neat and workmanlike manner without damage to the pipe. Unless otherwise authorized by the City Engineer, cutting shall be done by means of an approved type of mechanical cutter. In general, cast iron pipe shall be installed as described for vitrified clay pipe.

3. **PIPE JOINTING:**

a. Vitrified Clay Pipe (VCP)

Joints in the bell-and-spigot pipe shall be made by lubricating the resilient material on both the bell-and-spigot ends with a soap solution approved by the manufacturer. Position the spigot inside the bell of the next length and properly align the two sections in the trench. Push the joint home by hand or by means of a bar lever, with wooden blocking to protect the bell end from damage, until the joint is obtained.

Joints in plain-end pipe shall consist of three parts; a circular rubber sleeve, stainless steel compression bands with a bolt and nut mechanism for tensioning bands, and a stainless steel shear ring to insure proper alignment of the pipe joints. The bolt wrench, furnished by and preset to the manufacturer's specifications. Prior to tensioning, a lubricant approved by the manufacturer shall be applied to the rubber under the area of the bands.

b. Polyvinyl Chloride (PVC) Pipe

Joints in PVC Elastomeric joints shall be made as follows: Bell and rubber rings shall be cleared of foreign material that could interfere with the proper assembly of the joint. Wipe the spigot end of the pipe with a clean, dry cloth around the entire circumference from the end of one inch beyond the reference mark. Lubricate the spigot end of the pipe using only lubricant recommended or supplied by the pipe manufacturer. The lubricant shall be applied in a manner in accordance with the pipe manufacturer's recommendation. The spigot end of the pipe is then inserted into the bell so that it is in contact with the rubber ring keeping the pipe lengths in proper alignment. Brace the bell while the spigot end is pushed in under the rubber ring, so that previously completed joints will not be closed up. Push the spigot end in until the reference mark on the spigot end is flush with the end of the bell. This pipe shall be assembled by hand and/or bar and block and shall not be stabbed.

c. Cast-Iron Pipe

Before mechanical jointing, the socket and plain end of the pipe shall be brushed and wiped clean of dirt, oil, grease and scale. The socket and end shall be

washed with soapy water, then after the gland and gasket have been slipped on, the gasket shall be painted with soapy water. The gasket shall then be pushed into position and seated with the fingers after which the gland shall be positioned and all bolts tightened by hand before wrench tightening.

d. Jointing Different Materials

Sewer mains between manholes shall be of the same material, except when a section of cast iron pipe is required for crossing a water main, or when allowed by the City Engineer. When cast iron is joined directly to VCP or PVC pipe, it shall be done with a commercial transition coupling approved by the City Engineer. PVC house laterals may be joined to VCP wyes, provided that an adaptor bushing is installed on the PVC lateral and the wyes have a plain end branch for connecting with a band sleeve. VCP house laterals shall not be connected to PVC wyes.

e. Connecting House Laterals to Existing Main

When the sewer main is VCP at the point of connection and the lateral is half the size of the sewer main or smaller, the connection shall be made by chipping a neat hole in the main and clamping a vitrified clay wye saddle to the main. The main shall then be encased in concrete at the point where the saddle was installed as per Standard Drawing A-103.

When the sewer main is PVC at the point of connection and the lateral is half the size of the main or smaller, the connection shall be made by using a PVC solvent weld saddle. All other connections to an existing sewer main shall be made by installing a standard manhole over the main, and breaking out the main AFTER THE MANHOLE HAS BEEN INSPECTED BY THE CITY INSPECTOR. Under certain conditions, when the lateral is over half the size of the main, the City Engineer may allow the installation of a factory fabricated wye.

4. **SEPARATE WYES:**

Commercially manufactured wyes shall be installed where indicated on the plans and/or at such other locations required by the City Engineer. All wye branches not to be joined to house connections shall be installed with a suitable stopper of size of the wye branch. The wye branches, unless otherwise specified, shall be inclined upward at an angle not greater than 45° from a horizontal line. No wye branch shall be placed closer than five (5) feet to the centerline of any structure. The use of double wyes will not be permitted except as specified or required for chimneys.

5. **CHIMNEY PIPES:**

Chimney pipe shall be constructed as shown on Standard Drawing No. A-104 and at locations designated on the plans. Chimney pipes shall be installed where the depth

of the sewer main is twelve (12) feet or more in depth, or as designated by the City Engineer.

6. HOUSE CONNECTIONS (SEWER LATHERALS):

The term “house connections (sewer laterals)” as used in this specification or on the plans is used to designate branch sewers, laid from a main sewer to points at the property lines, or other locations as shown on the plans, from which sewer service can be obtained by proper extension. Where conditions are such that the house connection cannot be adequately supported on undisturbed earth or tamped backfill, the house connection pipe shall be encased in concrete and supported on a concrete cradle as directed by the City Engineer. Concrete shall be installed by the Contractor.

The house connection shall be constructed in accordance with details shown on Standard Drawing No. A-100 on an unyielding foundation, with joints closely and accurately fitted, true to line, and on a straight grade from the bend joining the main sewer to their upper ends, unless otherwise indicated on the plans. House connections shall not be laid on a slope greater than 45° from a horizontal line unless approved by the City Engineer. Wyes for house connections shall be installed as specified in Section 4. The house connection sewer lines shall be joined to the wye branch by eighth bends. All eighth bends are a part of the house connection sewer lines. Where a house connection sewer line is to be connected with a chimney, all bends leading away from the wye branch is a part of said house connection sewer line. House connections (sewer laterals) are not allowed directly into manhole.

a. Size and Depth

The minimum size house connection shall be four inches (4”) in diameter. All house connections shall be laid on a uniform slope from the main line sewer to the property line with a minimum grade of 2% (1/4” per ft.) for a four-inch (4”) house connection and a minimum grade for 1% (1/8” per ft.) for a six-inch (6”) house connection. The minimum cover over a house connection shall be five feet (5’) below the invert of the concrete curb and gutter. For multiple family dwellings, commercial lots, schools or the like, special consideration should be given to determining the correct size and depth of connection to meet the City’s approval.

7. MANHOLE:

a. General

Manhole invert channels shall be smooth and semicircular in shape, conforming to the inside of the adjacent sewer section. Changes in direction of flow shall be made with a smooth curve of as large radius as the size of the manhole will permit. Changes in size and grade of the channels shall be made gradually and evenly. The invert channels may be formed directly in the concrete of the manhole base, may be half tile laid in concrete, or may be constructed by laying full section sewer pipe through the manhole and breaking out the top half after the

surrounding concrete has hardened. The floor of the manhole outside the channels shall be smooth and shall slope toward the channels not less than one inch per foot nor more than two (2) inches per foot.

Manhole frames and covers shall be installed in accordance with Standard Drawing No. A-101. Top of manhole frames and covers shall be installed six (6) inches below finish grade in new tract developments. After paving is completed, top of manhole, frame and cover shall be adjusted to top of pavement. Manhole frames and covers in existing street pavement shall be constructed to top of pavement. Manhole diameter shall be 48" for sewers 15" and smaller, 60" for sewers 16" to 24" or as shown on the approved plans.

b. Precast Manholes

Precast manholes shall be installed and assembled in accordance with details shown on Drawing No. A-101 and in accordance with the manufacturer's specifications. Eccentric cones shall be used unless otherwise specified on the plans. Eccentric cones are to be installed with the straight wall downstream. All manholes shall have three (3) inch and six (6) inch, grade rings for a minimum height of twelve (12) inches, and a maximum height of eighteen (18) inches, below the manhole frame. When the manhole depth is less than four (4) feet, a concentric cone shall be used.

c. Drop Manholes

Drop manholes shall be constructed in accordance with Standard Drawing No. A-102.

d. Remodeling Existing Manholes

Pipe connections to existing manholes or existing stubs shall be made in such a manner that the finished work will conform as nearly as practicable to the essential applicable requirements specified for new manholes, including all necessary brick work, concrete work, cutting, and reshaping of inverts to provide proper channels for flow.

e. Spacing

The maximum spacing allowable between manholes on eight-inch (8") through thirty-inch (30") lines shall be 350 feet. For lines over thirty inches (30"), a maximum spacing of 600 feet is allowable. Manholes shall be placed at the end of all sewer mains, unless approved otherwise by the City Engineer.

f. Grades

A minimum drop of 0.10 foot and maximum of 0.60 foot shall be used on a straight-through line. For a bend through the structure, a minimum of 0.20 foot and maximum of 1.00 foot shall be used. Minimums do not apply to sewers

greater than eighteen inches (18"). Pipe connections to existing manholes or existing stubs shall be made in such a manner that the finished work will conform as nearly as practicable to the essential applicable requirements specified for new manholes, including all necessary brick work, concrete work, cutting, and reshaping of inverts to provide proper channels for flow.

8. DEAD ENDS:

Manholes shall be constructed at all dead ends unless shown otherwise on the construction plans.

9 BORED CROSSINGS:

a. General

The work covered by this paragraph of the specifications includes all pipe, pipe fittings, casing, special appurtenances, and materials between the stations indicated as bored crossings on the construction plans.

b. Installation

Crossings shall be bored with an earth auger to the line and grade shown on the plans. The maximum allowable variation in line or grade will be two-tenths (0.20) of a foot in the distance bored. Should voids be created outside the casing pipe, the voids shall be filled as directed by the City Engineer. After the pipe is in the casing, the lower one-half of the casing for the full length of the bore shall be grouted; the Contractor shall fill the space between the pipe and the casing with sand slurry, and seal the ends with brick rubble masonry and provide a one (1) inch diameter pipe drain in the lower end.

10. CONCRETE WORK:

Concrete as specified herein, shall be used for manhole bases, pipe bedding encasements and for other support and backfill as the City Engineer may direct. In general, forms will not be required, provided that concrete may be successfully placed to the minimum dimensions as shown on the drawings using side walls of excavations for support. If side walls of excavations are not suitably stable in the opinion of the City Engineer, the Contractor shall furnish and use forms for concrete placement.

11. TESTS:

a. Test for Displacement of Sewer

Sewer mains will be checked by the City Engineer to determine whether any displacement of the pipe has occurred after the trench has been completely backfilled and compacted as specified. If the interior of the pipe line shows poor

alignment, displaced pipe, or any other defects, the defects designated by the City Engineer shall be remedied by the Contractor at his expense.

b. Test for Leakage

- i. Hydrostatic Test Procedure – Manholes – if required by the City Engineer, manholes shall be hydrostatically tested. The inlet and outlet of the manhole shall be plugged and the cylindrical section of the manhole filled with water. The maximum allowable leakage rate per foot of depth tested shall be three (3) gallons per hour. The test shall run a minimum of thirty (30) minutes.
- ii. Air Test Procedure - Sewers – Each section of sanitary sewer constructed between two successive manholes or structures shall be air tested. The City may require that the final air test be conducted after all other utilities have been installed and compaction on trenches completed. Length of line tested at one time shall be limited to the length between adjacent manholes or structures.

Contractor shall pressurize the test section to 4.0 psi and hold at 4.0 psi for not less than two minutes. Add air if necessary, to keep the pressure at 4.0 psi.

Disconnect Air Supply. When pressure decreases to 3.5 psi, start stopwatch. Determine the time in seconds that is required for the internal pressure to reach 2.5 psi. This time interval shall be greater than time given in the following table. The section of sewer shall not have passed if the time is less than shown below:

Sewer Diameter	Minimum Time	
	With Laterals	Without Laterals
8 inches	2 min 25 sec	2 min 36 sec
10 inches	2 min 51 sec	3 min 0 sec
12 inches	3 min 17 sec	3 min 31 sec
15 inches	5 min 0 sec	5 min 0 sec
18 inches	7 min 0 sec	7 min 0 sec
21 inches	10 min 0 sec	10 min 0 sec

If the air test is not passed, the leak shall be found and repaired to the satisfaction of the City Engineer.

House sewers (Laterals) shall be considered part of the main sewer to which they are connected and no adjustment of test time shall be allowed to compensate for the smaller diameter of the house sewers.

The pressure gauge used shall be supplied by the Contractor: shall have minimum divisions of 0.10 psi and shall have an accuracy of 0.04 psi.

Accuracy and calibration of the gauge shall be certified when requested by the City Engineer.

c. Deflection Test for PVC Pipe

Following the placement and compaction of backfill and prior to permanent paving, the Contractor shall clean all PVC sewer mains and pull an approved mandrel through the sewer mains to measure the deflection of pipe of any obstructions caused by joint offsets, lateral pipe intrusions or rough joints. A rigid mandrel, approved by the City Engineer, with a circular cross section having at least 95% of the specified average inside diameter, shall be provided and pulled through the pipe by hand by the Contractor, in the presence of the City Engineer.

Ninety-five percent of the specified average inside diameter for PVC sewer pipe manufactured per the specifications of ASTM D-3034 is as follows:

Pipe Nominal Diameter	95% I.D. SDR 35
6"	5.619"
8"	7.524"
10"	9.405"
12"	11.191"
15"	13.849"

The Contractor shall notify the City Inspector 48 hours in advance of testing the sewer lines.

12. MAINTENANCE OF SEWER SYSTEM PRIOR TO ACCEPTANCE BY CITY

a. Cleaning

All new sewer lines shall be cleaned of debris, rocks, sand, or dirt before being accepted by the City. Cleaning the lines by balling and flushing or by using a hydraulic jet machine are acceptable methods. Devices approved by the City Inspector shall be provided and installed by the Contractor to catch all debris, rocks, sand, etc. in order to prevent it from entering the existing sewer system.

b. Connecting to Existing Sewer

No sewer line shall be connected to an existing sewer until the new portion of a line has been cleaned and inspected by the City Inspector. After cleaning the new sewer lines and prior to connecting to the existing sewer, the Contractor shall install an approved sandtrap in the outlet of the first upstream manhole from the point of connection to the existing sewer. The Contractor shall maintain and clean the sandtrap until the sewer is accepted for operation and maintenance.

c. Final Inspection

Prior to final inspection of the sewer, the Contractor shall remove all sandtraps and any other protection devices such as plywood over the manhole channels and shall insure that the sewer lines are clean, and shall raise all manhole covers to final grade.

Arrangements for the final inspection shall be made forty-eight (48) hours in advance by calling the City Engineer or Inspector.

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SECTION D

MAIN LINE SEWERS

1. LOCATIONS:

In general, main line sewer should be located on the centerline of existing and proposed streets. The Standard minimum horizontal distance between the main line sewer, sewer laterals, existing and proposed water mains, and water service laterals shall be ten (10) feet. Where this cannot be accomplished, special construction shall govern as shown on page 31 and page 32, of this specification. The sewer mains shall be in a straight line both in plan and profile between manholes. Where approved by the City Engineer, vertical and horizontal curves may be used based on the following criteria:

a. Horizontal Curves (Clay Pipe)

On a sewer 27 inches or less in diameter, one curve, either horizontal or vertical will be permitted between manholes spaced per Section 7(e), on page 19 of this specification.

On a sewer 30 inches or greater in diameter, compound curves or a combination of curves and tangents may be used. Vertical curves shall not be located within the limits of horizontal curves.

Special attention shall be given to the number and location of manholes to ensure normal maintenance operations.

The minimum radius of curvature allowable for vitrified clay pipe using compression joints (“speed sal” or equiv.) joints is given on the above **Table 1 (VCP)**. The minimum allowable radius is governed by the type of joints used by the pipe lengths and by the allowable separations or “pull”, measured in inches, of the abutting pipe ends permitted on the outside surface of the curved sewer. Beveled pipe shall not be used. If pipe lengths less than the standard are required, it shall be noted on the plans.

TABLE 1 (VCP)

Pipe Size (inches)	Maximum Pipe Length (feet)	Maximum Pull (inches)	Minimum Radius (feet)	Maximum Deflection
8	3-1/3	3/8	95	2° 00'
8	5	3/8	145	2° 00'
8	6	3/8	175	2° 00'
10	5	7/16	145	1° 58'
10	6	7/16	175	1° 58'
12	5	1/2	145	1° 58'
12	6	1/2	175	1° 58'
15	5	9/16	160	1° 50'
15	6	9/16	190	1° 50'
18	5	5/8	180	1° 38'

18	6	5/8	210	1° 38'
21	5	3/4	180	1° 38'
21	6	3/4	210	1° 38'
24	5	3/4	190	1° 32'
24	6	3/4	230	1° 32'
27	5	3/4	210	1° 23'
27	6	3/4	250	1° 23'
30	5	13/16	225	1° 15'
30	6	13/16	270	1° 15'
33	5	13/16	250	1° 09'
33	6	13/16	300	1° 09'
36	5	7/8	260	1° 07'
36	6	7/8	310	1° 07'
39	5	7/8	285	1° 01'
39	5-1/2	7/8	315	1° 01'
39	6	7/8	340	1° 01'
42	5	7/8	305	0° 57'
42	5-1/2	7/8	335	0° 57'
42	6	7/8	365	0° 57'

b. Horizontal Curves PVC Pipe

The minimum radius of curvature allowable for Polyvinyl Chloride Pipe (PVC) is as shown on **Table 2 (PVC)** below, and bend curvature manufacturer's recommendations. A maximum of one half of manufacturer's bend may be permitted subject to City approval.

TABLE 2 (PVC)

Pipe Size (inches)	Maximum Pipe Length (feet)	Minimum Radius (feet)	Maximum Deflection (Degrees)
8	10	380	1.5
8	12.5	475	1.5
8	20	765	1.5

c. Parabolic Vertical Curves

Vitrified Clay Pipe or Polyvinyl Chloride Pipe

Parabolic vertical curves shall be so designed that the limitations for horizontal curves are observed. The minimum horizontal length of vertical curve required to conform to the minimum radii permitted shall be computed as follows, but in no case shall the length be less than forty (40) feet.

Formula

$$L_{\min} = (S_2 - S_1) R_{\min}$$

Where, L_{\min} = minimum horizontal length of vertical curve in feet.

S_1 and S_2 = Slopes of tangents on the vertical curve expressed in feet per foot.

R_{\min} = Minimum radius of curvature permitted in feet from Table 1, for VCP or Table 2 for PVC.

Elevations on vertical curves shall be computed at intervals determined by the following equation and the results shown on the profile.

Formula

$$X_{\max} = 0.283 \sqrt{\frac{L}{S_1 - S_2}}$$

Where, X_{\max} = maximum horizontal distance between elevation intervals.

L = horizontal length of vertical curve.

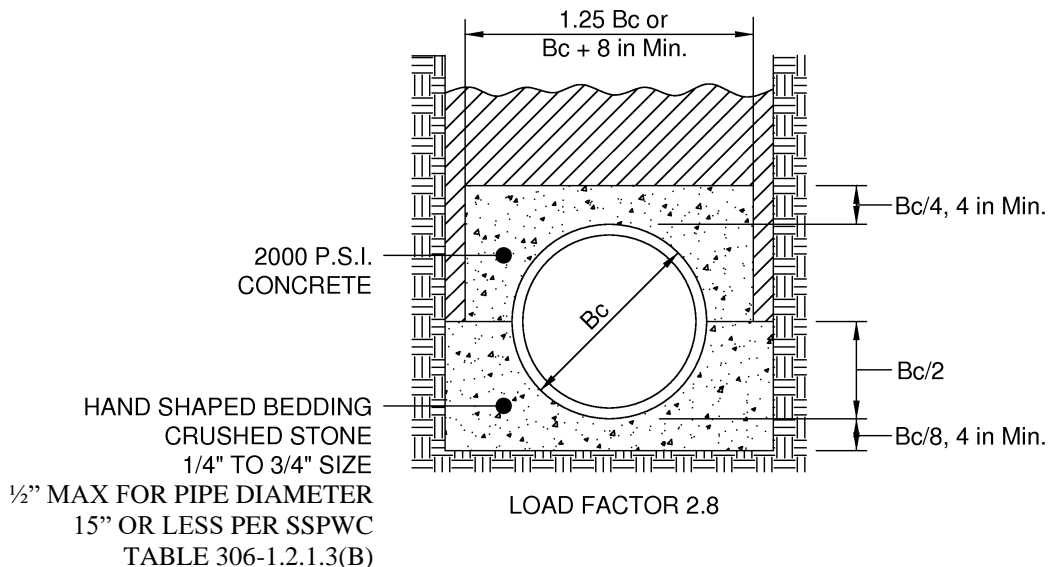
S_1 and S_2 = Slopes of tangents on the vertical curve expressed in feet per foot.

The interval used shall be the nearest multiple of 5 feet, that is less than the computed value of "X" but in no case shall it exceed 25 feet.

d. Depths

The normal minimum cover of the pipe shall be seven feet (7') below finished grade. In cases where street and/or lot grading requires sewers to be at a shallower depth, the depth may be approved by the City Engineer subject to the following construction requirements.

Depth of Cover: 7' to 4' – Submit load calculations on pipe
 4' to 2-1/2' – Sewer main shall be capped with
 concrete as follows:



Less than 2-1/2' of cover – Sewer main and/or laterals shall be Class 150 cast iron pipe with approved mechanical joints.

e. Size and Grades

The minimum pipe size shall be 8 inches. Pipe twelve inches (12") and smaller in diameter shall be designed to flow at ½ full at peak dry weather flow using $n = 0.013$ in the Manning Formula. Pipe 15 inches (15") and larger in diameter shall be designed to flow at ¾ full at peak dry weather flow using $n = 0.013$. Minimum slopes for various sizes of pipe are listed below.

8" Pipe at $s = 0.0040$ feet per foot
 10" Pipe at $s = 0.0032$ feet per foot
 12" Pipe at $s = 0.0024$ feet per foot
 15" Pipe at $s = 0.0016$ feet per foot
 18" Pipe at $s = 0.0014$ feet per foot
 21" Pipe at $s = 0.0012$ feet per foot
 24" Pipe at $s = 0.0010$ feet per foot
 27" Pipe at $s = 0.0008$ feet per foot
 30" Pipe at $s = 0.0007$ feet per foot

All sewers shall be designed for peak flow and using the above design criteria, however the velocity shall be not less than 2.5 feet per second nor greater than 10 feet per second at peak dry weather flow.

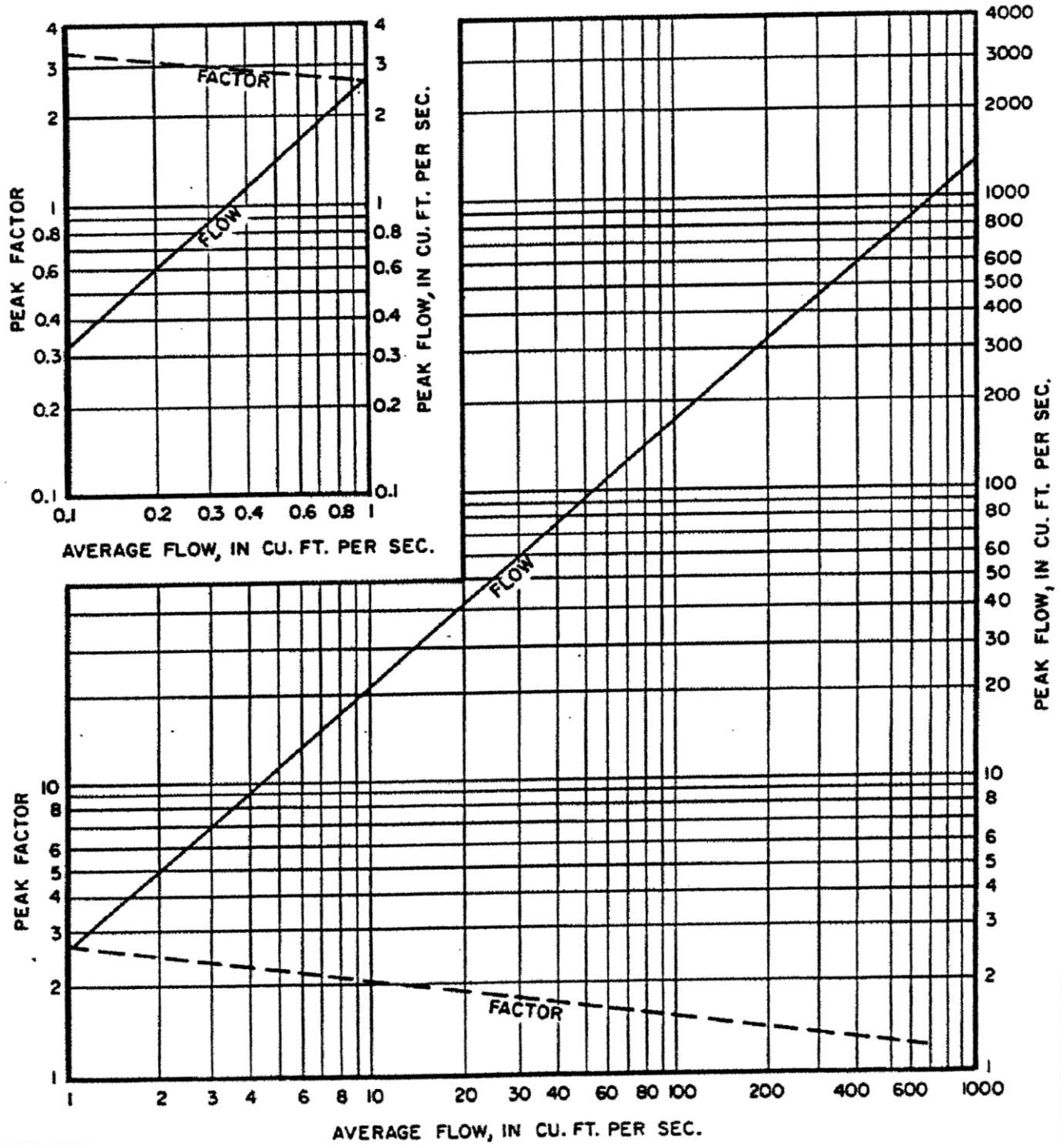
For determining the peak rate of flow in a main line sewer, the following tables shall be used with designated land use or persons per acre producing the greater rate of flow as the governing factor. The peak flow shall equal average flow (**Table 3**) x peak factor (**Table 4**).

TABLE 3
Wastewater Design Flows (Average Flow)

Land Use		Dwelling Units Per Acre	Persons per Dwelling Unit	Average Flows (cfs/acre)
Residential	Hillside	2	3.15	0.00083
	Low Density	4	3.15	0.0017
	Medium Density	10	2.50	0.0033
Commercial	Administrative & Professional			0.0022
	Neighborhood			0.0022
	Freeway Related			0.0022
	General			0.0022
Industrial	Urban Services			0.0022
	Light			0.0022
	General			0.0022
Public Use				0.0022

Those conditions not covered by the above table shall require special study.

TABLE 4
RATIO OF PEAK FLOW TO AVERAGE DAILY FLOW



(AVERAGE FLOW x PEAK FACTOR = PEAK FLOW - cfs)

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SECTION E

SPECIAL CONDITIONS

1. **JACKING OR MACHINE BORING**

Where it is necessary to construct a sewer beneath railroad tracks, across state or federal highways, or beneath a large obstruction where tunneling is not feasible, jacking or machine boring is required. All jacking or machine boring shall be approved by the governing body having jurisdiction.

2. **WELL PROTECTION**

Whenever a sewer passes within a horizontal radius of one hundred feet (100') of water well, material for the sewer main shall be Class 150 cast iron with mechanical joints. In accordance with the City of Redlands Municipal Code, every well shall be located no closer than fifty feet (50') from sewers, watertight septic tank, or any potential sources of contamination and pollution.

3. **SPECIAL CONSTRUCTION REQUIREMENTS**

The California Waterworks Standards (California Code of Regulations (CCR), Title 22, Division 4, Chapter 16, Section 64572) establish criteria for the separation of new water mains from non-potable pipelines. Public water systems should ensure that these distances are met, whenever feasible, for all new construction.

- (a) New water mains and new supply lines shall not be installed in the same trench as, and shall be at least 10 feet horizontally from and one foot vertically above, any parallel pipeline conveying:
 - (1) Untreated sewage,
 - (2) Primary or secondary treated sewage,
 - (3) Disinfected secondary-2.2 recycled water (defined in section 60301.220),
 - (4) Disinfected secondary-23 recycled water (defined in section 60301.225), and
 - (5) Hazardous fluids such as fuels, industrial wastes, and wastewater sludge.
- (b) New water mains and new supply lines shall be installed at least 4 feet horizontally from, and one foot vertically above, any parallel pipeline conveying:
 - (1) Disinfected tertiary recycled water (defined in section 60301.230), and
 - (2) Storm drainage.
- (c) New supply lines conveying raw water to be treated for drinking purposes shall be installed at least 4 feet horizontally from, and one foot vertically below, any water main.
- (d) If crossing a pipeline conveying a fluid listed in subsection (a) or (b), a new water main shall be constructed no less than 45-degrees to and at least one foot above that pipeline. No connection joints shall be made in the water main within eight horizontal feet of the fluid pipeline.
- (e) The vertical separation specified in subsections (a), (b), and (c) is required only when the horizontal distance between a water main and pipeline is less than ten feet.

- (f) New water mains shall not be installed within 100 horizontal feet of the nearest edge of any sanitary landfill, wastewater disposal pond, or hazardous waste disposal site, or within 25 horizontal feet of the nearest edge of any cesspool, septic tank, sewage leach field, seepage pit, underground hazardous material storage tank, or groundwater recharge project site.
- (g) The minimum separation distances set forth in this section shall be measured from the nearest outside edge of each pipe barrel.
- (h) With State Board approval, newly installed water mains may be exempt from the separation distances in this section, except subsection (f), if the newly installed main is:
 - (1) less than 1320 linear feet,
 - (2) replacing an existing main, installed in the same location, and has a diameter no greater than six inches more than the diameter of the main it is replacing, and
 - (3) installed in a manner that minimizes the potential for contamination, including, but not limited to:
 - (A) sleeving the newly installed main, or
 - (B) utilizing upgraded piping material

SECTION F

PLAN PREPARATION AND PRESENTATION

1. DRAWINGS

All drawings shall be ink on mylar. The minimum mylar thickness shall be 7 mil (0.007 inch). All plans shall be standard size sheet, 24 inches by 36 inches. The plans shall have a 1-½ inch border on the left side and a ½ inch border on the remaining three sides. A City of Redlands standard title block and revision block shall be located in the lower right corner. Sewer plans shall be on plan and profile paper at the scale of one inch equal forty feet (40') in plan and one inch equals four feet (4') in profile. The profile shall be on the upper half of the sheet, and the plan on the lower half. In all cases, the mylar shall have a matte finish on the front side of the drawing. Diazo mylars produced by a blueprint process are not acceptable for sewer plans.

2. CALCULATIONS

When requested by the City Engineer, the Design Engineer shall submit calculations as may be deemed necessary to evaluate the design. Such calculations may include, but are not limited to; hydraulics of the sewer, ability of the pipe to withstand the anticipated loads, development of the design flows, and alignment of the sewer. All calculations shall be submitted on 8-½ by 11 inch paper and shall be presented in the neat, professional form. Calculations shall bear the Engineer's license number and signature.

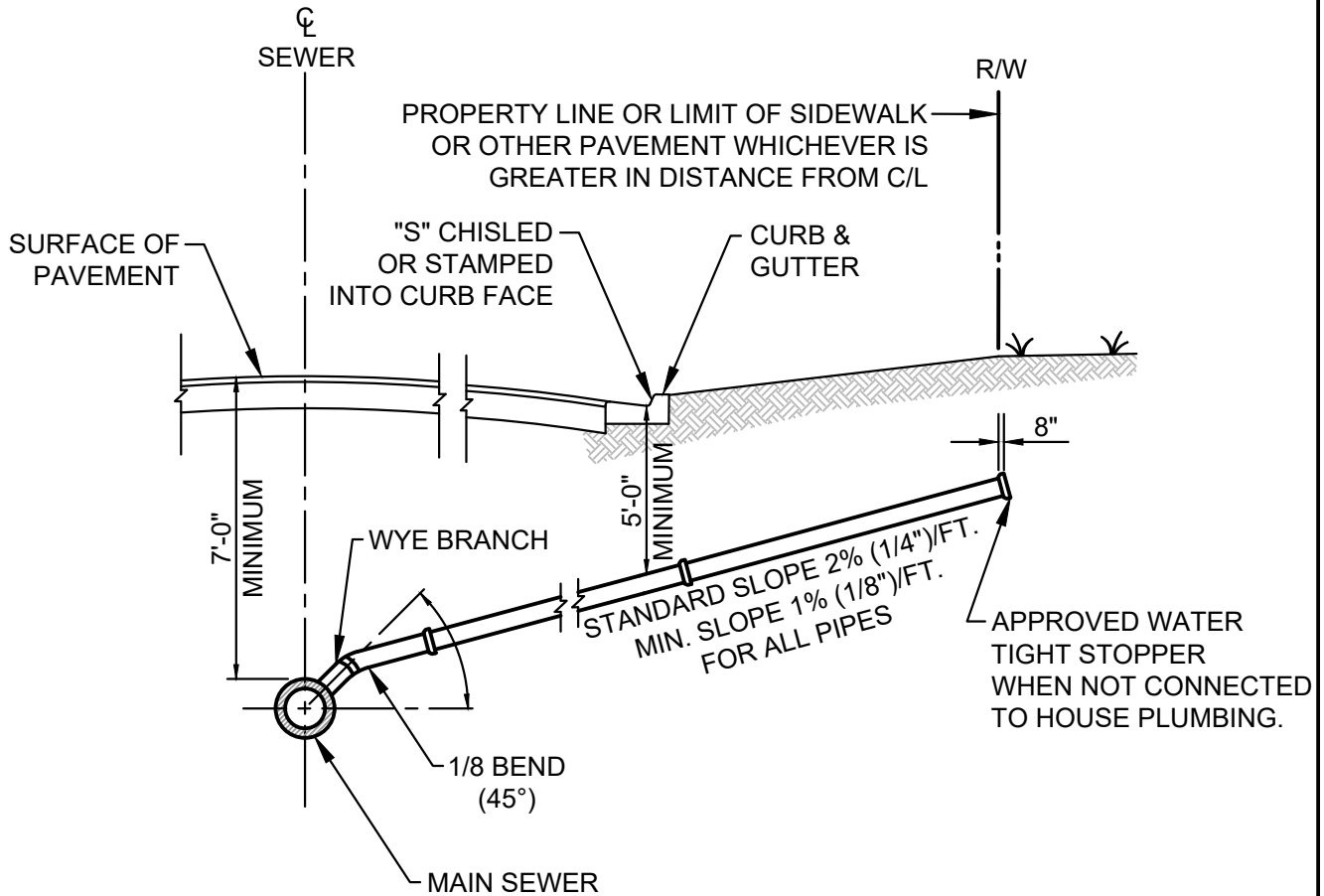
3. MISCELLANEOUS

If other design problems occur which are not covered herein, such as pump stations, siphons, industrial waste treatment facilities, or the like, consult the City.

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APPENDIX
STANDARD DRAWINGS

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NOTES:

- 1) WHERE CURB AND GUTTER IS DESIGNED, BUT NOT INSTALLED, SEWER LATERAL SHALL BE POSITIONED SO THE MINIMUM CLEARANCE WILL BE MAINTAINED UNDER PROPOSED CURB INSTALLATION.
- 2) WHERE CURB AND GUTTER DO NOT EXIST AND ARE NOT DESIGNED, THE LATERAL SHALL BE POSITIONED SO THAT THE MINIMUM COVER AT THE PROPERTY LINE WILL BE 6'-0" AS MEASURED FROM THE CROWN OF THE EXISTING STREET.
- 3) THE CITY SHALL APPROVE THE DESIGN OF LATERALS FOR MULTIPLE FAMILY DWELLINGS, COMMERCIAL LOTS, SCHOOLS AND PLACES OF A GREATER THAN NORMAL HOUSEHOLD WATER USE.
- 4) WHERE SEWER LATERAL CROSS OVER AN EXISTING OR PROPOSED WATER MAIN, CONTINUOUS PIPE SHALL BE USED FOR 10' FROM EITHER SIDE OF WATER MAIN AND SHALL HAVE A 4" MIN. CLEARANCE BETWEEN CROSSING.
- 5) HOUSE CONNECTION TO BE AT RIGHT ANGLES TO MAIN LINE SEWER UNLESS LOCATION OF MAIN SEWER DOES NOT PERMIT.
- 6) MINIMUM SLOPE MUST BE APPROVED BY CITY ENGINEER, SEE PAGE 18.
- 7) VCP OR PVC PIPE SHALL BE USED FOR HOUSE CONNECTION: LATERALS FROM SEWER MAIN TO THE PROPERTY LINE.

Date: 01/03/2023 Drawn: GKD

Scale: Not-to-Scale Revised: GKD

Approved by:

[Signature]
City Engineer

CITY OF REDLANDS

Municipal Utilities & Engineering Department

HOUSE CONNECTION
(SEWER LATERALS)

A-100

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DESIGN THE RADIUS OF
OUTER CHANNEL WALL
AS $\frac{1}{2}$ OF INSIDE DIAMETER
OF THE MANHOLE

24" OPENING ON DOWN
STREAM SIDE OF M.H.

NOTE "A":

48" DIAMETER FOR SEWERS 15"
AND SMALLER, 60" DIAMETER FOR
SEWERS 16" THRU 24" OR AS
SHOWN ON THE PLANS.

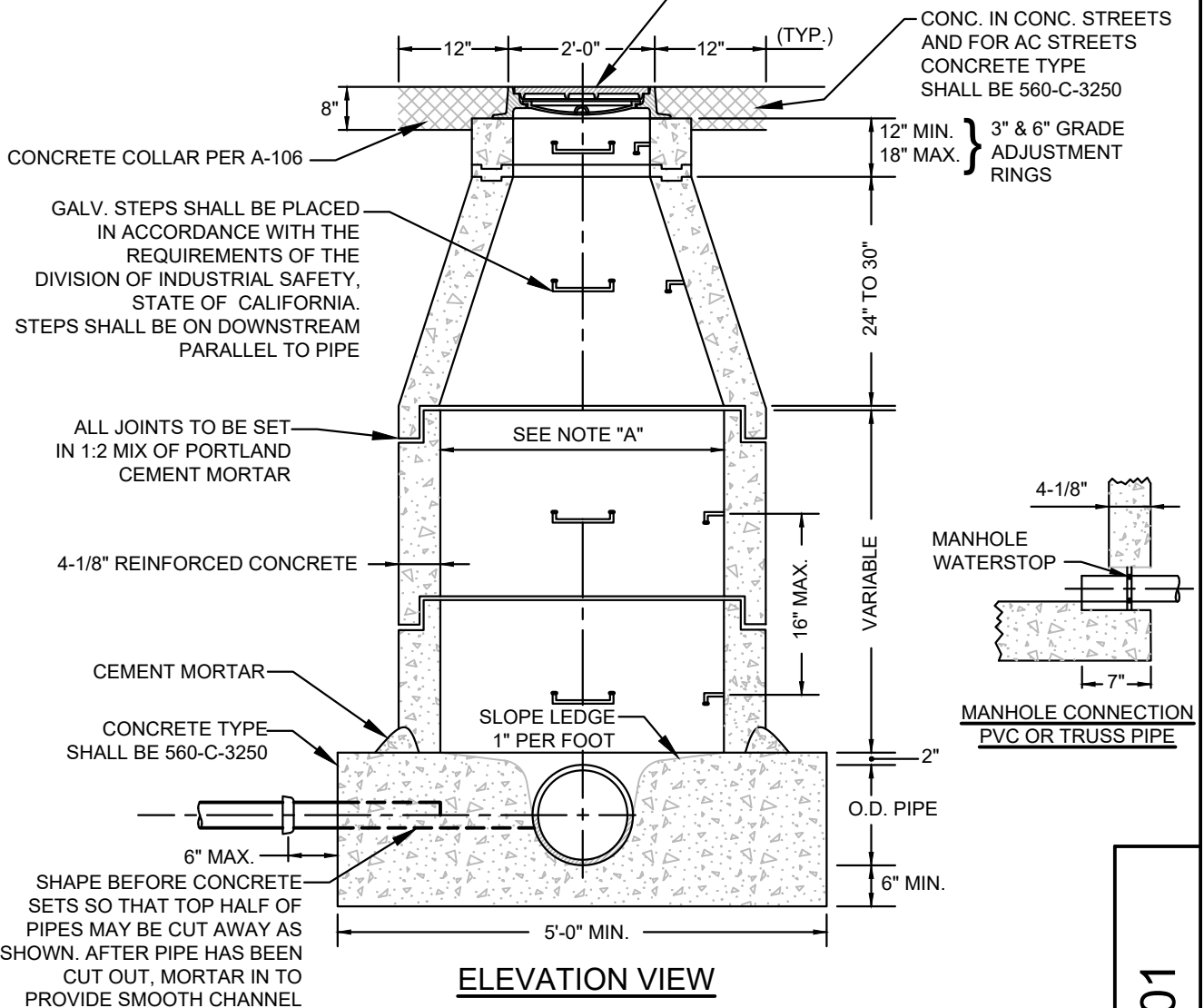
NOTE:

SEWER LATERALS ARE NOT
ALLOWED IN MANHOLES.

MANHOLES LOCATED IN EASEMENTS OR
NATIVE SOIL SHALL BE ELEVATED 12"
ABOVE NATURAL GRADE AND ENCASED
WITHIN A CONCRETE DOME.

CITY OF REDLANDS STANDARD
MANHOLE FRAME AND COVER
MANUFACTURED BY ALHAMBRA
FOUNDRY CO. TYPE A-1170 OR
APPROVED EQUAL.

PLAN VIEW



ELEVATION VIEW

Date: 01/03/2023 Drawn: GKD

Scale: Not-to-Scale Revised: GKD

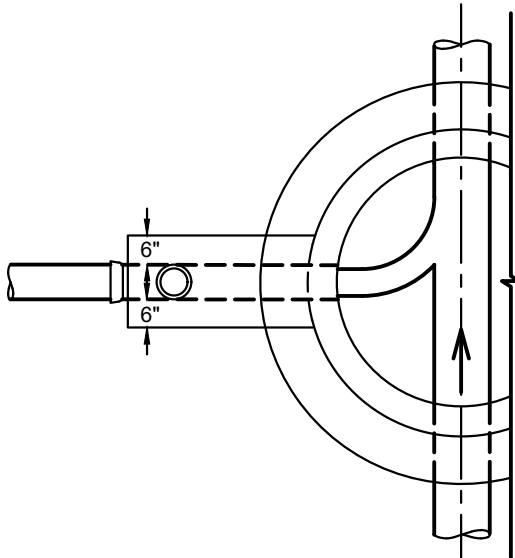
Approved by: 
City Engineer

CITY OF REDLANDS
Municipal Utilities & Engineering Department

STANDARD PRECAST REINFORCED
CONCRETE MANHOLE

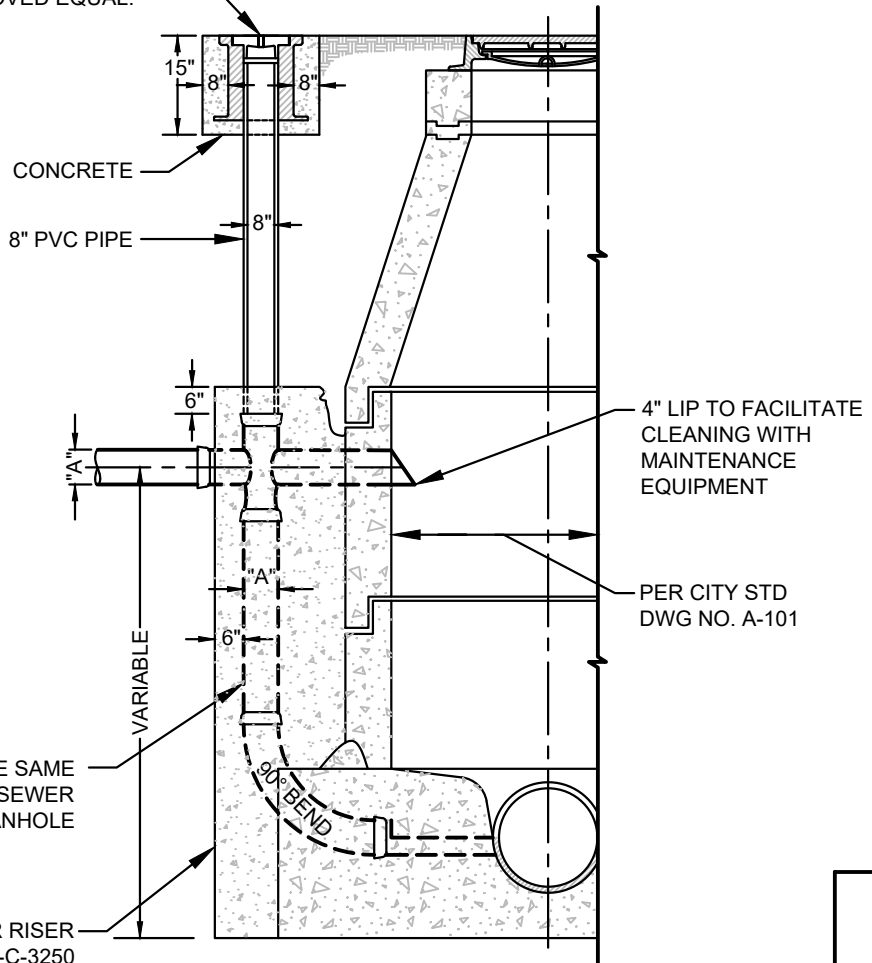
A-101

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PLAN VIEW

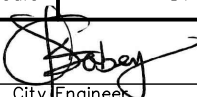
LAMP HOLE FRAME AND COVER
ALHAMBRA FOUNDRY NO. A-1240
OR APPROVED EQUAL.



ELEVATION VIEW

DROP PIPE SHALL BE SAME
DIAMETER "A" AS SEWER
DISCHARGING INTO MANHOLE

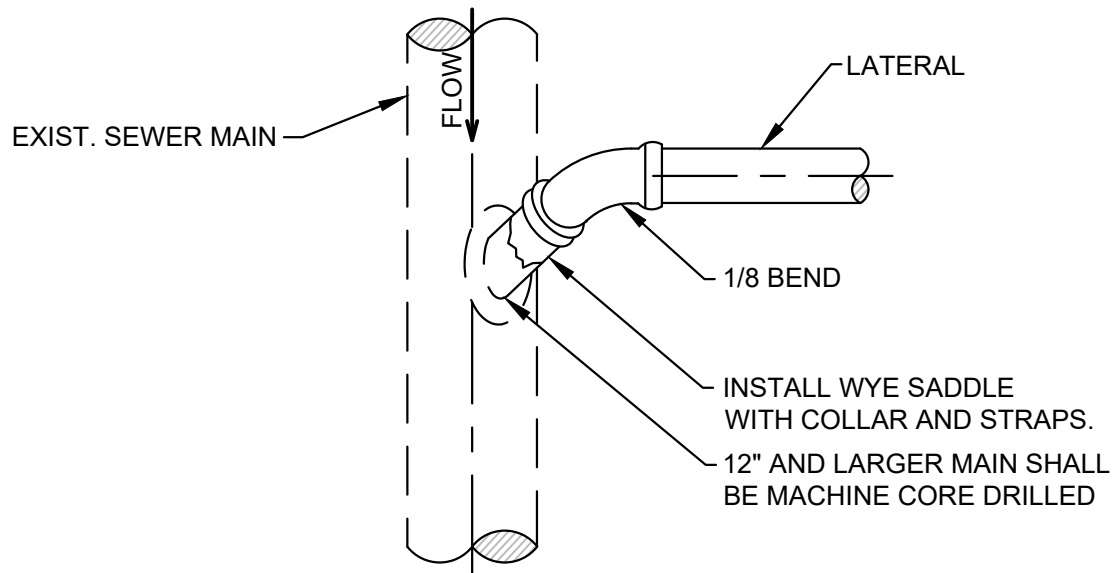
CONCRETE SUPPORT FOR RISER
CONCRETE TYPE SHALL BE 560-C-3250

Date: 01/03/2023	Drawn: GKD	CITY OF REDLANDS Municipal Utilities & Engineering Department DROP MANHOLE
Scale: Not-to-Scale	Revised: GKD	
Approved by: 	City Engineer	

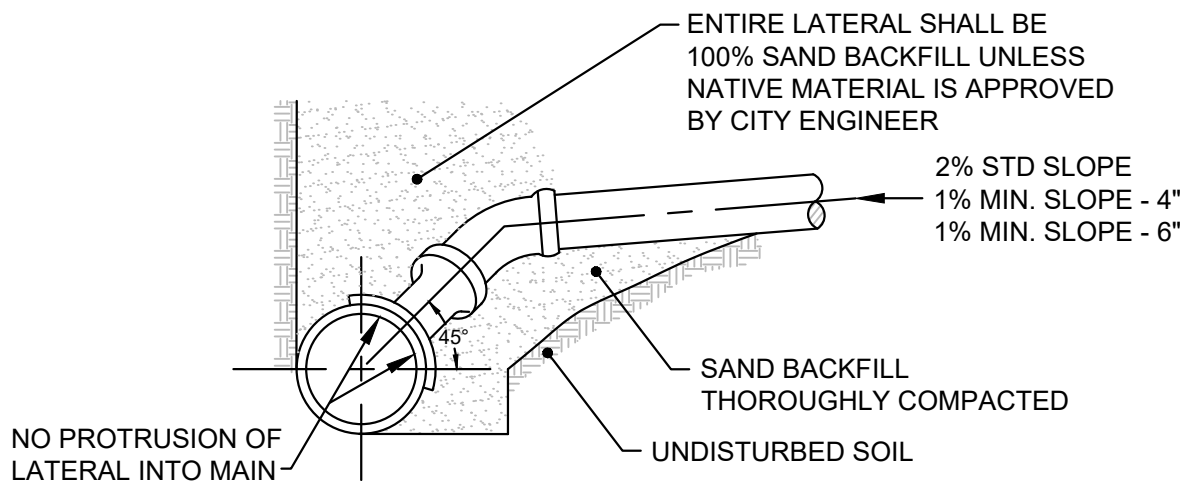
A-102

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INSPECTION: THE CONTRACTOR SHALL SCHEDULE INSPECTION WITH THE CITY. THE TAPPING HOLE AND THE WYE SHALL BE INSPECTED BEFORE THE LATERAL IS CONNECTED AND BEFORE BACKFILL BEGINS.



PLAN VIEW

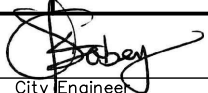


ELEVATION VIEW

NOTES:

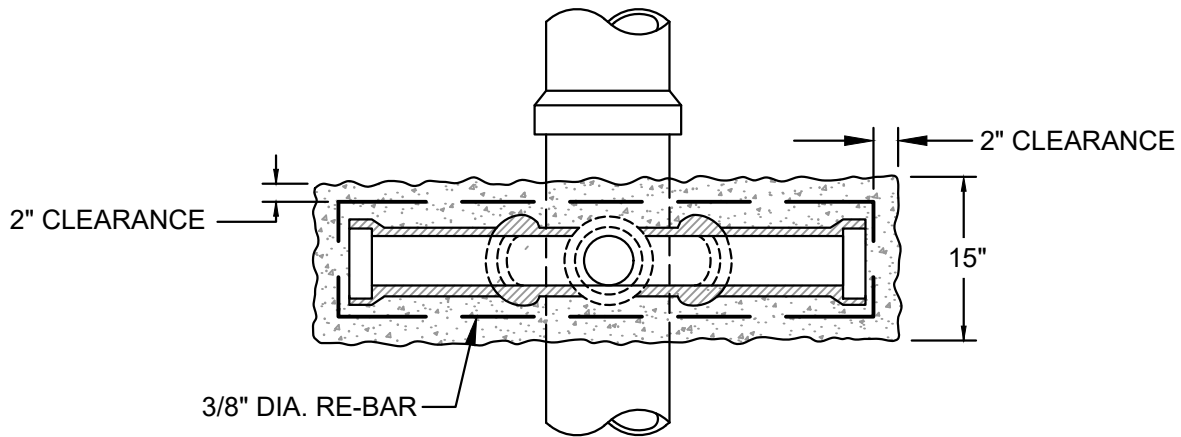
-WHERE SEWER LATERAL SIZE IS EQUAL OR GRATER THAN THE SIZE OF THE SEWER MAIN, A MANHOLE SHALL BE INSTALLED AT THE POINT OF CONNECTION. A WYE MAY BE INSTALLED IN THE MAIN AT THE POINT OF CONNECTION IF FLOW WILL PERMIT AND SUCH CONNECTION IS APPROVED BY THE CITY ENGINEER.

-TAPPING HOLE FOR VCP SHALL BE A CLEAN CUT OVAL WITHOUT SHARP EDGES.

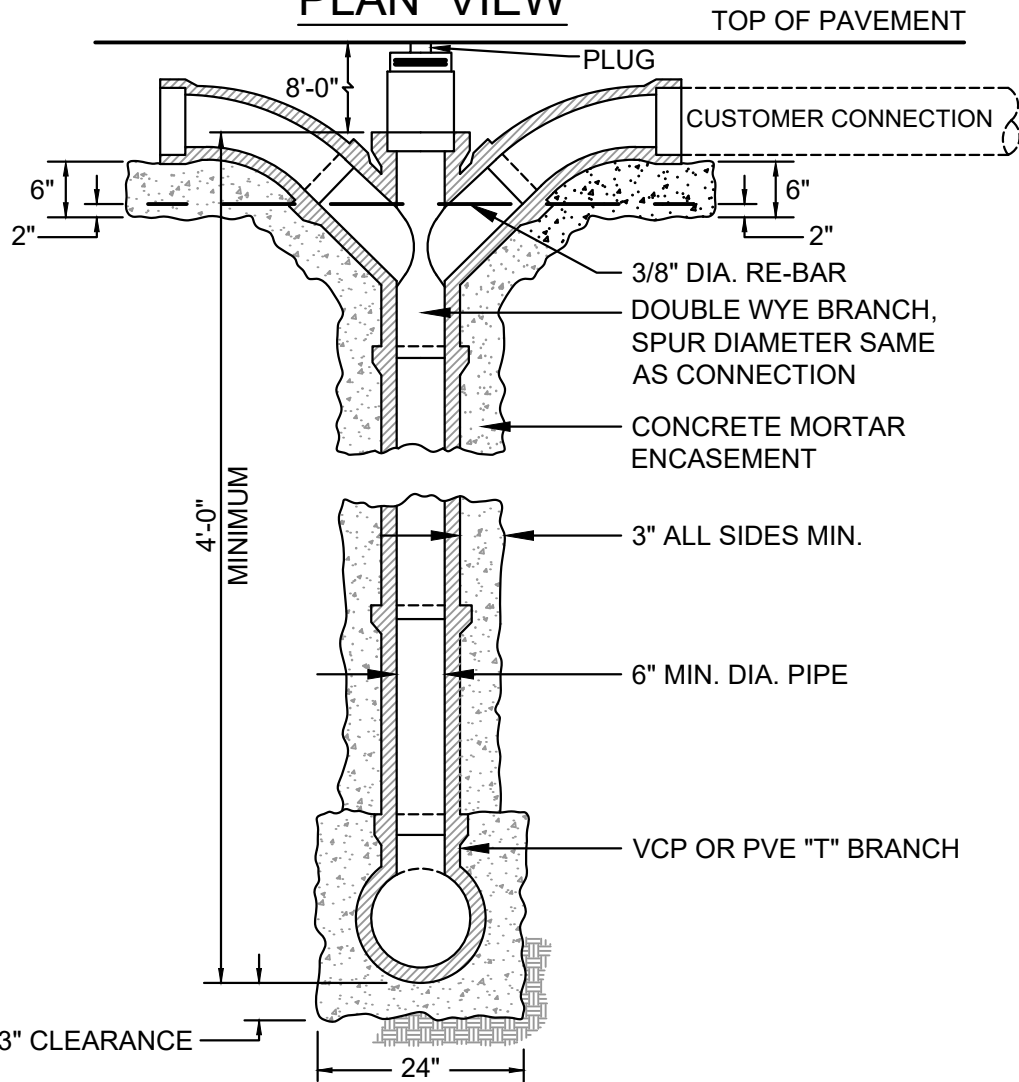
Date: 01/03/2023	Drawn: GKD	CITY OF REDLANDS Municipal Utilities & Engineering Department
Scale: Not-to-Scale	Revised: GKD	
Approved by: 		
City Engineer		TYPICAL WYE – SADDLE INSTALLATION CONNECTION TO EXISTING SEWER MAIN

A-103

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PLAN VIEW



ELEVATION VIEW

Date: 02/20/2020 Drawn: GKD

Scale: Not-to-Scale Revised: GKD

Approved by:

[Signature]
City Engineer

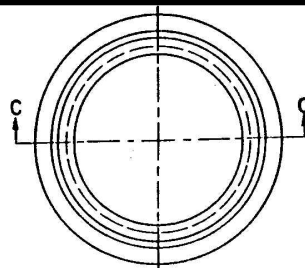
CITY OF REDLANDS

Municipal Utilities & Engineering Department

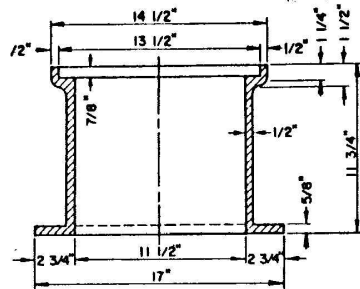
CHIMNEY PIPE

A-104

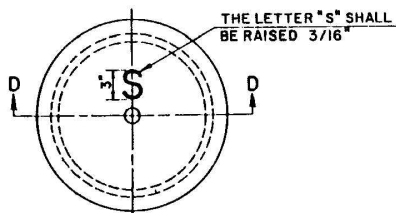
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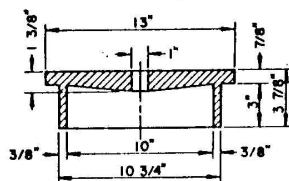
ACCESS FRAME



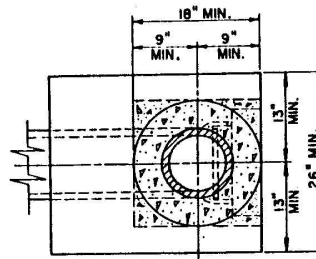
SECTION C-C



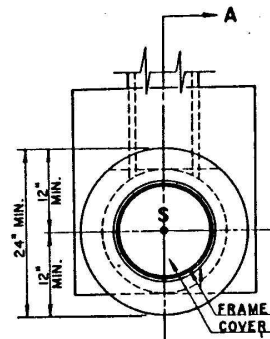
ACCESS COVER



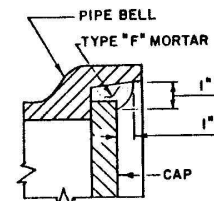
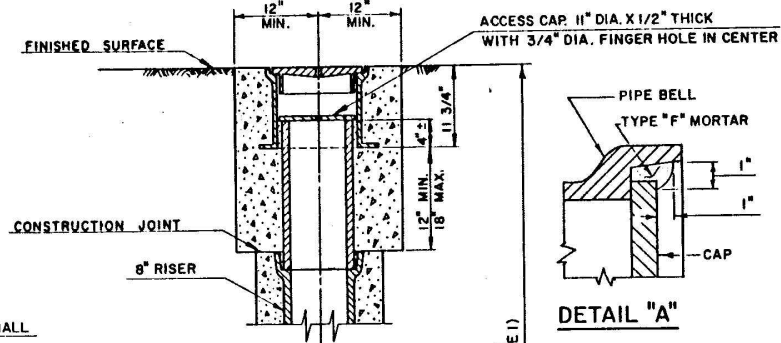
SECTION D-D



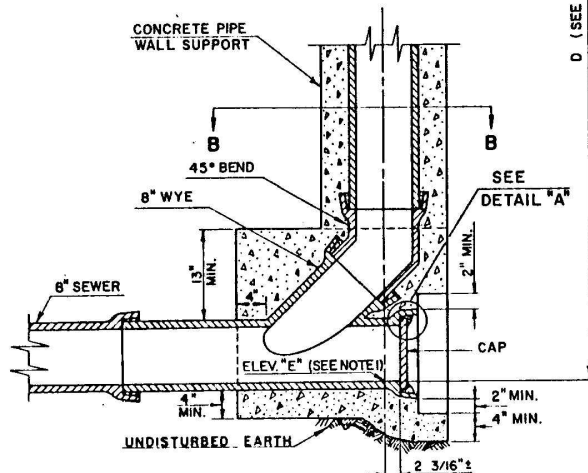
SECTION B-B



PLAN



DETAIL "A"



SECTION A-A

NOTES:

- SEE PLANS FOR VALUES OF DIMENSION 'D' AND ELEVATION 'E'.
- PIPE AND FITTINGS, UNLESS OTHERWISE NOTED, SHALL BE OF THE SAME MATERIALS AS THE SEWER, UNLESS APPROVED ADAPTORS ARE USED, AND MAY BE ANY OF THE FOLLOWING:
 - VC PIPE
 - PE PIPE
 - ABS SOLID WALL PIPE
 - ABS COMPOSITE PIPE
 - PVC PLASTIC PIPE
- PIPE AND FITTINGS SHALL BE BEDDED AND ENCASED IN PCC AS SHOWN. PCC SHALL BE CLASS 450-C-2000(265-C-14). JOIN AND ALIGN PIPE AND FITTINGS BEFORE PLACING CONCRETE. MAINTAIN ALIGNMENT WHILE PLACING AND ALLOWING PCC TO SET.
- THE ACCESS FRAME, COVER AND CAP SHALL BE CAST IRON. THE FINGER HOLES MAY BE DRILLED OR BLOCKED OUT PRIOR TO CASTING. THEY SHALL NOT BE PUNCHED OUT.
- THE CONTRACTOR MAY PLACE EITHER CIRCULAR OR SQUARE CONCRETE PIPE WALL SUPPORTS.

Date: 01/03/2023 Drawn: GKD

Scale: NONE Revised: GKD

Approved by:

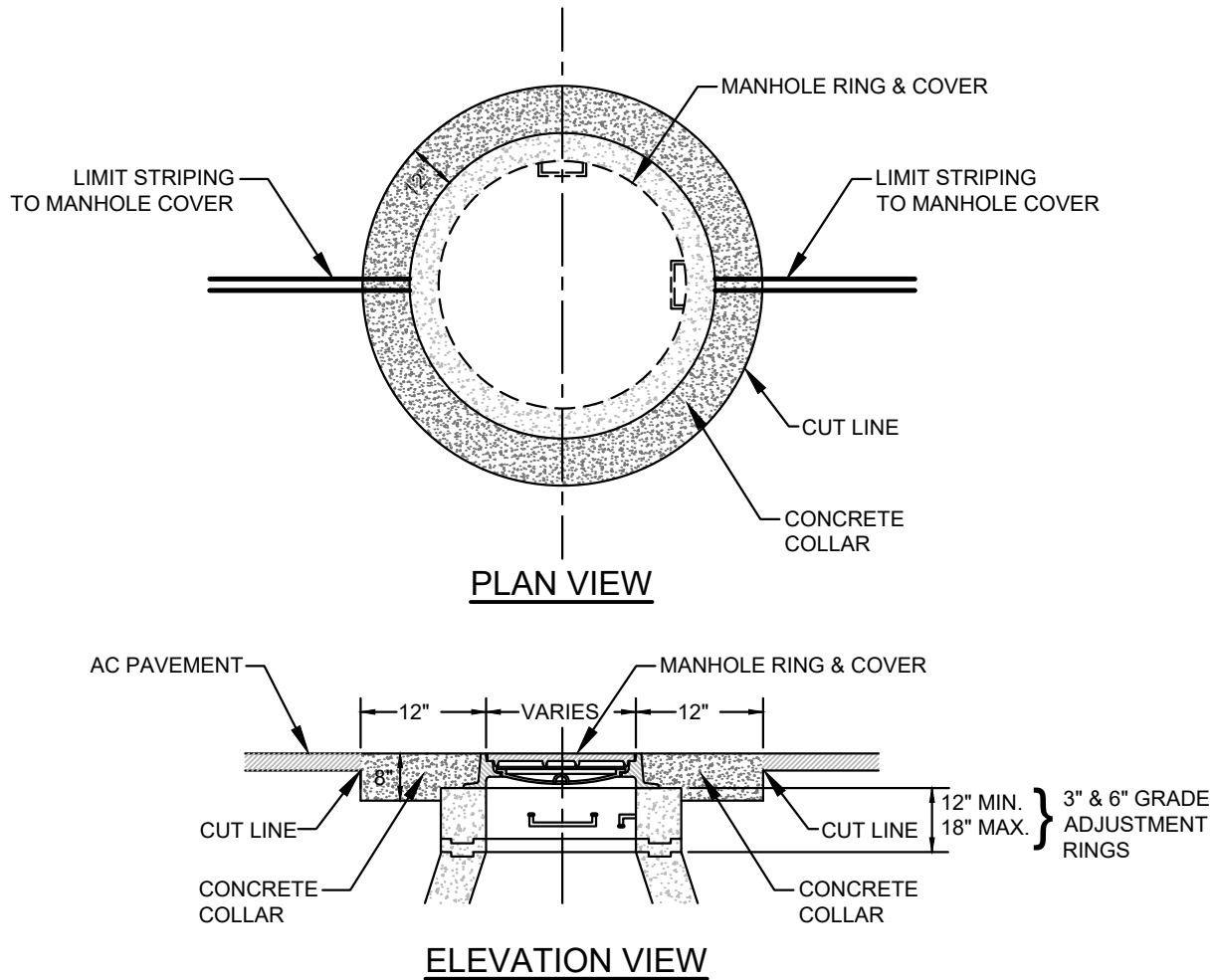
[Signature]
City Engineer

CITY OF REDLANDS
Municipal Utilities & Engineering Department

STANDARD CLEANOUT

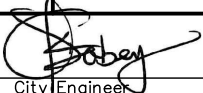
A-105

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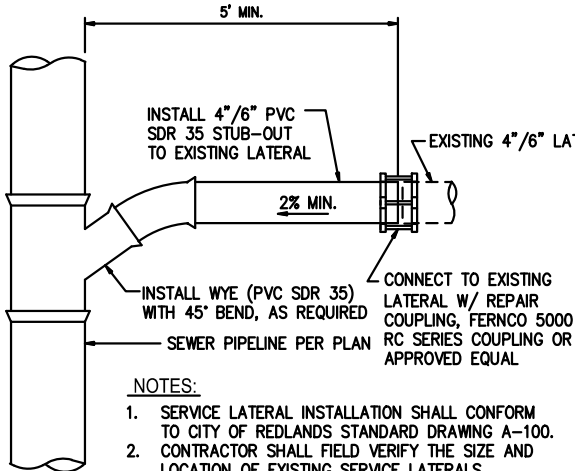
NOTE:

1. SAW CIRCULAR AROUND MANHOLE 12" FROM MANHOLE FRAME.
2. MANHOLE SHALL BE MARKED PRIOR TO CUT THE PAVEMENT.
3. RAISE MANHOLE FRAME AND COVER TO FINISH GRADE BY INSTALLING CONCRETE RINGS AND LEVELING MORTAR.
4. BACKFILL WITH PCC CONCRETE TO FINISH GRADE.
5. CONCRETE TYPE SHALL BE 560-C-3250.
6. ADD QUIKRETE LIQUID CEMENT COLOR - CHARCOAL BLACK.
7. PROTECT FROM TRAFFIC LOADING UNTIL CONCRETE HAS CURED.
8. APPLY TACK COAT TO EDGES OF EXISTING PAVEMENT BEFORE INSTALLATION PATCH.
9. COLLARS ARE REQUIRED FOR ALL PAVED TRAVEL WAYS.

Date: 01/03/2023	Drawn: GKD	CITY OF REDLANDS Municipal Utilities & Engineering Department
Scale: NONE	Revised: GKD	
Approved by: 		CONCRETE COLLAR

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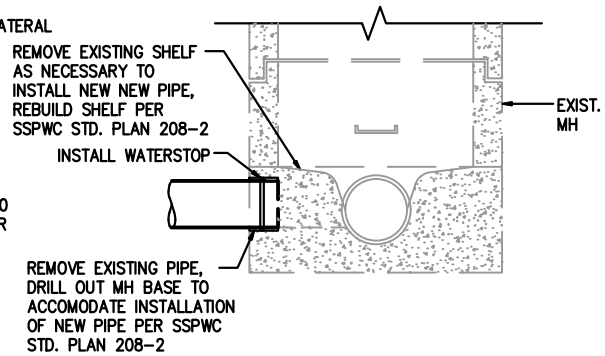


NOTES:

1. SERVICE LATERAL INSTALLATION SHALL CONFORM TO CITY OF REDLANDS STANDARD DRAWING A-100.
2. CONTRACTOR SHALL FIELD VERIFY THE SIZE AND LOCATION OF EXISTING SERVICE LATERALS.
3. THE LOCATION OF SERVICE LATERALS SHOWN ON THE PLAN ARE FOR REFERENCE ONLY.
4. ALL SERVICE LATERALS, SHOWN ON THE PLANS OR NOT, SHALL BE REINSTALLED UNLESS OTHERWISE DIRECTED BY THE CITY.

SERVICE LATERAL CONNECTION DETAIL

NOT TO SCALE

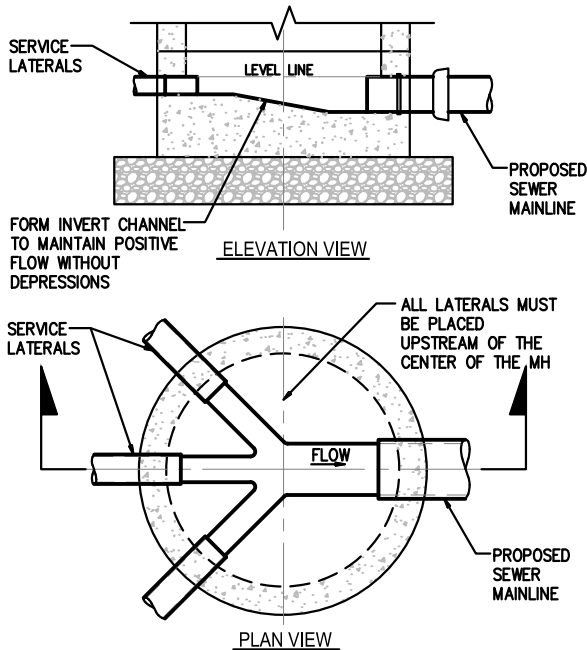


NOTES:

1. ORIENTATION OF INLET/OUTLET MAY VARY FROM WHAT IS SHOWN.
2. CONTRACTOR SHALL BE RESPONSIBLE FOR ANY DAMAGE TO EXISTING MAHNOLE, PIPES, BASE OR SHELF.

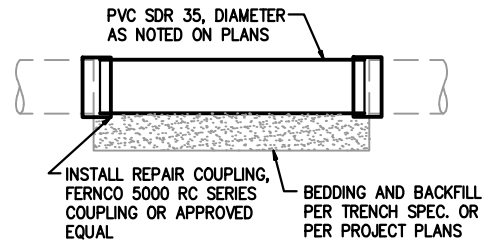
EXISTING MANHOLE CONNECTION DETAIL

NOT TO SCALE



TERMINUS MH WITH LATERALS DETAIL

NOT TO SCALE



NOTES:

1. ADJUST CONNECTION TO MINIMIZE OFFSET AT PIPE FLOWLINE CONNECTION.
2. NEOPRENE REDUCER BUSHING MAY BE REQUIRED TO MINIMIZE OFFSET AT CONNECTION POINT.
3. NO CONNECTION WILL BE ALLOWED AT BELL END OF VCP, CUT BELL OFF VCP PRIOR TO MAKING CONNECTION.
4. CONTRACTOR SHALL ENSURE ALL DAMAGED AREAS OF PIPE ARE REMOVED AND REPLACED WITHIN DISTANCE SPECIFIED ON PLANS.
5. IF ADDITIONAL REPAIR DISTANCE IS REQUIRED ABOVE WHAT IS SHOWN ON PLANS, NOTIFY CITY PRIOR TO COMPLETING WORK.

TYPICAL SPOT REPAIR DETAIL

NOT TO SCALE

Date: 01/03/2023 Drawn: GKD

Scale: NONE Revised: GKD

Approved by: 
City Engineer

CITY OF REDLANDS
Municipal Utilities & Engineering Department

MISCELLANEOUS DETAILS

A-107

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City of

REDLANDS

"A CITY THAT WORKS"