SECTION 6.0 - CONSTRUCTION REQUIREMENTS

6.1 ASTM References

1)	ASTM A48	Manhole Frames and Covers - Gray Iron Castings.
2)	ASTM A304	Steel Bars, Alloy, Requirements.
3)	ASTM A536-84	Manhole Frames and Covers – Gray Iron Castings.
4)	ASTM A615	Billet-Steel Bars for Concrete Reinforcement.
5)	ASTM C443	Connections between Precast Manhole Sections.
6)	ASTM C478	Precast Reinforced Concrete Manhole Sections.
7)	ASTM C923	Connections between Manholes and Pipe.
8)	ASTM C924	Low-Pressure Air Testing Method.
9)	ASTM C1107	Non-Shrink Grout.
10)	ASTM C1244	Vacuum Testing Concrete Sewer Manholes
11)	ASTM D3034	PVC Pipe and Fittings.
12)	ASTM D3035	High Density Polyethylene Pipe (HDPE) and connections.
13)	ASTM D3212	Elastomeric gasket.
14)	ASTM D4832	Testing of Controlled Low Strength Material (CDF).
15)	ASTM F1417	Standard Practice Using Low-Pressure Air Testing
16)	UNI-B-6	Recommended Practice for Low-Pressure Air Testing

6.2 CLEARING AND REMOVAL OF OBSTRUCTIONS

6.2.1 Clearing

Where clearing of the right of way or easement is necessary, it shall be completed prior to the start of the trenching. Trees and brush shall be cut as near to the surface of the ground as practical and piled for disposal. The Contractor shall observe all Federal and State Laws relating to fire permits and local regulations relating to burning such materials. Under no conditions shall excavated materials be permitted to cover brush or trees prior to clearing and disposal. Existing trees or tree limbs whether on public or private property, are not to be removed without permission from the Engineer or as designated on the plans.

6.2.2 Grubbing

Grubbing shall consist of the removal and disposal of stumps, roots larger than three inches (3”) in diameter, and matted roots from the construction area. This material, together with logs and other organic or metallic debris not suitable for backfill purposes shall be excavated and removed to a depth of not less than eighteen inches (18”) below the original surface level of the ground in the construction area. Stumps within easements shall be removed or ground to twelve inches (12”) below the existing surface level. Depressions made by grubbing shall be filled with satisfactory and suitable topsoil material and compacted to make the surface conform to the original adjacent surface of the ground.

6.2.3 Removal of Obstructions

This item refers to obstructions which may be removed and do not require replacement. Obstructions to the construction of the trench such as but not limited to stumps, abandoned piling, abandoned concrete structures, logs, rubbish, boulders, and debris of all types shall be removed by the Contractor at his/her own expense without additional compensation from the District.

6.2.4 Disposal of Cleared Material

Material generated by clearing, grubbing, removal of obstructions, and removal of pavement, shall be conveyed to a suitable waste disposal site and disposed of in a manner that will meet all the requirements of the applicable federal, state, and county regulations. The waste disposal shall be provided by the contractor at his/her expense and approved by the Engineer. Alternative disposal of brush and small limbs may be possible if approved by the Engineer through on-site shredding and dispersal within the limits of the temporary construction easement.

6.3 TRENCH

6.3.1 Trench Excavation

Trench excavation shall be classified as common excavation, rock excavation, or boulder removal as defined below:

6.3.1.1 Common Excavation

Common excavation is defined as the removal of all material which is not classified as rock excavation or boulder removal.

6.3.1.2 Rock Excavation

Rock excavation is defined as the removal of all materials which, by actual demonstration, cannot in the Engineer's opinion, be reasonably excavated with a 3/4 yard 225 Caterpillar Backhoe equipped with a 30-foot boom, general duty dipper and rock points, or similar approved equipment and which is in fact, systematically drilled and blasted. The Engineer reserves the right to waive the demonstration of the material encountered as well defined rock. The term "rock excavation" shall be understood to indicate a method of removal and not a geological material. In addition, rock excavation may include removal of well-defined rock by the method of systematic drilling and mechanical splitting.

No payment will be made under "Rock Excavation" for any method of rock removal other than systematic drilling and blasting or mechanical splitting. If the contractor elects to mechanically remove material classified as "Rock Excavation" by the above definition with other equipment, including excavating equipment of a larger size than specified above, it shall be understood that payment for the removal of the material by this method shall be at the unit price for Common Excavation.

6.3.1.3 Boulder Removal

Boulders, for the purpose of this specification, shall be defined as the removal of masses of igneous, sedimentary or metamorphic material which has one or more dimensions of thirty-six inches (36") or greater or boulders with a displacement of one cubic yard, or more, which are removed without drilling, blasting or splitting as specified for rock excavation. Solid masses other than rock or of lesser dimension shall be considered as cobble or debris and shall be removed as common excavation.

Boulder removal shall consist of the physical removal of boulders as defined above by any means other than those methods defined as "rock excavation".

6.3.1.4 Blasting

Blasting for excavation will be permitted only after securing approval of the Engineer and only when proper precautions are taken for the protection of persons and property. Any damages caused by the blasting shall be the responsibility of the Developer and / or Contractor. The Contractor's methods of procedure and blasting shall conform to all Local, State and Federal Laws.

6.3.1.5 Asphaltic Concrete Pavement Removal

All bituminous and concrete pavements, regardless of the thickness, shall be saw cut prior to excavation of trenches per the specifications of the agency having authority over the roadway.

6.3.2 Trench Width

Minimum width of trenches in which sanitary sewer mainline is to be laid shall be twelve inches (12”) greater than the outside diameter of the pipe. Minimum width of trenches where CDF is used as the entire backfill shall be as shown on the Plans or as directed by the Engineer. In all cases, trenches must be of sufficient width to allow for shoring and permit proper joining of pipe and compaction of the backfill material along sides of the pipe.

6.3.3 Trench Grade

The bottom of the trench shall be carried to the lines and grades shown on the Plans or as established by the Engineer, with proper allowance for pipe thickness and for gravel bedding. Any part of the trench excavated below grade shall be corrected with material of the type specified in Section 6.3.7 Trench Foundation, for the full width of the trench. Unless otherwise specified, service laterals shall be laid at a slope of 1/4 inch per foot.

6.3.4 Shoring and Sheeting

Whenever necessary to prevent caving during excavation in gravel, sandy soil, or other unstable material, the trench shall be adequately sheeted and braced. The design, planning, installation, and removal of all sheeting, shoring, shields or other devices shall be accomplished in such a manner as to maintain the required excavation or trench section and to maintain the undisturbed state of the sails below and adjacent to the excavation. Where sheeting and bracing are used, trench widths shall be increased accordingly. Ensure trench sheeting remains in place until the pipe has been placed and backfill of the pipe zone completed. Horizontal strutting below the barrel of the pipe and the use of the pipe as support for the trench support system shall not be permitted. All sheeting, shoring and bracing shall be designed and installed in accordance with OR-OSHA. Take special care to prevent movement of the pipe after installation when laid within a moveable trench shield.

6.3.5 Location of Excavated Materials during Trench Excavation

During trench excavation, locate the excavated material so it will not completely obstruct a traveled roadway or street; and, unless otherwise approved by the Engineer, all streets and roadways shall be kept open to at least one-way traffic.

6.3.6 Trench Dewatering

The Contractor during construction of the sanitary sewer system shall at all times provide and maintain ample means and devices with which to promptly remove and dispose of all water entering the trench excavation during the time the trench is being prepared for the pipe laying, during the laying of the pipe, and until backfill has been completed. Dispose of water in accordance with state and local regulations.

The control of groundwater shall be such that softening of the bottom of excavations, or formation of “quick” conditions or “boils” during excavation shall be prevented. Dewatering systems shall be designed and operated so as to prevent removal of the natural soils.

At no time shall stormwater or ground water be permitted to be discharged into the District’s sanitary sewer system. The discharge of stormwater or ground water in the District’s sanitary sewer system is a violation of District Regulations.

6.3.7 Trench Foundation

When, in the opinion of the Engineer, the material in the bottom of the trench is unsuitable for supporting the pipe, excavate as directed by the Engineer, and backfill with approved materials to the required grade. Any part of the trench excavated below grade shall be corrected with approved material for the full width of the trench and thoroughly compacted in layers not to exceed six inches (6”), to the established grade.

6.4 SANITARY SEWER SYSTEM INSTALLATION

6.4.1 Sub-Grade

The bottom of the trench shall be carried to the line and grade shown on the Plans or as established by the Engineer, with proper allowance for pipe thickness and for gravel pipe bedding.

6.4.2 Pipe Base/Bedding

Bedding material as specified in Section 6.5.2 shall be placed in the trench to a minimum depth of six inches (6”) below the bottom of the pipe. The pipe bedding shall be placed and leveled to approximate grade in advance of the pipe laying and shall provide a firm, unyielding support along the entire pipe length. Immediately following the placement of each pipe section, the crushed gravel pipe bedding shall be placed to the springline of the pipe. Special effort to properly bed the pipe by slicing backfill in the pipe haunches up to the springline shall be provided. The pipe bedding shall be a minimum of six inches (6”) for service connections.

6.4.3 Bell Holes

At the location of each joint, bell holes of ample dimensions shall be dug in the bottom of the pipe bedding to permit the joint to be properly fitted, to permit easy inspection of the entire joint; and to provide uniform bearing for the barrel of the pipe for its entire length.

6.4.4 Preparation of Sanitary Sewer Pipe

All pipes and fittings shall be carefully inspected before being laid and no cracked, broken or defective pipe or fittings shall be used in the work. Surface irregularities, in the form of air pockets or voids, will be cause for rejection as enumerated in ASTM D3034. The ends of the pipe shall be cleaned with a brush, washed and thoroughly scrubbed where necessary to remove dirt or other foreign material.

6.4.5 Line and Grade

Sanitary sewer pipe shall be laid in full lengths as manufactured and shall be laid on a constant grade and in a straight alignment from manhole to manhole, or cleanout. Pipe shall not be installed with elbows, bends, bows or bellies.

PVC pipe is flexible in nature and may be out of grade and alignment through the middle of a pipe length even though each end is on grade and in alignment as evidenced by a laser beam or grade boards. To prevent the above situation from occurring, the Contractor shall check the elevation of the top of each length of PVC pipe laid at each end and at the midpoint. The midpoint elevation shall be within 0.01 foot of the average elevation of the two ends.

The Contractor shall use the laser beam method of maintaining grade and alignment of the pipeline unless another method is approved by the Engineer. The Engineer will establish the center line and cut-to-flow line of each manhole by means of a stake. In addition, offset stakes indicating the cutoff-flow line will be set at each manhole and at approximate 50-foot intervals along the mainline. In all cases, it shall be the Contractor's sole responsibility to lay out the work from the offset stakes given and to transfer elevations from the cut stakes.

The Engineer will furnish all stakes and labor for staking out the work to the extent described above. The Contractor shall make every effort to notify the Engineer at least three (3) days in advance of the time when the grade and line will be needed.

Final service connection locations may be determined by the Engineer in the field after consultation with the property owner. The Engineer will provide a cut stake at the terminal point of each service connection. Unless otherwise directed by the Engineer, the Contractor will use a grading line to lay the pipe and the pipe shall be installed with the same accuracy as on the main sewer.

6.4.6 Manhole Connections

Unless otherwise provided, connections to existing District manholes shall be made using a core drilling method. Use of a jackhammer or other pneumatic devices shall be prohibited. Connect PVC pipe to concrete manholes by means of an approved coupling with an elastomeric gasket or flexible sleeve conforming to ASTM C923, (Kor-N-Seal or equal). The use of Portland Cement grout for connecting PVC pipe to manholes shall be prohibited.

6.4.7 Pipe Installation

The installation of sanitary sewer pipe shall commence at the lowest point in the sanitary sewer system and shall proceed so that the spigot end of the section being laid is placed into the bell end of the pipe already laid. Foreign materials shall be prevented from entering the pipe while it is being placed in the trench. During laying operations, no debris, tools, clothing or other materials shall be placed in the pipe.

Sanitary sewer pipe shall be installed in accordance with the manufacturers' recommended installation procedures and District Regulations.

6.4.8 Waterline Crossings

Sanitary sewer mainline pipe material specifications shall be in accordance with Section 5.3.4 for a minimum distance of approximately ten feet (10') on either side of a water main crossing, when there will be less than eighteen inches (18") of clearance between the outside diameters of the water main and sanitary sewer. One standard length of pressure pipe shall be centered under the waterline.

It is desirable to maintain a consistent material type and specification in the type of sanitary sewer pipe within any manhole-to-manhole run. Since the elevation of existing water mains is unknown, the determination of where pressure pipe for sanitary sewers will be required will be made during construction and after exposure of the subject water mains. If it is not practical to determine whether pressure or non-pressure pipe should be used at the time pipe laying proceeds upstream from a manhole, and a subsequent determination is made to change pipe type at a water main crossing, then an appropriate adaptor between the different pipe types may be required.

Adaptors shall be Fernco Couplings or equal. Extra effort shall be taken during pipe laying and backfilling to insure a smooth invert results through the adaptor and that no offset occurs in pipeline alignment. Any offset in which sewage can collect will be repaired or replaced.

6.4.9 Anchor Block

Anchor blocks shall be constructed of concrete one foot (1') thick parallel to the pipe, extending one foot (1') below the bottom of the pipe to three feet (3') above the top of the pipe, and extending one foot (1') beyond each side of the trench wall.

6.4.10 Impervious Zone

The impervious zone shall be constructed of CDF two feet (2') thick parallel to the pipe, extending one foot (1') below the bottom of the pipe zone to within three feet (3') of the ground surface, and extending one foot (1') beyond each side of the trench wall. The Contractor shall minimize the length of trench impacted by installing CDF through the use of temporary forms or other means to no greater than three feet (3') along the axis of the pipe. The trench in the top three feet (3') shall meet all requirements of the backfill classification shown on the drawings or otherwise specified.

6.4.11 Service Connection

The Contractor shall place a service connection tee at the locations indicated on the Plans or specified by the Engineer. The tee shall be installed at an angle of approximately 45 degrees with the horizontal or as directed by the Engineer. After the tee is in position, special pipe bedding material and select backfill shall be hand-placed around the tee to prevent any movement of the tee when the next pipe is laid.

Unless otherwise specified on the Plans or directed by the Engineer, each service connection shall be laid in a separate trench on a straight line and gradient from the tee to the end of the service connection. The service connection shall be at least six feet (6') deep at the property line crossing. No service connection shall be laid on a grade of less than two percent (2%), unless otherwise directed by the Engineer or shown on the Plans.

Unless otherwise directed by the Engineer, the Contractor will use a grading line to lay the pipe and the pipe shall be installed with the same accuracy as the mainline sanitary sewer.

Service Connections and cleanouts shall be installed as shown on the approved plans.

A cleanout shall be installed in the location shown on the approved plans. The riser pipe shall be installed flush with the ground. A watertight solvent weld cap shall be installed on the riser. The stubout from the cleanout wye shall extend to the edge of the easement line or the back of the Public Utility Easement. The stub out shall be capped with a watertight solvent weld end cap. A green metallic tape shall be placed six inches (6") above the service connection and up the riser pipe from the main sewer to the ground surface. A 2x4 stake painted green shall extend a minimum of three feet (3') below the ground and one foot (1') above the ground on the upstream side of the riser pipe.

Upon extension of the Building Sewer the cleanout riser pipe shall be adjusted to finish grade and a solvent weld removable end cap shall be installed.

For additional information see Appendix D, Sanitary Sewer Standard Detail drawing SAN-017 and SAN-018 Service Connection.

6.4.12 Manhole Installation

All manholes shall be made of concrete unless an alternate material is shown on the approved Plans. All manholes shall be a minimum of forty-eight inches (48") inside diameter. Larger diameter manholes shall be installed in locations per the approved Plans

6.4.12.1 Base

The base shall be constructed per the standard detail drawing and in locations as noted on the Plans. Knockouts for pipe extensions will be based upon the alignment as shown or directed. Minor adjustments to alignment as directed by the Engineer may be necessary to better position manholes.

The Contractor may, at their option, use precast or poured-in-place manhole bases, provided all details of construction are approved by the Engineer.

Precast manhole bases shall be installed on a level compacted layer of gravel bedding a minimum of six inches (6") think on a suitable foundation. Poured in place bases do not require additional bedding. The concrete base for the manhole shall be constructed so the first section of the manhole has a uniform bearing throughout the full circumference of the manhole wall. Sufficient non-shrink grout shall be deposited on the concrete base to provide a watertight seal between the base and the manhole wall.

The manhole shelf shall be integrally poured against the wall and over the pipe stub. Construct the shelf in such a manner that when capacity of the pipe is reached, no portion of the shelf surface is used as part of the cross sectional flow channel required for free flow through the manhole. Manholes with more than ten percent (10%) change in slope on inlet versus outlet pipe shall have full depth channels placed across the base. The shelf shall have a slope of one inch (1") per foot. All areas of the shelf shall freely drain into the channel.

The inverts of the manholes shall be constructed in conformance with the details shown on the plans. The manhole channels shall provide a smooth flow-through characteristic. No sharp edges or rough sections which will obstruct the flow of sewerage will be permitted. All cement used in the construction of the channels shall be trowelled smooth. All manhole channels must be able to pass a seven by thirty inch (7"x30") cylinder into the mainline pipe.

Manholes added over an existing mainline shall have a base which achieves watertight connections to the existing pipe type.

6.4.12.2 Manhole Barrel Sections

Precast concrete sections for manholes shall be in one foot (1') to four foot (4') sections placed in such combinations as to achieve the finish grade shown on the Plans. The joints for the manhole sections shall be made watertight with the use of non-shrink grout or flexible material. The wall sections and flexible material used to join them shall be compatible. The walls shall be constructed true to line and grade as established by the Engineer. Ample non-shrink grout shall be placed into the groove of the lower section prior to placing the next barrel section. The entire joint shall be completely filled with non-shrink grout and trowelled to a smooth surface. Preformed gaskets may be used in lieu of non-shrink grout type joints and shall be RAM-NEK, manufactured by K.T. Snyder Company, Inc., Houston, Texas; Kent-Seal by Hamilton Kent, Kent, Ohio; or as approved. Manhole sections with a captive groove rubber gasket need not be grouted between sections.

Cones shall be eccentric with the wall thickness and reinforcement similar to that of manhole pipe sections. The tops and bottoms of the cones shall be parallel.

Flat-top manhole sections for all size manholes shall be used in lieu of eccentric cones where the depth from shelf to the top of the last barrel section is four feet (4”) or less. A concentric top is required when the height from the shelf to the top of the last barrel section is three feet (3”) or less.

6.4.12.3 Manhole Extensions/Grade Rings

Install precast concrete grade rings on top of manhole cones so as to positively prevent all infiltration of surface or groundwater into manholes. Grade rings shall be laid straight and true and set in a bed of non-shrink grout with the grout carried over the frame. Grade rings shall be set so the tops of the frame is flush with the finish grade or grade of adjoining pavement, or six inches (6”) above the finish grade in areas outside the right-of-way. Extension rings shall be limited to achieve a maximum distance of twenty-eight inches (28”) from the center point of the first step to the top of the frame. Precast rings shall be constructed so as to have an opening of no more or no less than twenty-five inches (25”).

6.4.12.4 Manhole Frames and Covers

Frames:

Standard frames shall have a total height of ten inches (10”) as shown in Clackamas County Department of Transportation and Development Drawing U600. Frames shall be of the type detailed on the approved Plans or equal.

Suburban frames shall have a total height of six inches (6”) and are designed for areas of light traffic loading and may be used as approved in non traffic areas, easement areas and subdivision streets. Suburban frames are prohibited in collector streets, arterial streets or streets in industrial areas.

Tamperproof/Locking and Watertight (Secured) frames shall be installed in locations as noted on the approved Plans. Secured frames shall be installed per the manufactures specifications. On Secured frames with internal lugs, one lug shall be centered on the manhole steps.

Covers:

Standard Sanitary Sewer Manhole covers shall have a maximum of two seven-eighths inch (7/8”) pick holes.

Tamperproof/Locking covers shall match frame type and shall be installed per the manufactures specifications.

Watertight covers shall have no open pick holes and shall be installed per the manufactures specifications.

6.4.12.5 Manhole Steps

Steps shall be placed where there are no incoming or outgoing lines. Steps shall be placed a maximum of twelve inches (12”) from the shelf and twenty-eight inches (28”) from the top of the frame. Steps shall be twelve inches (12”) on center. Steps shall extend from the manhole wall six inches (6”). Steps in a manhole shall be of the same type. Steps

shall be installed straight and true. Loose steps shall be cause for rejection of that manhole cone or section. Manholes less than four feet (4') in depth do not require steps.

6.4.12.6 Manholes Future Development

All manholes, from which future Public Sanitary Sewer Extensions are anticipated, shall be channeled and have a Kor-N-Seal (or equal) boot and water tight plug installed in the direction of the anticipated Public Sanitary Sewer Extension. Boots shall be located at least 0.20 feet above the lowest invert in the manhole. Channels shall be formed in the manhole base to accommodate the future flow. Effort must be made to protect the boot and plug during vacuum testing of the manhole. Stub outs shall only be installed in manholes when permitted by the District. Pipe stubs shall be a minimum of eight inches (8") in size or as permitted by the District and shall be of an approved type of pipe. Stubs shall protrude a maximum of fifteen (15) feet without a temporary cleanout unless otherwise permitted by the District and shall be plugged with a standard watertight plug or cap. An exception to this section may be made by the District if the direction of the new mainline cannot be established at the time of construction.

6.4.12.7 Drop Manholes.

Drop manholes shall be outside drops and constructed at the location shown and as detailed on the Plans. The first run of pipe from the drop assembly shall be a full length of PVC or ductile iron pipe (match pipe type to drop assembly type). If concrete pipe is used concrete encasement, as shown on the drawing detail is required. PVC or ductile iron drop assemblies may be installed without the encasement above the springline of the inlet pipe.

6.4.13 Mainline Cleanout Pad and Cover

The cleanout shall be installed as shown on the Plans or as directed by the Engineer. The cleanout shall be constructed of the same size and material as the mainline. Special attention should be paid to the details for the concrete pad required. When using PVC pipe for the cleanout, the concrete support block is not required. The cleanout riser shall be protected by the pad and cover but shall not touch or be a structural part of the pad. A watertight end plug shall be installed on the riser. No load from the frame, pad or cover shall be placed on the pipe or plug. Provide compacted three quarter inch (3/4") minus crushed gravel up and around the cleanout assembly to finish grade.

6.4.14 Sanitary Sewer Standard Detail Drawings

For further details regarding sanitary sewer specification the Sanitary Sewer Standard Detail Drawings are in Appendix D and can be found on the District website at http://www.clackamas.us/wes/dreview.html .

6.5 MATERIALS

6.5.1 Foundation Stabilization

Two and one-half inch (2 ½") minus clean pit-run gravel, crushed rock or gravel, having reasonably even gradation from coarse to fine or open graded, Maximum percent passing the ¼ inch screen shall be 20% by weight. Gravel shall be placed in thoroughly compacted layers not to exceed six inches (6") to the established grade.

6.5.2 Pipe Base and Pipe Zone

Material for pipe base and pipe zone shall be three quarter inch (3/4") minus crushed gravel, having reasonably even gradation from coarse to fine, in accordance with the Oregon State Highway Commission Standard Specifications for Highway Construction specification for Aggregate and Aggregate Base, Section 02630.10.

6.5.3 Trench Backfill

Backfill material specifications above the pipe zone within the right-of-way shall be approved by the Roadway Authority.

Backfill material specifications above the pipe zone outside the right-of-way shall be of the class (Section 6.6) specified on the approved plans.

6.5.4 Controlled Density Fill (CDF)

Controlled Density Fill (CDF) shall not be a replacement for stone pipe base/bedded within the pipe zone. CDF is approved as an alternative to "Gravel for Trench Backfill" and may be used at any location on the project at the option of the contractor. The use of CDF is required for backfill material associated with the installation of manholes constructed of any material except concrete. CDF shall be a mixture of Portland cement, pozzolans, fine aggregate, water and admixtures proportioned to provide a non-segregating, self-consolidating, free-flowing and excavatable material. CDF shall be a hardened, dense, non-settling fill with an unconfined compressive strength at 28-days of 100 to 200 (one hundred to two hundred) psi.

6.5.5 District Manhole Connection

Connections to District manholes shall be made with an elastomeric gasket or flexible sleeve conforming to ASTM C923, (Kor-N-Seal or equal).

6.5.6 Pipe

Pipe shall be Polyvinylchloride (PVC) gravity sewer pipe (less than eighteen inches (18") in diameter) conforming to ASTM D-3034, SDR 35. Minimum stiffness shall be forty six (46) psi. Joint type shall be elastomeric gasket conforming to ASTM D3212.

6.5.7 Precast Manhole Base Bedding

Material under the precast manhole base shall be 6" of three quarter inch (3/4") minus crushed gravel, having reasonably even gradation from coarse to fine, in accordance with the Oregon State Highway Commission Standard Specifications for Highway Construction specification for Aggregate and Aggregate Base, Section 02630.10.

6.5.8 Detectable Caution Tape

Tape shall be green and permanently labeled “CAUTION BURIED SEWER LINE BELOW”. Tape shall be a minimum of three inches (3”) in width. Tape shall meet APWA Standards for underground burial tape. Tape shall be metallic such that it can be located with a metal detector. Tape shall be acid and alkali resistant polyethylene constructed with a minimum 4.5 mil solid aluminum foil core with an imprinted warning legend that is completely encased to prevent ink rub-off.

6.5.9 Concrete

Concrete shall be so proportioned and mixed as to meet a minimum three-thousand (3,000) psi compression test after twenty-eight (28) days. There shall be a minimum of five sacks of cement per cubic yard of concrete.

6.5.10 Manhole Bases

Precast bases shall conform to ASTM C-478 specifications. Poured in place manhole bases shall be constructed using concrete. Kor-N-Seal or equal shall be used for pipe connections with precast bases. All metal parts used shall conform to ASTM A-304 stainless steel, and all neoprene shall conform to ASTM C443 specifications.

6.5.11 Manhole Barrel Sections

Manhole barrel section shall be made of reinforced concrete pipe, Class 2, conforming to ASTM C-478 specifications, with the added requirement that the reinforcement shall be circular and not elliptical. Material for connecting precast manhole section shall be either rigid or flexible. Rigid connection shall be made using non-shrink grout mixture. Flexible materials must conform to ASTM C443 specifications. Construction of the precast joint shall be matched to the material used for connection.

6.5.12 Non-Shrink Grout

Commercial grout exhibiting zero shrinkage shall be used. Non-shrink grout shall not be amended with cement or sand and shall not be reconditioned with water after initial mixing. Non-shrink grout shall meet ASTM C1107 specifications. Non-shrink grout shall be placed or packed only with the use of an approved commercial concrete bonding agent. Unused grout shall be discarded after twenty (20) minutes and shall not be used.

6.5.13 Manhole Extension Rings

Extension rings shall be made of precast concrete two inches to four inches (2” to 4”) in thickness and of standard construction.

6.5.14 Manhole Frames

Castings shall be tough, close-grained, gray iron, free from blowholes, shrinkage and cold shuts. They shall conform to ASTM A48 - Class 30 and shall be sound, smooth, clean and free from blisters and all defects. All castings shall be planed and ground where necessary to ensure perfectly flat and true surfaces. Castings shall be sound, smooth, clean, and free from blisters and defects. Plane and grind all castings where necessary to ensure perfectly flat and true surfaces. Secured frames shall meet specifications as found in the Sanitary Sewer Standard Detail Drawings.

6.5.15 Manhole Covers

Castings shall be tough, close-grained, gray iron, free from blowholes, shrinkage and cold shuts. They shall conform to ASTM A48 - Class 30 and shall be sound, smooth, clean and free from blisters and all defects. All castings shall be planed and ground where necessary to ensure perfectly flat and true surfaces. Covers shall be true and shall seat within the ring at all points. Secured covers shall meet specifications as found in the Sanitary Sewer Standard Detail Drawings.

6.5.16 Manhole Steps

Steps shall be Polyethylene with iron reinforcement, eight inches by 12 inches (8" x 12") wide with a two inch (2") drop. Manhole steps shall meet specifications as found in the Sanitary Sewer Standard Detail Drawings.

6.6 BACKFILL COMPACTION

6.6.1 General Compaction

Backfill material shall not be placed in the trench in such a way as to permit free-fall of the material until a minimum of two (2) feet of cover is provided over the top of the pipe.

Backfill shall be maintained at proper moisture content so that the material is within five percent (5%) plus or minus of optimum moisture.

Maximum density and optimum moisture will be determined using Method A of AASHTO T-99. All listed compaction levels are based on the T-99 compaction requirements unless otherwise stated.

Native backfill used in Class A shall be compacted to at least ninety percent (90%) of maximum density above the pipe zone and to within three feet (3') of the ground surface. The top three feet (3') shall be compacted to at least ninety-two percent (92%) of maximum density.

Imported trench backfill used for Class B, Class C and the lower portions of Class D trenches where designated shall be mechanically compacted. The full trench depth to within one foot of the ground surface shall be compacted to a least ninety-five percent (95%) of maximum density. The top one foot (1') shall be compacted to no less than one-hundred percent (100%) of maximum density prior to placement of asphalt concrete.

Unless otherwise noted, the Contractor shall be responsible to provide the proper size, type and specification of backfill.

6.6.2 Pipe Zone

The pipe zone for both mainline and service connection laterals shall be defined as extending from the bottom of the pipe bedding to a point twelve inches (12") above the outside of the pipe for the full width of the trench, for all classes of backfill. The pipe zone shall be backfilled with compacted 3/4 inch minus crushed gravel and shall provide a firm, unyielding support along the entire pipe length. Immediately following the placement of each pipe section, the crushed gravel pipe bedding shall be placed and compacted to the springline of the pipe. Special effort to properly bed the pipe by slicing backfill in the pipe haunches up to the springline shall be provided. Backfill shall then be placed and compacted in lifts of not greater than six inches (6") to the top of the pipe zone.

6.6.3 Trench Backfill Above Pipe Zone

The following types of backfill shall be used on the project in the areas not governed by a roadway authority such as the State, County or City permitting the construction of the right-of-ways and private streets. For trench backfill within a right-of-way and private street contact the appropriate roadway authority.

Service Connection backfill will generally be the same as that used for the sanitary sewer mainline to which they are connected.

6.6.4 Easements

After the Contractor has backfilled the pipe zone of the trench as required, the Contractor shall then backfill the balance of the trench, with the type of backfill specified on the approved plans. The Trench Backfill shall be mechanically compacted in one foot layers, to 95% of maximum density in roadways and 85% to 90% in all other areas.

6.6.5 Public and Private Roadways

After the Contractor has backfilled the pipe zone of the trench as required, the Contractor shall backfill the balance of the trench per the material and specification of the roadway authority.

6.7 Backfill Classifications (District)

6.7.1 Class "A" Backfill

The entire trench above the pipe zone shall be backfilled with native excavated material and compacted in accordance with the specifications in Section 6.6. Placement of native backfill material for Class A backfill shall include the working of material to achieve suitable moisture content and compaction to the specified density. In lieu of using native material excavated from the trench for Class A and C backfill, the contractor may at his/her option place and compact to specified density an approved imported backfill material. Imported material must be approved by the engineer prior to placement. Material shall be earth, gravel, rock, or combinations thereof, free of humus, organic matter, vegetative matter, frozen material, clods, sticks, and debris and containing no stones having a dimension greater than four inches (4”). Sand or pea gravel will not be an approved backfill material. The Sanitary Sewer Standard Detail Drawings can be found in Appendix D, see drawing SAN-001 Class “A” Excavation & Backfill.

6.7.2 Class "B" Backfill

With the exception of the top ten inches (10"), the trench above the pipe zone shall be backfilled with gravel for Trench Backfill and compacted according to the specifications. The top ten inches (10”) of the trench shall be backfilled and compacted in successive layers of four inches (4”) of 1-1/2 inch minus "Crushed Gravel", and two inches (2”) of 3/4 inch minus "Crushed Gravel". The Sanitary Sewer Standard Detail Drawings can be found in Appendix D, see drawing SAN-002 Class “B” Excavation & Backfill.

6.7.3 Class "C" Backfill

With the exception of the top eleven inches (11"), the trench above the pipe zone shall be backfilled with Gravel for Trench Backfill and compacted according to the specifications of the Road Authority. The top eleven inches (11") of the trench shall be backfilled and compacted in successive layers with eight inches (8") of 1-1/2 inch minus "Crushed Gravel", and layers of Asphaltic Concrete according to the specifications of the Road Authority. The Sanitary Sewer Standard Detail Drawings can be found in Appendix D, see drawing SAN-003 Class "C" Excavation & Backfill.

6.7.4 Class "D" Backfill

Controlled Density Fill (CDF) shall not be a replacement for stone pipe base/bedded within the pipe zone. CDF is approved as an alternative to "Gravel for Trench Backfill" and may be used at any location on the project at the option of the contractor. When called out on the plans as a requirement by the Engineer the entire trench shall be backfilled with Controlled Density Fill (CDF), with the exception of the Trench Foundation, Pipe Base/Bedding and Pipe Zone which shall be backfilled with crushed gravel to District specifications. In paved areas the top three inches (3") of the trench shall be backfilled and compacted in successive layers with two (2) 1-1/2 inch layers of Asphaltic Concrete. The use of CDF is required for backfill material associated with the installation of manholes constructed of any material except concrete. Contact the roadway authority for specifications of CDF backfill within a private street or public Right-of-Way.

6.8 TESTING OF SANITARY SEWER MAINLINE AND APPURTENANCES

6.8.1 General

1. Test all gravity Sanitary Sewer Mainlines and Service Connections by "low pressure air testing" and all mainlines by deflection testing.
2. Test all manholes using the negative pressure (vacuum) method.
3. Air Tests For Gravity Sanitary Sewers: Ensure all gravity sanitary sewers and appurtenances successfully pass the air test prior to acceptance and are free of visible leakage or infiltration.
4. The Contractor may desire to make an air test prior to backfilling for his/her own purposes; however, the acceptance air test shall be made after backfilling and compaction has been completed to final grade.
5. The testing equipment and personnel shall be subject to the approval of the Engineer.
6. Acceptance testing shall be conducted on all of the manholes with the following exception of existing manholes used to extend new sanitary sewer mainline.
7. The Engineer or Engineer's Inspector shall observe all testing and record and submit the results on the District testing forms which can be found in Appendix B.

6.8.2 Low Pressure Air Test

The Engineer or Engineer's Inspector shall observe all testing and record and submit the results on the District testing forms which can be found in Appendix B.

1. Summary of Method: Plug the section of the sewer line to be tested. Introduce low-pressure air into the plugged line. Use the quantity and rate of air loss to determine the acceptability of the section being tested.
2. The Contractor may desire to make an air test prior to backfilling for his/her own purposes. However, the acceptance air test shall be made after backfilling and compaction has been completed to finish grade.
3. Preparation of the sewer line: Flush and clean the sewer line prior to testing, to clean out any debris. A wetted interior pipe surface will produce more consistent results. Plug all pipe outlets using approved pneumatic plugs with a sealing length equal to or greater than the diameter of the line being tested to resist the test pressure. Give special attention to service connections.
4. Infiltration: The District does not allow new construction of sanitary sewer piping system to have any visible sign of ground or surface water infiltration. If infiltration into the sanitary sewer piping system is visible it will need to be corrected prior to proceeding with any sanitary sewer testing.
5. Ground Water Determination: Install a 1/2 inch capped galvanized pipe nipple, approximately 12 inches long, through the manhole on top of the lowest sewer line in the manhole. Immediately prior to the line acceptance test, the ground water elevation shall be determined by removing the pipe cap and blowing air through the pipe nipple into the ground so as to clear it, and then connecting a clear plastic hose to the pipe nipple. The hose shall be held vertically and a measurement of the height in feet of water over the invert of the pipe shall be taken after the water has stopped rising in the plastic hose.
6. Procedures: Determine the test duration for the section under test by computation from the applicable formulas shown in ASTM F1417 & UNI-B-6. The pressure gauge used shall have a minimum divisions of 0.10 psi and have an accuracy of 0.0625 psi. Pressure-holding time is based on an average holding pressure of 3 psi gage or a drop from 3.5 psi to 2.5 psi gage above the groundwater pressure.

   Add air until the internal air pressure of the sewer line is raised to approximately 4.0 psi gage. After an internal pressure of approximately 4.0 psig is obtained, allow time for the air pressure to stabilize. The pressure will normally show some drop until the temperature of the air in the test section stabilizes.

   When the pressure has stabilized and is at or above the starting test pressure of 3.5 psi gage, commences the test. Before starting the test, the pressure may be allowed to drop to 3.5 psig. Record the drop in pressure for the test period. If the pressure has dropped more than 1.0 psi gage during the test period, the line shall be presumed to have failed. The test may be discontinued when the prescribed test time has been completed even though the 1.0 psig drop has not occurred.

The test procedure may be used as a presumptive test which enables the installer to determine the acceptability of the line prior to backfill and subsequent construction activities.

If the pipe to be tested is submerged in ground water, the test pressure shall be increased by 1.0 psi for every 2.31 feet the ground water level is above the invert of the sewer.

7. Safety: The air test may be dangerous if, because of lack of understanding or carelessness, a line is improperly prepared. It is extremely important that the various plugs be installed and braced in such a way as to prevent blowouts. In as much as a force of 250 lb. is exerted on an 8 inch plug by an internal pipe pressure of 5 psi, it should be realized that sudden expulsion of a poorly installed plug or of a plug that is partially deflated before the pipe pressure is released can be dangerous. As a safety precaution, pressurized equipment shall include a regulator or relief valve set at perhaps 10 psi to avoid over-pressurizing and damaging an otherwise acceptable line. No one shall be allowed in the manholes during testing.

6.8.2.1 Calculating Time (T) - Low Pressure Air Test

1. Minimum Testing Times: See the table below for the “LOW AIR TEST MINIMUM TESTING TIME”.
2. The pipeline shall be considered acceptable when tested as described herein before if the section under test does not lose air at a rate greater than 0.0015 cfm per square foot of internal sewer surface. The following formula shall be used for calculating (T) for lengths of pipe and diameter of pipes not shown in the table referenced below.

$$T = (d^2)(L/42)$$

T = test duration, seconds

d = pipe diameter, inches

L = section length, feet

42 = conversion factor

$$\text{Test PSI} = (4.0) + (G/2.31)$$

G = Ground Water height in ft

LOW AIR TEST MINIMUM TESTING TIME			
(d) Pipe Dia. Inches	(T) Minimum seconds	(L) Minimum feet	(T) for Addition Length (T/L) seconds / foot
6	340	398	0.855
8	454	298	1.520
10	567	239	2.374
12	680	199	3.419
15	850	159	5.342
18	1020	133	7.693
21	1190	114	10.471
24	1360	100	13.676

6.8.2.2 Low Pressure Air Failed Test

If the pipe installation fails to meet these requirements, the Contractor shall determine, at his/her own expense, the source or sources of leakage, and shall repair or replace all defective materials and correct all faulty workmanship. The type of repairs proposed by the Contractor must be approved by the Engineer before the repair work is begun.

The portion of sanitary sewer mainline that failed to pass the test(s) shall be repaired and retested for Low Pressure Air and Mandrel/Deflection. The completed pipe installation shall meet the requirements of the air tests before being considered acceptable.

Subsequent Failure: Infiltration of groundwater, in any amount, following a successful vacuum or low pressure air test as specified, shall be considered as evidence that the original test was in error or that subsequent failure of the sanitary sewer system has occurred. The Contractor will be required to correct the infiltration of groundwater. The portion of sanitary sewer mainline that was repaired and/or failed to pass the test(s) shall be repaired and retested for Low Pressure Air and Mandrel/Deflection Tests.

6.8.3 Manhole Vacuum Test

1. Manhole Vacuum Test (Adapted from ASTM C1244-93). The Engineer or designated inspector shall observe all testing and record and submit the results on the District testing forms which can be found in Appendix B.
2. Summary of Practice: Plug all lift holes and pipes entering the manhole. A vacuum will be drawn and the vacuum drop over a specified period of time is used to determine the acceptability of the manhole.
3. Significance and Use: This is not a routine test. The values recorded are applicable only to the manhole being tested and at the time of testing.
4. Preparation of the Manhole:
    a. Plug all lift holes with an approved non-shrink grout.
    b. Plug all pipes entering the manhole, taking care to securely brace the pipes and plugs from being drawn into the manhole. The manhole shall be set to finish grade and all paving (if applicable) completed.
    c. Air testing of Storm Manholes will not be required.
    d. Air testing of existing manholes that new mainline is being connected will not be required.
5. Procedure
    a. Place the test head at the inside of the top of the frame and the seal inflated in accordance with the manufacturer’s recommendations.
    b. Draw a vacuum of 10 inches of mercury, with the valve on the vacuum line of the test head closed, and the vacuum pump shut off. With the valves closed measure the time for the vacuum to drop to 9 inches.

c. The manhole shall pass if the time for the vacuum reading to drop from 10 inches of mercury to 9 inches meets or exceeds the values indicated below.

d. Utilizing the formulas that follow, the comparable times for a successful vacuum test for different size manholes are:

DEPTH (ft)	TIME (sec)		
	Manhole Diameter (ft)		
Depth of MH (ft)	4-ft	5-ft	6-ft
8	20	26	33
10	25	33	41
12	30	39	49
14	35	46	57
16	40	52	67
18	45	59	73
20	50	65	81
22	55	72	89
24	59	78	97
26	64	85	105
28	69	91	113
30	74	98	121

6.8.3.1 Manhole Vacuum Failed Test

a. If the manhole vacuum test fails the initial test, make necessary repairs with a non-shrink grout after the vacuum has been released. Proceed with retesting until a satisfactory test is obtained.

b. Subsequent Failure: Infiltration of groundwater, in any amount, following a successful vacuum or low pressure air test as specified, shall be considered as evidence that the original test was in error or that subsequent failure of the manhole has occurred. The Contractor will be required to correct such failures should they occur. The manhole that failed to pass the test(s) shall be repaired and retested.

6.8.4 Mandrel Test

The Engineer or Engineer's Inspector shall observe all testing and record and submit the results on the District testing forms which can be found in Appendix B. In addition to low pressure air testing, sanitary sewers constructed of PVC sewer pipe shall be tested for deflection not less than 30 days after the trench backfill and compaction has been completed.

6.8.4.1 Mandrel Size

The rigid mandrel shall have an outside diameter (O.D.) equal to 95% of the inside diameter (I.D.) of the pipe. The inside diameter of the pipe, for the purpose of determining the outside diameter of the mandrel, shall be the average outside diameter minus two minimum wall thicknesses for O.D. controlled pipe and the average inside diameter for I.D. controlled pipe. All dimensions shall be per appropriate standard. Statistical or other "tolerance packages" shall not be considered in mandrel sizing.

6.8.4.2 Mandrel Design

The rigid mandrel shall be constructed of a metal or rigid plastic material that can withstand 200 psi without being deformed. The mandrel shall have nine or more "runners" or "legs" as long as the total number of legs is an odd number. The barrel section of the mandrel shall have an effective length of not less than the nominal diameter of the pipe. A proving ring shall be provided and used for each size mandrel in use.

6.8.4.3 Mandrel Type

Adjustable or flexible mandrels are prohibited. A television inspection is not a substitute for the deflection test. Mandrels with removable legs or runners may be accepted on a case-by-case basis. Mechanical devices will not be used to pull the mandrel. The mandrel shall be a rigid, nonadjustable with an effective length of not less than its nominal diameter.

6.8.4.4 Manhole to Manhole

Testing shall be conducted on a manhole to manhole basis and shall be done after the line has been completely cleaned and flushed. The tests shall be performed without mechanical pulling devices. Any portion of the sewer which fails to pass the test shall be excavated, repaired or realigned, and retested with both air and deflection tests.

6.8.4.5 Mandrel/Deflection Failed Test

Any portion of the sanitary sewer mainline which failed to pass the test shall be excavated, repaired, or realigned and retested. The portion of sanitary sewer mainline that failed to pass the test(s) shall be repaired and retested for Low Pressure Air and Tests.