CHAPTER 6 – DESIGN CRITERIA FOR GRAVITY SEWER LINES AND APPURTENANCES

Engineer will submit a rough layout of system for review and approval by the City Engineer prior to preparation of improvement plans.

1. SEWER MAIN DEPTH AND SIZE

   A. Sewer main depth and size shall be as shown below unless approved by the City Engineer.

   B. Minimum depth, finish grade to top of pipe 6 feet

   C. Maximum depth, finish grade to top of pipe 15 feet

   D. Design calculations shall be submitted to verify size and bedding design. (Manning "N" PVC = 0.011 is norm).

   E. Minimum size of mainline shall be 8".

   F. 6" main line will be allowed on cul-de-sac streets with a maximum of 10 units.

   G. All sewer laterals and main line invert elevations shall be shown in profile on the improvement plans and shall include stations, slope, and distance.

   H. All sewer mains over 15" in diameter shall require special design and City Engineer approval.

2. SEWER LATERAL DEPTH AND SIZE

   A. 4" minimum diameter for single-family residence.

   B. 6" minimum diameter for all other use.

   C. Desirable depth at property line is 5 feet (top of pipe to finish grade @ top of curb).

3. PIPELINE MATERIAL TYPES

   A. Gravity sewer pipe and fittings shall have PVC conforming to ASTM D3034 for diameters 4" – 15" and ASTM F 679 for 18" – 24", with integral-bell gasketed joints (gasket and spigot end joint design). Pipe shall be made of PVC plastic having a cell classification of 12454-B or 12364-B as defined in ASTM D 1784 and shall have SDR of 35 and a minimum stiffness of 46 psi according to ASTM D 2412.

   B. All fittings and accessories shall be as manufactured and finished by the pipe supplier or approved equal and have bell and spigot configurations compatible with that of the pipe.

C. PVC pipe joints shall be elastomeric gasket joints type conforming to Standard Specifications for Public Works (Greenbook) most recent edition. Rubber gaskets shall be factory installed and conform to ASTM F 477. Pipe joints shall have been tested and meet watertight performance requirements of ASTM D 3212, "Joints for Pipe Using Flexible Elastomeric Seals."

D. PVC C-900 shall be used for gravity sewer pipelines with depths equal or greater than 15 feet.

E. Use of other pipe and fitting materials and types may be required by the City Engineer to meet specific conditions during design or construction.

F. Service connections to the sewer main shall be watertight and not protrude into the sewer pipe. All materials used to make the service connections shall be compatible with each other and with the pipe material to be joined and shall be corrosion proof.

G. Couplings used for repair, or transition to dissimilar pipe materials shall be approved by the City Engineer and provide corrosion proof watertight seal.

4. DESIGN PARAMETERS FOR SEWER MAIN SLOPE, FLOW AND DEMAND

A. Gravity sewer pipelines shall be designed for a minimum velocity of 2 feet/second. Velocity unless otherwise stated shall be calculated from peak dry weather flow.

B. Pipeline slopes shall satisfy the minimum velocity requirement aforementioned. Maximum velocities greater than 10 ft/second should be avoided.

Slopes for Specific Pipe Sizes 8 through 12-inch diameter:

1)	8" minimum	0.40%	desirable	0.50%
2)	10" minimum	0.28%	desirable	0.40%
3)	12" minimum	0.21%	desirable	0.30%

Slopes for larger than 12-inch diameter pipe shall be designed to meet flow and velocity criteria and require specific approval of the City Engineer. Pipelines with horizontal curvature will require increase slope to achieve minimum required velocities.

C. 10" and smaller depth of peak flow ½ diameter
12" and above depth of peak flow ¾ diameter

D. Gravity pipelines with diameters of 12" and less shall be designed to flow at depths of 0.5D during peak flow. Gravity pipelines with diameters greater than 12" shall be designed to flow at depths of 0.75D during peak flow.

E. Flowrate Generation

1) An Equivalent Dwelling Unit (EDU) = 220 gal/day, Average Daily Flow (ADF)

2) A peaking factor (PF) of 2.5 multiplied times the ADF shall be used to determine Peak Daily Flows (PDF). PDF = ADF x 2.5

a) Residential: Single Family Residence = 1 EDU

b) Commercial Property: 1 EDU/1,800 ft^2 (building space)

i) To convert raw land to square feet of building space, assume 30% coverage. This could vary significantly dependent development constraints.

ii) To convert improved pads to square feet of building space, assume 40% of coverage.

3) Industrial Property: 1 EDU/5,000 ft^2 (warehouse space)
1 EDU/1,800 ft^2 (office space)

a) To convert raw land to square feet of building space, assume 30% coverage. This could vary significantly dependent issues such as environmental restrictions.

b) To convert improved pads to square feet of building space, assume 40% of coverage.

c) Assume 60% of building space is warehouse, and 40% is office space.

5. HORIZONTAL AND VERTICAL LAYOUT

A. Streets: See City of Carlsbad Standard Drawing No. GS6 for location.

B. Alley: Main to centerline shall be a minimum of three feet (3') offset.

C. Private Street: Shall require special design and conditions. Easement shall be 20 feet.

D. Horizontal Curve: SDR 35, PVC pipe may be curved horizontally with the following limitation:

Pipe Diameter (SDR 35)	Minimum Radius of Curvature
6-inch	150 feet
8-inch	200 feet
10-inch	250 feet
12-inch	300 feet
15-inch	375 feet
18-inch	450 feet

City Engineer shall approve curvatures for larger diameter pipe.

E. Vertical Curve: Vertical curves shall be permitted only when specifically approved by the City Engineer. A detailed design drawing shall be required for review and approval.

F. Utility Clearances: Show all underground utilities in both plan and profile. Provide minimum separation per the State Department of Health Services "GUIDANCE MEMO NO. 2003-02: GUIDANCE CRITERIA FOR THE SEPARATION OF WATER MAINS AND NON-POTABLE PIPELINES".

G. Access Holes: Maximum spacing between holes is 350 feet.

1) All standard access holes shall be a minimum of five feet (5') in diameter with no steps.

2) Install access holes at all changes of slope that exceeds 2% and show inlet and outlet inverts on all access holes.

3) Install access holes at all changes in horizontal direction.

4) Install access holes at all intersections of mains.

5) Install access holes at changes of pipe sizes.

6) Install access holes at the end of all sewer mains.

7) Access holes shall be sequentially numbered on the plans with access hole numbers beginning at the lowest invert. Two-foot stubs shall be provided for future tie-ins and main extensions.

8) Access holes shall be PVC lined per Std. Dwg. S1A when: depth is 15-feet or greater; slope of sewer pipe coming into the access hole is greater than 5%; all force main discharge access holes; the immediate upstream and downstream access holes of inverted siphons; drop access holes; on sewer lines 15-inch and greater; when required by the City Engineer.

9) Install access holes for all lateral connection in pipelines 15-inch diameter and larger.

10) When intercepting flows from smaller pipelines in access holes, set invert of a smaller main at ¾ of the depth of the larger main.

H. Cleanouts: Extend beyond permanent pavement when street is a temporary dead end. See Standard Drawing No. S6 for type of cap and box.

I. Laterals: Laterals shall be constructed per Std. Dwg. No. S7. Minimum horizontal distance from water service, fire hydrants, light standards, electrical transformers, etc., is 5 feet. Desirable horizontal distance is 10 feet.

1) Install at right angle or radial to the main.

2) Laterals shall <u>not</u> be located in driveways.

3) No connections shall be permitted on laterals other than provided in Standard Drawing No. S7.

4) Location of property cleanout: See Standard Drawing No. S7.

J. Steep Slope Protection:

1) A detail drawing of the anchor shall be provided for City Engineer's approval prior to construction. Sewer pipelines on 20 percent slopes or greater shall be anchored securely with concrete, or equal anchors, spaced as follows:

a. Not over 36 feet center to center on grades 20 percent and up to 35 percent;

b. Not over 24 feet center to center on grades 35 percent and up to 50 percent; and

c. Not over 16 feet center to center on grades 50 percent and over.

2) Erosion control of sloped trenches shall be provided with approved cut-off wall (RSD S-10, Type A).

6. PRECAST CONCRETE ACCESS-HOLES

A. All precast access-holes shall meet the appropriate specifications, ASTM C478, Concrete and ASTM A48, Gray Iron Castings.

B. Precast reinforced concrete access hole riser and tops shall be constructed of Class A concrete and shall conform to the Specifications of ASTM C478, except as herein modified. The minimum allowable steel shall be hoops on No. 4 wire, to be cast into each unit at adequate places as a precautionary measure for handling. Access-hole components shall be designed for H-20 highway loads and site sole conditions. The minimum nominal shell thickness for formed and vibrated sections shall be 1/8 of the internal diameter of the riser or largest cone diameter. Access-holes shall be fabricated only from eccentric taper sections and standard cylinder units of the proper internal diameter. Access-hole sections shall be cast without galvanized steel ladder rungs.

C. Drop access-holes, if approved by the City Engineer, shall conform to the applicable provisions of the specifications for precast access-holes (including frames and covers).

D. Access-hole frames and cover sets shall conform to the requirements of gray iron castings in ASTM A48 for Class 30 castings. Frames and covers shall be designed for H-20 loading. Castings shall be smooth, clean, and free from blisters, blowholes and shrinkage. Mating surfaces of the frame and cover shall be machined to prevent movement of the lid. Frames and covers shall be match marked in sets before shipping to the site. All castings shall be dipped twice in a preparation of asphalt or coal tar and oil applied at a temperature of not less than 290°F nor more than 310°F and in such a manner as to form a firm and tenacious coating. Covers shall have the words "CITY OF CARLSBAD" and "SEWER" cast into the cover. No other lettering on the topside will be permitted.

E. The access-hole base shall be poured in place against undisturbed soil with Class "A" Portland cement concrete. The access-hole stubs and sewer main shall be set before the concrete is placed and shall be rechecked for alignment and grade before the concrete has set. The various sized inlets and outlets to the access-hole shall be located as indicated on the Approved Plans. The access-hole base shall extend 12 inches below the bottom of the lowest pipe. Invert elevations of connecting sewers may vary depending upon sizes. When intercepting flows from smaller pipelines in access holes, set invert of the smaller mains at ¾ of the depth of the larger main. The invert of the access-hole base shall be hand worked so as to provide channels conforming in size and shape to the lower portions of the inlets and outlets. The channel shall vary uniformly in size and shape from inlet to outlet and be constructed higher than pipe as indicated on the Approved Plans. The manhole invert channels shall be smooth and accurately shaped. Channels may be formed directly in the concrete base. All transitions shall be smooth and of the proper radius to give an uninterrupted transition of flow. The concrete base shall be shaped with a wood float and shall receive a hard-steel trowel finish prior to the concrete setting. In the event additional mortar is required after initial set has taken place, the surface to receive the mortar shall be primed and the mortar mixed with "Willhold Concrete Adhesive" in the amounts and proportions recommended. The bases shall set a minimum of 24 hours before the access-hole construction is continued.

F. Straight through channels in access holes with no tributaries may have SDR 35 PVC pipe installed through the access hole. The top section of pipe shall be removed flush with top of shelf. All cuts shall be neat and dressed minimizing burrs and rough edges.

G. Each access-hole section shall be set in a bed of mortar with butyl rubber sealant rope (Std Dwg S1A) to make a watertight joint, shall be neatly banded and the inside and outside and shall be set plumb. Sections of various height grade rings shall be used in order to bring the top of the access-hole ring and cover to the elevation on the Approved Plans, but limited to a maximum of 18 inches of grade ring. The precast concrete access-hole rings shall be jointed with a minimum thickness of ½ inch of Portland cement mortar along with butyl rubber sealant rope. Mortar shall be composed of one part Portland cement to two parts clean well-graded sand of such size that all pass a No. 8 sieve. Preformed, cold applied ready-to-use plastic joint sealing compound may be substituted for mortar between units and shall be used when ground water is encountered. The finished elevations at which the access-hole frames and covers are to be set shall conform to the requirements set forth in the Approved Plans. Where the frame and cover are in existing pavement or in the traveled way of the existing road shoulder, it is to be placed flush with the existing surface. When the structure is outside the limits of the traveled shoulder but not in the roadside ditch, it should be placed 1/10-foot above the existing ground surface. Where the access-hole cover falls in the existing roadside ditch or easement right-of-way "offsite", it is to be placed approximately 6-inches above the existing ground surface. Access-hole frames shall be set at the required grade and shall be securely attached to the top precast access-hole shaft unit with a cement-mortar bed and fillet. After the frames are securely set in place, covers shall be installed and all necessary cleaning and scraping of foreign materials from the frames and covers shall be accomplished to ensure a satisfactory fit.

H. Sewer pipe shall be furnished and installed in access-holes per the Approved Plans. All stubs shall be plugged with stoppers or brick wall plugs. Where new construction is started at the stub of an existing access-hole, the Contractor shall brick the opening into the access-hole before they remove the plug or stopper from the stub. Said bricked opening shall remain in place until the Contractor has tested and completed the work.

I. Brick and mortar bulkheads shall be installed by the Contractor at the downstream end of all unused stub channels over 5-feet in length to prevent the creation of a septic condition resulting from ponding of sewage and debris in the unused channels until the access-hole stub is connected and normal sewage flow can occur. On short stubs a plug will be required.

J. To prevent the accidental use of the new sewer prior to completion and acceptance, the inlet to existing tie-in access-holes shall be sealed with mortar. The City Engineer or their representative shall approve the installation of these plugs. Plugs shall be removed at the time of final inspection or as directed by the City.

K. Damp-proof material shall be applied, when ground water is present or anticipated and at the discretion of the City Engineer, to the exterior surfaces of access-holes in accordance with the manufactures recommendations. The material shall be applied to all exterior surfaces below a point one foot above the water table or indications of seepage or moisture as directed the City Engineer. Use water-proofing material for exterior surface when below ground water, per Std Dwg S1A or as required by City Engineer.

L. Selected clean backfill material shall be used around all access-holes. It shall be compacted by pneumatic tampers to obtain a relative density of 95% in the upper pipe zone, unless otherwise specified on the Approved Plans. See Standard Drawing No. S5.

M. A Class A concrete ring shall be cast around access-hole frames to within 3” of finished grade and capped with asphalt, as shown on the Approved Plans. The ring shall be placed after the final grading or paving together with the final cleanup.

7. <u>PVC LINED ACCESS-HOLES</u>

A. All access-holes on sewer lines 15” and larger, all drop access-holes, regardless of size and all force main terminal access-holes shall be PVC lined, including the bench.

B. All access-holes with sewer lines with a slope of 7% or greater will be PVC lined.

C. Where there is a slope change from steep to flat of 5% or greater the access hole at the grade change and the next access-hole upstream will be PVC lined.

D. Precast shaft sections, cone sections and grade rings on PVC lined access-holes shall have an integrally cast PVC T-shaped liner of 0.065” minimum thickness.

8. WATER-TIGHTNESS OF ACCESS-HOLES

A. It is the intent of the City of Carlsbad that all access-holes and appurtenances be water tight and free from infiltration. All access-hole joints shall use butyl rubber sealant material to provide water tight seal. Where access-holes are to be given a protective lining or coating, they shall be free of any seeping or surface moisture. The adequacy of access-holes and appurtenances as to water tightness shall be determined by the City Engineer or their representative and shall be tested by vacuum test of filling with water. Sections of access holes below ground water levels or anticipated ground water levels shall have sealant material installed on the external surface per Std Dwg S1A.

9. VACUUM TESTING OF ACCESS-HOLES

A. At the City Engineers option, access-holes that are PVC lined or when ground water is present or anticipated may be vacuum tested.

B. Vacuum testing equipment shall be as manufactured by P.A. Glazier, Inc. or approved equal.

C. Access-holes shall be tested after assembly and prior to mortaring the joints or backfilling. In case of access-holes incorporating a PVC liner, the testing is to take place prior to mortaring the joints, welding the linear seams between sections or backfilling.

D. All lift holes shall be plugged with an approved grout prior to testing. All pipes entering the access-hole shall be plugged and bracing installed to prevent the plug from being drawn into the access-hole. The test head shall be placed inside the top of the cone section and the seal inflated in accordance with the manufacture's recommendations. A vacuum of 10 inches of mercury shall be drawn. The time shall be measured for the vacuum to drop 9-inches. The access-hole shall pass the test if the time taken for the drop is greater than 60 seconds. If the access-hole fails the test, necessary repairs shall be made and the test repeated until acceptable results are obtained. The leak(s) shall be located and repaired, according to their nature, with material-in-kind.

10. PULL-TESTING OF PVC-LINED ACCESS-HOLES

At the City Engineers request, PVC-lined access-holes shall have field-welded joints pull tested. Field welds shall withstand a pull test of at least 100 pounds per linear inch applied perpendicularly to the concrete surface for a period of one-minute without evidence of cracks or separation. This test shall be conducted at a temperature of 70°F to 80°F, inclusive.

11. HOLIDAY TESTING OF PVC-LINED ACCESS-HOLES

PVC-lined and polyurethane coated surfaces shall be holiday tested with an electrical holiday detector as manufactured by Tinker and Rasor (model No. AP-W with power pack) with the instrument set at 20,000 volts and used as directed by the City Engineer. All imperfections identified on the PVC lining and polyurethane coating shall be repaired with materials-in-kind and the test shall be repeated until no holidays are evident

12. CONNECTIONS TO EXISTING ACCESS-HOLES

New connections to existing access-holes where stubs have not been provided shall be made by core drilling through the walls and base as directed by the City Engineer or their representative. If intercepting flows from smaller pipelines in access holes, set invert of a smaller main at ¾ of the depth of the larger main. Special care shall be used to facilitate the flow when forming the tributary channel into the existing channel.

13. SEWER PIPE INSTALLATION

The Contractor shall furnish and install pipe, specials, fittings, closure pieces, supports, gaskets, jointing materials and all other appurtenances as shown and as is required to provide a complete and workable installation. Pipe installation shall be as recommended in UNI-B-5 except as modified and as shown on the Approved Plans.

A. Install pipe according to the manufacturer's approved order of installation and to the proper lines and grades as shown on the Approved Plans.

1) Pipe shall be installed with pipe bells up-grade. Lay pipe uphill if the grade exceeds ten percent (10%).

2) Installation tolerances for pipe installation shall not vary more than 2" horizontally and 1" vertically from the alignment and elevations shown on the Approved Plans.

3) Avoid reverse slopes: Any pipeline installed with reversed slope, as evidenced by ponding of water or sag, is not allowed. Such pipeline shall be removed and replaced at the proper line and grade to the nearest upstream and downstream sewer structure.

B. The pipe shall have firm bearing along its full length and bell holes shall be provided at each joint to permit visual inspection of the joint and prevent the pipe from being supported by the bell end or the coupling.

C. Pipe curvature shall comply with design requirements specified under 5. Horizontal and Vertical Layout. Mechanical means should not be used to accomplish bending. Bending should be done manually by workers in the trench. Curvature will be accomplished by bending the pipe rather than deflecting joints, with pipe lengths first assembled in a straight line and then offset.

D. PVC wyes shall be located as shown on the Approved Plans and in accordance with the Standard Drawings. Wyes shall not be placed closer than 5 feet from the exterior of any structure such as access-holes.

E. When the work requires and the size of the pipe allows entry of personnel into the pipe, the Contractor shall comply with all Federal and State Regulations for confined space entry. Work inside the pipelines shall not be undertaken until all tests and safety provisions of the Code of Federal Regulations 1910.146 and the General Safety Orders of the California Code of Regulations, Title 8, Section 5159 for confined space entry have been performed and the area is verified as safe to enter.

14. SEWER LATERALS

A. The Contractor shall install sewer laterals using wye fittings sized and located as shown on the Approved Plans.

B. All sewer laterals shall run perpendicular from the sewer main to property line. They shall be bedded, backfilled and compacted in the same manner as the sewer main they're connected to.

15. SEWER PIPE CLEANING

A. All sewer pipe shall be thoroughly flushed with clean water, from access-hole to access-hole with an appropriately sized inflatable ball.

B. All construction debris and water shall be removed from each access-hole prior to removal of expandable plugs.

C. Water used in flushing the new sewer mains and laterals shall not be discharged into the existing sewer system.

16. MANDREL TESTING

A. Following sewer pipe installation, trench compaction and installation of other utilities and prior to the placement of permanent pavement, all sewer lines shall be mandrelled to check for obstructions. A rigid mandrel, circular in cross section, having a diameter of 95% of the inside pipe diameter and equal in length to the pipe diameter, shall be hand pulled through the pipe.

B. The Contractor shall correct obstructions encountered by the mandrel. If an obstruction is encountered, the City Engineer or their representative shall approve the corrective measure prior to implementation.

17. CLOSED CIRCUIT TELEVISION INSPECTION

A. A closed circuit television shall be conducted of the new sewer lines after sewer pipe cleaning and the mandrel testing.

B. Closed circuit television inspections shall be performed in accordance with the regional Supplement Amendments to the SSPWC, 500-1.1.5. Video documentation shall be made available with VHS-formatted tape and/or digital formatted (DVD) per the Engineers request.

C. All defects and evidence of reverse slope by ponding of water or dips in pipe alignment revealed by the closed circuit television inspection shall be repaired to the satisfaction of the City Engineer at the Contractors expense.

18. MISCELLANEOUS NOTES

A. The City of Carlsbad will only maintain sewer lines located in dedicated City right-of-ways and easements which have all weather vehicular access.

B. New sewer lines and appurtenances shall remain plugged and/or disconnected until the City authorizes its use.

C. Sewer laterals constructed from the property line to the building shall be per the Uniform Building Code.

1) The vertical cleanout shall be stubbed and capped 3 feet above rough grade during grading and/or construction of project.

2) All sewer lateral taps on existing sewer lines shall be by “shewer” or approved equal. All work will be inspected by a City Representative.

3) A three-inch (3”) high “S” shall be stamped on the curb face at all sewer lateral locations.

D. Sewer Access-Holes

1) The top cone shall be 6” below finished subgrade. Circular steel covers shall be placed on the access-holes during subgrade preparation and base rock grade work, in order to keep the sewer system clean. Additionally, roadwork above live sewer access-holes shall require plywood type sheeting be placed inside the access-hole and above the channel to keep any debris from entering the sewer line.

2) In unpaved areas, sewer access-hole frames and covers shall be set 6”above finished grade with concrete ring and marker post marked “sewer” per Standard Drawing S9.

E. Standard Sewer Improvement Plan Notes (to be placed on all Sewer Improvement Plans)

1) All sewer main and appurtenances shall be constructed and tested in accordance with the “City of Carlsbad Sewer System – Design Criteria, Standard Drawings and Specifications”, latest edition and the Standard Specifications for Public Works Construction, latest edition (Green Book).

2) The contractor shall obtain an excavation permit from the Division of Industrial Safety before any excavation and shall adhere to all provisions of the State Construction Safety Orders.

3) Before construction begins in any public right-of -way a City right-of-way permit shall be required.

4) Before any connection to the City’s existing system, a Water/Sewer Connection Permit shall be obtained from the City. It must be signed and approved by the City Engineer and the Public Works Maintenance and Operations designee.

5) The contractor shall notify the City of Carlsbad Engineering Inspection 48 hours prior to their desire to begin construction. Telephone: (760) 438-3891.

GENERAL GUIDELINES FOR SEWER FORCE MAINS

1. The developers engineer shall submit a rough layout plan including surge protection design and flow analysis for review and approval by the City Engineer prior to the preparation of improvement plans.

2. Minimum cover of sewer force mains shall be 48 inches (48") from top of pipe to ultimate finished grade. Top of pipe profile shall be shown on the improvement plans.

3. Show all other underground utilities in both plan and profile. Provide minimum clearances per the State of California Department of Health Services "GUIDANCE MEMO NO. 2003-02: GUIDANCE CRITERIA FOR THE SEPARATION OF WATER MAINS AND NON-POTABLE PIPELINES".

4. Sewer force mains shall be polyvinyl chloride pipe that meets A.W.W.A. Std. C-900 or as approved by the City Engineer.

GENERAL GUIDELINES FOR PUMP STATIONS

1. The developers engineer shall meet with the City Engineer prior to the preparation of plans.

2. The pump station design shall be approved by the City Engineer. All component submittals shall go through City Engineer review.