

SANITARY SEWER SYSTEM CONSTRUCTION STANDARD SPECIFICATIONS

SECTION 130 – SANITARY SEWER SYSTEM CONSTRUCTION

130-1.01 Description

All sanitary sewer system components and related items for new construction and rehabilitation projects shall be constructed in accordance with all applicable City Standards, the latest version of the Standard Specifications as they apply, and any modifications herein. Any proposed deviations must first be approved in writing by the Director of Santa Rosa Water.

The Contractor shall provide all means necessary, to the satisfaction of the Engineer, to ensure continuous service to all existing customers during and after work hours, weekends and holidays, including the installation of temporary lines and/or temporary pumping equipment. Sewage shall be controlled in a pipeline at all times and flows or leaks in the street or open ditches shall not be allowed.

The Contractor shall provide a full size set of sanitary sewer system “record plans” for their project to the Engineer within 7 calendar days from the final connection to the City’s sanitary sewer system. All deviations from the improvement plans shall be recorded on the plans in red ink.

Permanent paving shall not take place until all underground work is finished, except as otherwise noted, and the Engineer has given written notice of acceptance to the Contractor.

130-1.02 Materials

Sewer pipe shall be ductile iron pipe (DIP), or SDR 26 polyvinyl chloride (PVC) pipe.

Per U.S. et al., ex rel. Hendrix v. J-M Manufacturing Co., Inc., et al., Case No. ED CV-06-0055-GW (C.D. of CA), the City of Santa Rosa is not currently accepting PVC pipe manufactured by J-M Manufacturing Co. or JM Eagle for installation on City projects.

The pipe manufacturer shall legibly mark pipe materials. Name and/or trademark of manufacturer, nominal pipe size and manufacturing standard reference number shall be printed on the pipe.

The Contractor shall use a single manufacturer for each of the following types of items supplied for their project unless otherwise approved by the Engineer;

- Pipe
- Fittings
- Manhole components
- Lateral cleanout plug

For a list of approved manhole components see the “Engineer’s List of Approved Items”.

Lateral bends from the cleanout to main shall be SDR 26 PVC gasket x spigot long radius bends.

Couplers used to connect PVC pipe to PVC pipe shall be SDR 26 PVC gasketed type. Transition couplings shall have Series 300 stainless steel shear bands with a minimum thickness of .012". Couplers used for ductile iron pipe shall be per the City's Water System Standards.

Bolt-down lids, as required per City Standards, shall be equipped with minimum 1/2" stainless steel bolts with a 3/4" hex-head. All bolts shall receive an application of an anti-galling lubricant prior to installation.

The City reserves the right to reject any material that may be supplied for use, whether on the "Engineer's List of Approved Items" or not. If the City obtains information indicating that a listed item is not performing satisfactorily or is found to be defective, that item will be rejected and the Contractor shall submit a replacement for review at no additional cost to the City.

130-1.02A Material Submittals

The Contractor shall submit to the Engineer, in writing, a list of all materials proposed to be used on this project, and any supporting documentation and/or samples required by the Water Department.

For materials listed on the current "Engineer's List of Approved Items" the Engineer shall be provided with the name of the manufacturer and model/part number for all material proposed for this project.

For any proposed material not listed on the "Engineer's List of Approved Items" the Contractor shall provide to the Engineer, the name of the manufacturer and model/part number along with supporting documentation and/or samples that will allow the Engineer to make an informed decision on acceptance or rejection of the material.

The Contractor shall provide submittals to the Engineer for all manhole components and their proposed construction prior to the start of work. Manholes shall be constructed per an accepted submittal and any request and approval for alteration must be in writing.

130-1.02B Polyvinyl Chloride (PVC) Pipe

PVC solid wall sewer pipe and fittings for gravity sewers shall be made from all new, rigid, unplasticized polyvinyl chloride in accordance with ASTM D-3034 and ASTM F-679 and shall have a minimum pipe stiffness of 46 psi. Joints shall be gasketed and conform to the requirements of ASTM D-3139 and ASTM F-477.

All pipe shall have a **manufacturer marked home-mark insertion line** to indicate proper insertion of the spigot **into the bell** when the joint is made. Bevel and lubricate all field cut PVC pipe per manufacturer's instructions before joining. **Where field cutting of pipe removes the manufacturer's insertion line, the cut pipe shall be remarked per manufacturer instructions prior to installation. Pipe joints that are not installed per manufacturer's instructions may be required to be**

removed and relayed at the discretion of the Engineer.

All PVC pipe entering or leaving a concrete structure shall have an approved manhole gasket firmly fitted around the pipe exterior and cast into the structure base or near the structure wall center as a water stop.

130-1.02C Restrained Joint (PVC) Pipe and Fittings

Restrained joint PVC pipe and fittings shall conform to the requirements of ASTM D-2241. Joints shall be gasketed and conform to the requirements of ASTM D-3139 and ASTM F-477.

130-1.02D Ductile Iron Pipe

Ductile iron pipe shall be new pipe conforming to AWWA Standard C151/A21.51, pressure class. The pipe shall be furnished with rubber gasket push-on, or mechanical joint ends, except where otherwise specified on the plans.

Ductile iron sewer pipe and fittings shall be lined with Protecto401 Ceramic Epoxy or an approved equivalent. The interior of the pipe and fittings shall not have been previously lined and the liner shall be applied by a certified applicator where the pipe and/or fittings are manufactured or at a certified off site coating facility approved by the pipe and/or fitting manufacturer. The pipe and/or fitting manufacturer shall be fully responsible for insuring the liner complies with all manufacturer's recommendations, including, but not limited to, pipe wall preparation, wet and dry film thickness, coating integrity and curing prior to shipment to jobsite.

Any request for substitution shall be accompanied by documentation showing a history of successful use in sanitary sewer systems and that the liner was applied by a certified applicator with a history of applying linings to the interior of ductile iron pipe and fittings.

All ductile iron pipe buried underground shall be encased in polyethylene film in the tube form. Polyethylene material and installation procedure for the encasement shall conform to ANSI/AWWA C105/A21.5.

130-1.02E Ductile Iron Restrained Joint Fittings

Restrained joint fittings shall be ductile iron in accordance with applicable requirements of AWWA C111/A21.11 and AWWA C153/A21.53 of latest revision and shall be compatible with the type and pressure class of pipe used.

130-1.03 Excavation, Backfill and Resurfacing

Excavation and backfill shall conform to Standard 215, "Standard Trench Detail" of the City of Santa Rosa Standard Plans.

Trench resurfacing shall conform to Standard 215 unless otherwise specified elsewhere.

If existing utility crossings or other potential conflicts are shown on the plans or specified in other contract documents, the Contractor shall pot hole said areas as well as proposed connection points to the City's sanitary sewer system prior to the start of pipe laying. If conflicts are discovered during this investigation the Engineer shall be notified immediately.

It is the Contactor's responsibility to ensure that sewer components are laid and bedded on sound, stable material. All existing material that has been disturbed shall be removed from the trench prior to installation of new material. The Contractor shall promptly notify the Engineer of any field conditions that may affect alignment and/or grade.

Abandoned utilities found to reside in a common trench with sewer components shall be removed and disposed of prior to the installation of any new sewer facility unless otherwise directed by the Engineer. Any exposed pipe ends on abandoned lines that remain shall be plugged per Standard 507.

All excavations shall be able to accommodate equipment and personnel required for backfilling and compaction testing. If, in the opinion of the Engineer, typical compaction methods cannot be used, the Engineer may require the use of a pneumatic Pogo Stick/Powder Puff type compactor at no additional cost to the City. Excavations around new and existing manholes shall be a minimum of 24 inches wider than the outside of the barrel section.

Blasting shall not be permitted unless first approved of, in writing, by the Building Department and the Director of Santa Rosa Water.

Control density fill (CDF) shall be placed at the locations shown on the plans and where cover is less than 3 feet. CDF shall conform to Standard 215. A material submittal is required. All excavations in a traveled way with CDF backfill shall be plated or otherwise safely covered to allow for safe passage during curing.

All stumps and large roots encountered during trenching operations shall be removed to the satisfaction of the Engineer.

Trenching operations shall be conducted in such a manner that will not disturb existing facilities. The Contractor shall incur all costs associated with repairs needed, in the opinion of and to the satisfaction of the Engineer, by any such damage due to their operations.

The trench shall be opened sufficiently ahead of the pipe laying operations to reveal obstructions. Trench crossings shall be provided as necessary to accommodate public travel and to provide convenient access to adjacent properties. Flow shall be maintained in any sanitary sewers, storm drains, water lines, or water courses encountered in trenching.

Cutting of Asbestos Cement Pipe (ACP) shall be done utilizing a Pipe Cutter (snapper), of the proper type and size for the intended use. A ratcheting hand snapper shall only be used on ACP sizes of 6 inch and smaller. The "snapper", and all appurtenances shall have been inspected by the Contractor to ensure that it is in good working order prior to use.

If field conditions require an alternative method for cutting the ACP, the alternative method shall comply with all laws and requirements as specified by OSHA, the Contractor's State Licensing Board, and any other governing body for this type of work.

In all cases, cutting, handling and disposal shall be done per the above stated governing bodies. Cut pipe shall be properly enclosed as soon as possible after removed from the trench.

When the public works involved will exceed an estimated \$25,000 for the excavation of any trench or trenches five feet or more in depth, the Contractor shall, except for subdivisions, submit to the Engineer for acceptance in advance of job excavation, a detailed plan showing the design of shoring, bracing, sloping, or other provisions to be made for worker protection from the hazard of caving ground during the excavation of such trench or trenches. If such plan varies from the shoring system standards established by the construction safety orders, the plan shall be prepared by a registered civil or structural engineer. A permit to do the above described work shall be obtained from the State of California, Division of Industrial Safety. Proof of such permit shall be submitted to the Engineer prior to starting the trench work.

Unless otherwise specified, excess material from excavation shall become the property of the Contractor and shall be disposed of to the satisfaction of the Engineer. If the work is in existing City streets the excess material shall be removed from the site daily unless it has been preapproved for reuse.

Prior to disposal of any materials or operation of any equipment on sites provided by the Contractor for disposal of excess trench excavation owned by him, the Contractor shall submit to the Engineer written authorization for such disposal of materials and entry permission signed by the owners of the disposal site and the required permits.

On projects to remove and replace existing sewer facilities and the existing sewer main is a material other than asbestos, the Contractor shall assume that approximately 15% of all existing sanitary sewer laterals to be replaced are constructed of asbestos cement pipe. Where the existing sewer main material is asbestos cement, it should be assumed that all laterals are asbestos cement pipe. All related disposal costs shall be the bourn by the Contractor.

All excavated material shall be removed from the jobsite at the end of each day unless otherwise approved by the Engineer.

130-1.04 Trench Bracing and Shoring

All bracing and shoring shall conform to Section 7-1.02K(6) of the Standard Specifications or any later revision, and the Division of Industrial Safety Construction Safety Orders which are currently in use.

The Contractor shall take all necessary measures to protect the workers and adjacent areas and structures from the hazards of the trenching or excavation operations.

Trench sheeting or boxes shall be withdrawn in such a manner as to prevent caving at the walls of

excavations or damage to piping or other structures. Sheeting shall be completely removed from the trench and no backfill shall be installed against the sheeting before it is removed.

Trenching operations shall be conducted in such a manner that will not disturb the existing curb, gutter and existing utilities that are to remain in place.

130-1.05 Pipe Laying

The Contractor shall provide the equipment, materials and personnel to maintain continuous sanitary sewer service to all customers, 24 hours a day and 7 days a week during construction, including but not limited to the installation of temporary lines and pumping equipment at no additional cost to the City unless otherwise specified. Any deviation from this requirement must first be approved by the Engineer.

Where ground water occurs, pumping shall continue until back filling has progressed to a sufficient height to prevent flotation of the pipe. Water shall be disposed of in such a manner as to cause no property damage or not be a hazard to public health.

Where construction consists of constructing a new main or extension of an existing main, the downstream end of the new main shall be securely closed with a tight fitting plug until the construction is accepted by the Engineer.

Sewer pipe shall be installed on the alignment and grade as shown on the plans and in accordance with applicable City Standards and the Standard Specifications, or as directed by the Engineer. Existing sewer laterals shall be removed and replaced at the locations shown on the plans, or as directed by the Engineer.

Sewer pipe shall be laid in straight lines and on uniform rates of grade between points where changes in alignment or grade are shown on the plans. The interior of the pipe shall be free of foreign matter before lowering into the trench.

If proper separation between new sewer lines and water mains, per the latest guidelines from the California State Water Resources Control Board cannot be maintained, the Contractor shall inform the Engineer immediately to get direction, unless direction has already been provided in the contract documents. See Appendix "A" of the City of Santa Rosa Water Distribution System Design Standards for additional information and direction.

The pipe manufacturer's written instructions covering the installation of their pipe, and any related materials, shall be closely followed unless otherwise directed or approved in writing by the Engineer. The trench shall not be backfilled until authorized by the Engineer. Pipe laying shall proceed upgrade with the spigots pointing in direction of flow. The invert of the pipe shall be set at required line and grade as determined from batter boards set not over 25 feet apart.

Electro-optical grade setting devices may be used provided that the device will be operated by a person proficient in its operation.

Any section of pipe found to be defective or which has had grade or joints disturbed shall be re-laid by the Contractor at their expense.

Proper implements, tools and facilities satisfactory to the Engineer shall be provided and used by the Contractor for the safe and efficient execution of the work. All pipe, fittings and accessories shall be carefully lowered into the trench by means of derrick, ropes, or other suitable equipment in such a manner as to prevent damage to pipe and fittings. Under no circumstances shall pipe or accessories be dropped or dumped into the trench. The pipe and accessories shall be inspected for visible defects prior to lowering into trench. Any visibly defective or unsound pipe shall be replaced.

The line and grade of existing utilities shall not be altered. Any leakage caused in existing utilities by reason of the Contractor's operations shall be immediately repaired at the Contractor's expense.

Existing storm drains shall be supported or removed and replaced at the Contractor's option and at no additional cost to the City. In any case, the Contractor shall be responsible for maintaining the existing line and grade of the storm drains. If the Contractor elects to remove and ~~replace~~, ~~it~~ **replace, it** shall be done in conformance with all applicable City Standards and to the satisfaction of the Engineer.

Existing water lines shall be supported in place with service maintained during construction. The Contractor shall be responsible for any damage to the water lines during construction and any damage resulting from improper backfilling.

Existing sewer lines shall be supported in place with service maintained during construction. The Contractor may, at their option, remove and replace any sewer laterals which are not in use during construction. The Contractor shall be responsible for damage to sewer lines during construction and any damage resulting from improper backfilling.

Sewer lateral inverts shall be set above the midpoint of the sewer main unless otherwise directed by the Engineer in writing. Any lateral invert installed below the midpoint of the main without prior written approval shall be replaced and the lateral relayed at the Contractor's expense.

If the proposed sewer main is replacing an existing main but at a higher elevation, the Contractor shall submit a temporary connection plan to the Engineer for approval a minimum of 5 working days prior to start of work. The temporary connection plan shall include a schedule of work and will show how all existing flow will remain active. The Contractor shall continuously monitor the upstream manhole of any temporary connection.

Any temporary connections between new and existing sewer mains and/or manholes required for the progress of work shall be made with approved rigid piping and sheer band and/or gasketed couplings. If bends are required to make the connection, the bends shall be long radius bends unless otherwise approved.

Any proposed temporary main connection that may be in place longer than 24 hours, except those

specified in Section 130-1.06 herein, shall be submitted to the Engineer for approval prior to installation.

Both new and existing mains shall have the ability to be accessed individually for maintenance and emergency response by City personnel at all times. All temporary connection material shall be fully removed after its intended use.

Where a sewer main is to be installed in a pipe casing, installation shall be similar to City Standard 872 "Water Main Encasement and End Seal", including joint restraints. All proposed material shall be submitted to the City for review and approval.

130-1.05A Abandon or Remove Existing Sanitary Sewer System Components

Abandonment of existing sewer components shall conform to applicable City Standards, specifically Standards 507 & 508, and any modifications specified in the contract documents.

Existing sewer system components shall be removed where shown on the Plans or to facilitate the progress of work. The Contactor must receive written approval from the Engineer prior to removing any component, fully or in part, that is active during construction. Any removed components from an active system shall be replaced with approved materials to the satisfaction of the Engineer.

When a sewer lateral is to be removed or abandoned in place that is connected to an existing main 12" and smaller that is to stay active, the connection shall be fully removed by cutting out a section of the main, at least 4 feet in length, and replacing the removed section with approved pipe and couplers. Where the lateral is to be removed or abandoned in place on a main 15" or larger, and the connection is by "break in" or tap, the lateral pipe and all appurtenances shall be removed from the main and an approved full circle stainless steel clamp installed over the penetration. The length of the full circle clamp shall provide a minimum of 2 inches of overlap over the penetration. The plugging or capping of connections on mains that are to stay active shall only be done with prior approval from the Director of Santa Rosa Water. Where a wye or tee fitting that is not a tapped fitting is installed on a trunk sewer, approval to plug or cap the wye or tee in an approved watertight manner is acceptable but the method and material must first be approved by the Water Department. When allowed, the cap or plug must be visible from the pipe interior when televising the main. Any plugging or capping of connections shall be noted on the record plans.

130-1.06 Sewer Laterals

Sewer laterals shall be installed or replaced at the locations shown on the Plans and in accordance with City Standards.

Unless otherwise specified, sewer laterals shall be installed with a two-way cleanout per City Standard 513A. unless conditions, as noted in the Standard, do not allow their use, or if otherwise specified in contract documents.

If field conditions require the installation of a one-way cleanout per the conditions called out in City Standard 513A, the cleanout shall be installed behind the sidewalk or PUE, in accordance with City Standard 513, unless otherwise depicted on the Plans.

All two-way cleanouts shall be installed 18 to 24 inches behind face of curb unless otherwise shown on the Plans or approved by the Engineer.

Where a project involves the replacement of existing sewer laterals, the estimated locations of the existing laterals that are shown on the Plans are based on record information, television inspection, and field evidence. This information is available for review upon request. The City assumes no responsibility for the accuracy of this information or the inadvertent omission of any such information. Not all existing sewer laterals are guaranteed to be located through these means, the Contractor may, therefore encounter sewer laterals not shown on the Plans. The Contractor shall have the sole responsibility for determining the exact location for all existing laterals. During sewer mainline construction but prior to the installation of each individual new sewer wye on the main, the Contractor shall determine the exact location of the existing sewer lateral at back of sidewalk or PUE. Two acceptable methods of locating a sewer lateral at the back of sidewalk are:

1. Removing sidewalk and/or potholing by hand digging at the back of sidewalk to locate the existing lateral pipe a minimum of 24-hours prior to sewer main installation in that area;
2. Inserting a metallic electrician's "fish tape" into the existing lateral pipe after the pipe is exposed during sewer main excavation and tracing the "fish tape" to the back of sidewalk using a pipe and cable metal locator.

If the Contractor chooses to use method "2" above and cannot locate the existing sewer lateral at the back of sidewalk, they shall locate the lateral by potholing at back of sidewalk prior to the installation of the wye at the main.

Typically, each active sewer lateral found to exist shall be replaced, unless specifically deleted by the Engineer.

If a sewer lateral shown to be replaced appears to be inactive the Contractor shall notify the Engineer and then attempt to verify their conclusion.

All sewer laterals shall be installed perpendicular to the curb unless otherwise shown on the Plans or approved by the Engineer. Any lateral that is not installed perpendicular to the curb shall tracer wire installed in the following manner:

1. Wrap wire two times around wye connection at main and secure.
2. Lay both ends on top of and along the lateral to the cleanout and up the cleanout riser. Both ends of wire shall extend approximately 6 inches beyond riser.
3. Secure wire to top of lateral pipe at approximately 5 foot intervals. Ends of wire must be easily accessible inside the cleanout box.

For tracer wire specifications see Sanitary Sewer System Design Standards.

Any change in alignment needed from face of curb to back of sidewalk or PUE shall be accomplished using long radius bends. If the cleanout is installed 18 to 24 inches behind face of curb all alignment changes shall take place between the cleanout and the back of sidewalk or PUE. Any use of short bends in this area must first be approved by the Water Department.

Connections to existing laterals shall be made at back of sidewalk or PUE unless otherwise specified herein or depicted on the Project Plans. Prior to connecting, the Contractor shall investigate to see if there is an existing cleanout not already shown to be removed located beyond where the typical connection point would be and up to three feet behind the back of sidewalk. If an existing cleanout is discovered within these limits the Contractor shall remove it and any existing lateral piping as needed and then make the connection using approved pipe and couplings.

A 4-inch high letter 'S' shall be legibly inscribed in the face of new and existing curbs at the location of each lateral. Where bends are required behind the curb to make a connection an additional 'S' shall be legibly inscribed at the back of sidewalk where the connection to the existing lateral was made.

Whether shown to be installed on the plans or not, all sewer laterals that; have 3 feet or less cover at the connection to the main; or, that are connected to the main within 5 feet of an upstream manhole, shall have a same size as lateral "Clean Check PVC Extendable" or approved equivalent backwater valve installed. The valve shall be installed per Standard 527 within 5 feet of the building, if conditions allow. The exact location shall be determined in the field by the Engineer after the Contractor has located the onsite alignment of any existing lateral using a fish tape and pipe and metal locator or other approved method. Any valve installed onto an existing lateral shall have a minimum of 1 foot sections of approved pipe installed on both ends of the lateral and connected to the existing lateral with approved couplings. If installing a ~~6-inch~~ 6-inch valve, it shall be covered with a Christy G5 box, or approved equivalent set to grade with a lid marked "Sewer".

Active sewer laterals are to remain in service at all times, to facilitate this when removing and replacing an existing main the Contractor shall install a temporary connection between the new wye and the existing lateral until the new sewer lateral is constructed.

Plastic flex pipe may be used for temporary connections between active existing sewer laterals and the new wyes on the main. The flex pipe shall be the same size as the existing lateral pipe and shall be connected to the new wye and the existing lateral by means of an approved flexible sewer coupling. Squeezing the flex pipe and inserting it into the cut end of the existing lateral or into the lateral opening of the wye will not be allowed. All temporary connection material shall be removed from the trench prior to final compaction.

Temporary sewer lateral connections shall be replaced with permanent laterals after installation of the sewer mainline is completed for each block, or at a maximum of 20 calendar days, whichever is sooner.

Provide 1-foot minimum clearance between wyes on all sewer mains as measured between adjacent bell ends.

Sewer wyes installed at incorrect locations shall be removed and replaced with a 4-foot minimum length of pipe and approved couplings. Capping of wyes installed at incorrect locations will not be allowed. Prior to installing wyes on the main, the Contractor shall investigate to ensure that the proposed alignment of new laterals will not be in conflict with any other facilities, existing or proposed. The Contractor shall promptly notify the Engineer of any field conditions that prohibit installing the wye in accordance with City Specifications and/or Standards.

A minimum separation of 3 feet shall exist between new sewer laterals and existing water services. If this separation requirement cannot be met the Contractor shall notify the Engineer immediately for direction prior to continuing work on this lateral. In all cases, a minimum of 5 feet separation is required between new sewer laterals and new water services.

Sewer laterals constructed under existing curb, gutter and driveway culverts shall be accomplished by use of a trenchless method approved by the Engineer, unless otherwise specified. Boring under sidewalks and/or concrete filled planter strips will not be allowed. Boreholes shall be only large enough to allow for the size of pipe to be installed. If the Contractor's operations disturb the supporting soil, the Engineer may require the removal and replacement of any undermined curb, gutter or culvert; and/or the use of CDF backfill at the Contractor's expense. The limits of the curb and gutter replacement and any required dowelling will be at the discretion of the Engineer at the Contractor's expense.

The Contractor shall remove and replace existing sidewalk and concrete planter strips for the installation of sewer laterals to the nearest transverse score mark on both sides of the lateral. All concrete removed shall be backfilled and compacted level with temporary asphalt concrete or covered with 1 inch thick plywood, laid flat with ADA compliant tapers on both ends.

Where an excavation for a new sewer lateral occurs within the drip line of any tree the Contractor shall hand dig to protect tree roots as directed by the Engineer. Root pruning shall be done only when directed by the Engineer and shall be accomplished by use of sharp tools appropriate for the size of the root to be cut. Each cut shall be clean with no torn bark or splintered wood remaining on the root. At no time shall roots be pulled on by excavating equipment.

Existing irrigation facilities not shown on the plans may be encountered during sewer lateral installation. The Contractor shall repair any damage to existing irrigation facilities caused by their operations.

Where an existing sewer main is a material other than asbestos cement, the Contractor shall assume that approximately 15% of all existing sanitary sewer laterals to be replaced are constructed of asbestos cement pipe. Where the existing sewer main material is asbestos cement, it should be assumed that all laterals are asbestos cement pipe. All related removal and disposal costs shall be the responsibility of the Contractor.

The Contractor shall notify and coordinate the replacement of individual sewer laterals with the effected resident or business.

130-1.07 Sewer Structures

All active manholes shall be considered as confined spaces.

Manholes shall be constructed per an accepted submittal and any request and approval for alteration must be in writing.

Manholes shall be standard precast concrete manholes as detailed on ~~City~~ City Standard 500. Mains larger than 18 inches in diameter require ~~60-inch~~ 60-inch diameter manholes.

Manhole bases may be poured-in-place concrete on undisturbed earth. The bases shall be poured full thickness against the side of the manhole excavation or to dimensions shown on Standard 500. The manhole excavation site shall be dewatered before pouring.

Pre-cast manhole bases, conforming to City Standard 500 in dimensions and the requirements outlined below for materials may be used. Such pre-cast bases shall be placed on a minimum ~~6 inch thick~~ 6-inch-thick cushion of drain rock, as specified in Standard 500. The drain rock shall extend a minimum of 6 inches beyond the outside edges of the base.

Precast manhole bases shall be constructed per ASTM C478. Concrete for cast-in-place manhole bases shall be portland cement concrete in compliance with Section 90 of the City Standards and Specifications.

If a new manhole is to be installed on an existing asbestos cement main, the Contractor shall remove all asbestos cement piping to a minimum of 12 inches beyond the manhole trench and into the mainline trench, any visible joints up to 36 inches beyond the manhole trench shall also be removed. All replacement materials shall be per City Standards, and all removed asbestos cement material shall be disposed of in accordance with all laws and regulations.

Except as noted below, or where otherwise specified, all manholes regardless of diameter shall have concentric tapered sections.

Prior to any work taking place in a new or existing manhole, a platform shall be constructed in the manhole above the top of the sewer to prevent any dirt or debris from entering into the sewer line. The platform shall remain in place until all work on the manhole has been completed. All dirt and debris shall be removed from the platform prior to its removal.

Eccentric tapered sections shall be installed when the installation of an inside drop is required. Where a manhole has a single drop structure the opening of the eccentric tapered section shall be directly over the drop. When multiple drops are required, the alignment of the opening shall be determined by the Water Department.

Where the constructed height of a precast base does not allow for the installation of a tapered section due to rim to invert elevation constraints, the Contractor shall submit for a cast-in-place base for review. Slab sections shall only be considered where the height of a cast-in-place base will not allow for the installation of a tapered section.

Where steel reinforcement is required in manhole base construction, such reinforcement shall be furnished and placed as shown on the plans and in accordance with the applicable provisions of

Section 52 of the Standard Specifications.

The base slab and initial riser section shall be connected with integrally poured concrete to create a watertight joint. Flow channels shall be constructed as shown on the plans. Changes in size and/or grade shall be made gradually in constructed channels, and changes in direction shall have smooth curves with proper radiuses that direct flow toward the outlet pipe and minimizes turbulence. All finished surfaces shall be smoothly troweled with a steel trowel. All manhole barrels and taper section shall be precast concrete sections using Type V portland cement complying with ASTM Designation: C 150 or low-alkali Type II cement meeting the requirements for Type V cement.

The ~~48~~48-inch and ~~60~~60-inch diameter barrels and taper sections shall be constructed in accordance with the applicable provisions of ASTM Designation: C 478 and shall be inspected by the Engineer to determine that the interior surfaces are smooth and free of pockets or depressions.

Manhole frames and covers shall be in accordance with Standard 512. Tops of manhole frames and covers shall be set accurately to finished grade in paved streets and 1 foot above finished grade in unimproved areas. The frames shall be evenly set on the manhole on a portland cement mortar bed. Where manholes are set above finished grade, the earth shall be mounded up around the manhole in a neat and acceptable manner to the satisfaction of the Engineer.

The entire interior surface of all new manholes, and existing manhole being connected to, shall be coated including the flow channel down to the spring line after all cracks and/or chips have been patched and existing surfaces prepared. Coating and patching materials shall be per the Engineer's List of Approved Items and shall be applied in accordance with the manufacturer's recommendations.

All joints in manholes shall be sealed by means of a preformed, self-bonding, self-sealing gasket from the Engineer's List of Approved Items, or an approved equivalent. Joint seals shall be installed in full compliance with the manufacturer's current recommendations.

The interior surface of all sanitary sewer main line cleanouts (area under frame and cover and around pipe), shall be troweled and brushed smooth and free of pockets or depressions.

Except as otherwise specified, all manholes on active mains shall be accessible at all times.

After placing the surface course of asphalt concrete, all manholes and cleanouts shall be located and marked with white paint before the close of that work day.

Within two working days of paving, all manholes and cleanouts shall be adjusted to grade and inspected.

130-1.07A Existing Manholes

Existing manholes and clean outs located within the street right of way shall be adjusted to conform to finished pavement grades in accordance with the details shown on the plans.

When a new sewer pipe is connected to an existing manhole, the manhole shall be modified to accept the new size of pipe and grouted to form a new flow channel in the manhole base. The wall of the manhole shall be breached by core drilling, sawing, or other approved method that does not disturb the manhole. The Contractor shall seal the penetration with StopAQ™ or SealGuard II, or an approved equivalent water stop, and shall grout the sealed penetration with a rapid set, high strength, non-shrink cementitious mortar to protect the sealer. The Contractor shall backfill the exterior of the manhole around the pipe penetration with concrete to stabilize the main and create a watertight connection.

When any modifications are made to a new or existing manhole, the Contractor shall use a bonding agent such as Sakrete Concrete Bonder and Fortifier, or approved equivalent, to adhere modification material to the existing structure.

Prior to the removal of an existing manhole frame, a platform shall be constructed in the manhole above the top of the sewer to prevent any dirt or debris from falling into the sewer. The platform shall remain in place until all work on the manhole has been completed. Prior to the removal of the platform from the manhole, all dirt and debris shall be removed.

Lowering of the manhole frame and cover can be accomplished by the removal of existing concrete grade rings below the manhole frame or by removing the upper section of manhole barrel and substituting therefore a shorter section of barrel.

At the Contractors option, in lieu of removing and replacing barrel sections as above provided, the top of the existing upper barrel section may be trimmed and the taper section replaced on such trimmed surface provided, however, that such trimming shall not crack or otherwise damage the remaining portion of barrel section and that the new joint can be sealed watertight.

In the event that the portion of barrel section to remain is cracked or damaged or otherwise made unsuitable for use by such trimming, the entire section shall be removed and replaced with a new section of barrel.

Trimming of taper sections is not permitted.

All sections of the manhole shall be set in cement mortar or in approved gasket material. Trim excess gasket material and plaster inside joints smoothly. Manhole sections set in cement mortar shall be smoothly plastered inside and out.

After placing the surface course of asphalt concrete, all manholes and cleanouts shall be located and marked with white paint before the close of that working day.

Within two working days of paving, all manholes and clean out shall be adjusted to grade and inspected.

Existing grade adjustment rings in the adjustment of manhole frames shall become the property of the Contractor and, if undamaged and thoroughly cleaned of mortar, may be reused in the work. If not so used, they shall be disposed of away from the site of the work at the expense of the

Contractor.

130-1.08 Testing of Sewers

Testing of all portions of the sewer including manholes is required, and it's the Contractor's responsibility to coordinate all testing and inspections with the Engineer.

The Contractor, at their option, may conduct testing at any time during construction, however, final inspection and testing for acceptance shall take place only after all sewer facilities have been installed and all trenches backfilled and compacted, including roadway base rock as specified elsewhere in these specifications.

Manholes, after all inlets and outlets have been plugged, shall be filled with water to the rim of the frame casting and shall lose no more than 2 inches over a period of 30 minutes.

Even though the test for leakage is within the prescribed limits, the Contractor shall repair any obvious leaks.

In lieu of the water test, testing of sewer manholes may be done by vacuum testing as specified herein. If the vacuum testing method is used, all manholes shall be tested for leakage in accordance with ASTM C 1244-93 as modified herein.

Vacuum testing shall not take place until all permanent paving is complete.

Installation and operation of vacuum equipment and indicating devices must be in accordance with manufacturer's recommendations and performance specifications, which must be provided by the manufacturer and approved by the Engineer. The equipment must be capable of testing the entire manhole, including the cast iron frame and grade adjustment rings.

All new or rehabilitated sanitary sewer manholes shall be tested unless otherwise directed by the Engineer. If the manhole fails the test, the manhole shall be repaired and retested at the Contractor's expense. If manhole joint sealants are compromised during the vacuum test, the manhole must be disassembled and the joint sealants replaced. If there is reason to believe that the manhole has been disturbed after the initial vacuum test, additional tests may be requested by the Engineer and performed at the Contractor's expense.

The Contractor may pre-test manholes at any time during construction. Any pre-test results are solely for the Contractor's use and shall not be accepted as the final test.

Testing shall be done in the following manner:

1. All lift holes and joints shall be grouted and the entire manhole, including grade rings, sealed prior to testing.
2. All pipes entering the manhole shall be temporarily plugged, taking care to securely brace the pipes and plugs to prevent them from being drawn into the manhole.

3. The test head shall be placed in accordance with the manufacturer's recommendations. The test unit shall be braced against the manhole frame and not the grade ring(s) or taper.
4. The vacuum gauge and test equipment used for this test shall be supplied by the Contractor and shall be operated per manufacturer's specifications by qualified personnel. Accuracy and calibration of the gauge shall be certified by a reliable testing firm at six month intervals, or when requested by the Engineer.

A vacuum of 10 inches Hg (4.91 PSI) of mercury shall be drawn on the manhole, the valve on the vacuum line of the test head closed, and the vacuum pump shut off. The time it takes the indicator gauge to drop from 10 inches Hg (4.91 PSI) to 9 inches Hg (4.4 PSI) shall be measured. The manhole will pass the vacuum test if the time is greater than shown in the following table:

Minimum Test Time Based On Manhole Diameter (sec.)

<u>Manhole Depth in Feet</u>	<u>Manhole Diameter in Inches</u>			Time in Seconds
	48	60	72	
0-4	10	13	16	
4-8	20	26	33	
8-12	30	39	49	
12-16	40	52	67	
16-20	50	65	81	
20-24	59	78	97	
24-30	74	98	121	

After the vacuum test, manholes shall be visually inspected for leaks and defects and repaired as required by the Engineer.

For either exfiltration or infiltration test on sewer lines, the maximum leakage shall not exceed 250 gallons per inch of pipe diameter per mile per 24 hours as measured over a period of 30 minutes minimum. Should the leakage exceed the maximum allowable rate, the contractor shall repair, overhaul, or rebuild the defective portion of the sewer line to the satisfaction of the Engineer at no additional cost to the City. After repairs have been completed by the Contractor, the line shall be retested as specified above, all at no cost to the City.

In the event that the exfiltration test prescribed above is impractical due to wet trench conditions, these portions of the sewer line where such conditions are encountered will be tested for infiltration. The Engineer shall determine whether the exfiltration or infiltration test will be used.

Low pressure air testing may be used on sewer lines in lieu of water testing at the option of the Contractor. Water testing may still be required by the Engineer for certain installations.

The following procedure shall be used for low pressure air testing:

1. Clean pipe to be tested by propelling a snug fitting inflated rubber ball through the pipe

with water. Remove any debris.

2. Plug all pipe outlets with suitable test plugs. Brace each plug securely.
3. If the pipe to be tested is submerged in ground water, insert a pipe probe, by boring or jetting, into the backfill material adjacent to the center of the pipe, and determine the pressure in the probe when air passes slowly through it. This is the back pressure due to ground water submergence over the end of the probe. All gauge pressures in the test should be increased by this amount.
4. Add air slowly to the portion of the pipe installation under test until the internal pressure is raised to 5.0 p.s.i.g.
5. Check exposed pipe and plugs for abnormal leakage by coating with a soap solution. If any leakage is observed, bleed off air and make necessary repairs.
6. After an internal pressure of 5.0 p.s.i.g. is obtained, allow at least two minutes for air temperature to stabilize, adding only the amount of air required to maintain pressure.
7. After the two-minute period, disconnect the air supply and start stopwatch. The pressure of 5.0 p.s.i.g. shall be maintained for 5 minutes.
8. As an alternate, the contractor may request the air testing procedure as presented in Section 306-1.4.4 of the 2012 edition of the "Greenbook" Standard Specifications.

After pipe installation and placement and compaction of backfill, but prior to placement of pavement, all PVC pipe shall be cleaned and then mandrel tested for obstructions, such as, but not limited to, deflections, joint offsets and lateral pipe intrusions. A rigid mandrel, conforming to Standard 518 shall be pulled through the pipe by hand. The minimum length of the circular portion of the mandrel shall be equal to the nominal diameter of the pipe. All obstructions encountered by the mandrel shall be corrected by the Contractor. Obstructions due to deflection shall be corrected by replacement of the over-deflected pipe. Mechanical re-rounding is not permitted.

If a section of pipe fails to meet the mandrel test and is reinstalled and fails the second time, said section(s) of pipe shall be replaced with an approved rigid pipe material.

The contractor shall furnish mandrel as shown on the City Standards.

The Contractor shall retest PVC pipe using a mandrel conforming to Standard 518 eleven (11) months after recordation of Notice of Completion of a Public Works Sewer Contract or after the acceptance by the City Council of a subdivision. Any pipe which fails to pass the mandrel test shall be replaced at the expense of the Contractor. The City reserves the right to determine the longitudinal limits of any pipe that is required to be replaced. Pipe replacement shall be guaranteed by the project maintenance bond.

130-1.09 Televising Inspection

Prior to scheduling televising inspection work, all sanitary sewer construction, and any other underground work which, in the opinion of the Director of Santa Rosa Water, has the potential to impact sanitary sewer work, shall be installed, their trenches compacted, and all other testing and inspections completed and accepted. Final paving over the work shall not take place until all underground work, including television inspection, is completed and accepted by the Engineer.

The Contractor shall hire an independent television inspection service to perform a closed circuit television inspection of all newly constructed sewers lines, including laterals from the main to the cleanout, and if lateral line is a replacement, from cleanout to connection point of the existing lateral.

The Contractor shall notify the Engineer in writing 2 working days in advance of the date for television inspection. The Engineer or their authorized representative shall be given the opportunity to be present during the inspection. Upon receipt of the completed televising inspection digital video files and written logs, the Engineer shall be allowed 10 working days to review the video records and logs before giving written notice of acceptance and/or deficiencies of the lines to the Contractor.

The Contractor shall supply plans and specifications for this work to the televising subcontractor with manhole and mainline cleanout numbers, street names, addresses and any other information required to facilitate the work.

During this inspection, the Contractor or their authorized representative shall be present to observe the televising inspection. Acceptance of any portion of the sanitary sewer work shall not be given in the field at the time of televising.

The Engineer shall only receive video and written logs for areas not known by the Contractor to need correction. If while conducting the initial television inspection in the field, the General Contractor or their authorized representative discovers areas that need correction, these corrections shall be made and the area televised again prior to submitting the logs to the Engineer for review. If footage of video that is not required for inspection, such as; areas known to need repair, stationary video footage in sanitary sewer lines other than where required and footage not of sanitary sewer facilities, the submittal will be rejected.

Any damage to facilities or obstruction to service caused by the televising operations shall be corrected immediately by the Contractor at no cost to the City.

The Contractor shall obtain permission from the Engineer prior to the removal of any manmade or natural obstruction needed to complete this work. Any item removed shall be replaced in kind to the satisfaction of the Engineer, and will be done at the Contractor's expense.

All lines shall be flushed clean with a high-pressure commercial sewer flusher unit or by balling prior to televising. If required to televise an existing line it may be necessary to remove roots, grease or other obstructions prior to flushing per these Special Provisions. The equipment shall be appropriate for the type of obstruction being removed and shall not damage the pipe in any way.

All debris shall be trapped at the first downstream manhole and removed. Debris will be hauled to an appropriate disposal site at the Contractor's expense.

After flushing and prior to televising, an approved source of water will be discharged into the upstream manhole or mainline cleanout until water flows out of the downstream manhole. This is to be done no more than 24 hours before the video inspection takes place. High pressure flushing of the line is not to be considered as a substitute for this requirement. This shall be done to insure that all dips or sags are filled before televising, if the sanitary sewer has live flow, the Engineer may waive this requirement. Live flows that are greater than the depth of the gauge shall be temporarily plugged upstream and bypass pumped to allow for proper televising.

The televising of all lines shall be recorded in a digital color format that does not require the use of specialized equipment and/or programs not already in use by the City's Engineering Department. Video files shall be on non-rewritable DVD disc(s) or flash drive(s), and shall be delivered to the Engineer along with computer program generated written inspection logs. The video files and written logs shall become the property of the City of Santa Rosa. Every televised run (manhole to manhole, manhole to mainline cleanout, and laterals) shall be recorded as a separate video file, with the name of the file being the manhole and/or mainline cleanout numbers for the main, and the property address for the lateral. A lateral file shall consist of the run from the clean out to the connection at the main and the run from the clean out to the connection of the existing lateral.

A pan and tilt color camera shall be used for all video inspection of main lines and shall be one specifically designed and constructed for such inspections. The camera shall be mounted on adjustable skids, a tractor, or when approved by the Engineer, a raft to keep it in the center of the pipe. Lighting for the camera shall be supplied by a lamp on the camera, capable of being dimmed or brightened remotely from the control panel. The lighting system shall be capable of lighting the entire periphery of the pipe. The camera shall be operative in 100% humidity conditions and shall have a minimum of 330 lines of resolution. The camera equipment shall produce a continuously monitored color picture, which will have the resolution capability to discern small hairline cracks and other minor and major defects in the sanitary sewer line. The camera equipment shall be capable of producing digital still pictures for permanent record as required. The camera shall be self-propelled or pulled by a cable winch from the downstream manhole, through the line along the axis of the pipe, at a uniform rate of 1/2 foot per second maximum.

Where infiltration in the sanitary sewer line is suspected, the camera shall be stopped for at least 30 seconds in the area of question and the camera shall pan and/or tilt as needed to ascertain that infiltration is occurring and the possible cause. The camera shall stop at all lateral connections, defects, sags, etc. for a period of at least 10 seconds and the camera shall pan and/or tilt as needed so that all portions of the connection or defect that is visible from within the main line can be completely inspected.

Each pipe run between manholes being inspected may be required to be isolated from the remainder of the line by the use of a line plug to insure total viewing of the inside periphery of the pipe. The inspection shall be performed in a forward and/or backward direction according to line conditions at the time of the inspection. Every effort shall be made by the Contractor to televise in

the same direction as the flow, especially during live flow conditions. The Engineer must approve any video inspection that goes against the flow.

Televising subcontractor personnel shall be in constant communication during the televising operation.

The Contractor shall keep a copy of the written logs on site that clearly show the exact location, in relation to the starting manhole/mainline cleanout or lateral cleanout, of each following item discovered during the television inspection; infiltration points, lateral locations, cracks, open/pulled joints, roots, broken or collapsed sections, grease, debris, location of dips (starting and ending footage plus depth), and any other discernible features. In addition to the items noted, the video and written logs shall also note; name of project, general contractor, date, line size, length of section, manhole condition and live flow. Measurement for location of defects shall be at ground level by means of a metering device. Markings on the cable, or the like, which would require interpolation for depth of manhole or lateral cleanout will not be allowed. Measurement meters will be accurate to plus or minus one foot in a thousand and must show on video. A one-inch depth gauge pulled or pushed in front of the camera is required for all main lines up to and including 12 inch. For any line larger the Contractor shall verify required gauge size with the Engineer prior to scheduling television inspection. Measurement of laterals must be recorded on video and written log from bottom of cleanout to main and bottom of cleanout to connection at existing lateral.

The following conditions shall exist prior to the television inspection:

1. All sewer lines shall be in installed, backfilled and compacted;
2. All structures shall be in place, all channeling complete and all pipelines accessible from structures;
3. All other underground facilities, utility piping and conduit within two feet of the sewer main, shall be installed, backfilled and compacted;
4. Pipelines to be video inspected shall have been flushed, and all other testing completed and accepted, including the mandrel test;
5. Immediately before the television inspection, run fresh water into the sewer until it passes through the downstream manhole.

All work performed must meet the quality and clarity standards set by the City of Santa Rosa and is subject to City review and rejection.

Deficiencies revealed by the television inspection, in the opinion of the Engineer, shall be repaired by the Contractor to the satisfaction of the Engineer. After all required repairs are completed the areas of repair shall be televised again at the Contractor's expense.

The Contractor shall be notified in writing of any deficiencies revealed by the television inspection that will require repair, following which, the Contractor shall excavate and make the necessary repairs and perform a television re-inspection. Television re-inspection shall be at the Contractor's expense.

Although the final determination for required repairs will be made by the Engineer, the following

observations are typical defects found in the construction of the sewer pipelines and will require corrections prior to acceptance whether or not there is a passing air test:

1. Off grade - deviation "down" from grade (sag) of 1" or more, unless otherwise allowed on mains larger than 12" in diameter. Any sag in the line greater than 15 linear feet, unless otherwise approved. Any deviation "up" from grade, unless coming out of sag of less than 1"; ~~0.08 foot, or over, deviation from grade;~~
2. Separations in mainline pipe joints connected by a coupling shall be no more than ~~over 1"~~ in length on mainline sizes of 12" ~~coupled together mainline pipe joints where the pipe is 8 inches in diameter~~ or smaller, and no more than 2" on trunks 15" ~~inches or more in coupled together mainline pipe joints where the pipe diameters are 10 inch~~ or larger;
3. Separations over 1/2" ~~inch~~ in lateral pipes connected by a coupling; ~~coupled together lateral piping;~~
4. Any bell & spigot joints not installed per the ~~open joint or pulled joint that is beyond~~ manufacturers installation recommendations;
5. Offset joints;
6. Chips in pipe ends - none more than 1/4" deep;
7. Cracked or damaged pipe or evidence of the presence of an external object bearing upon the pipe (rocks, roots, etc.);
8. Infiltration;
9. Debris or other foreign objects;
10. Other obvious deficiencies when compared to Approved Plans and Specifications, these Standards and Standard Drawings.

The above list is not a complete list of items that may be considered as deficiencies. The final determination for any required repair shall be made by the Engineer.

130-1.10 Bypass Pumping and/or Diversion System

When bypass pumping and/or flow diversion is required to keep existing services active, the Contractor shall provide a system that furnishes and maintains all personnel, equipment, tools, power, piping and incidentals required to maintain existing sewer flows and services without interruption.

The Contractor shall submit a bypass pumping and/or diversion plan for review by the Engineer at least 10 working days prior to planned commencement of bypass pumping and/or diversion. The Engineer shall approve the bypass pumping plan before commencing any bypass pumping work. The Contractor shall notify the Engineer 2 working days prior to commencing with the bypass pumping operation.

Any proposed flow diversion plan that includes a temporary connection to existing sewer components shall also comply with Section 130-1.05 herein.

The bypass pumping plan shall include design flow, documentation of pump and discharge line capacities, manufacturer, and age. Bypass pumping plan shall also include shop drawings that identify pumping location(s) and methods with sufficient detail to assure that the work can be accomplished without sewage spills. The plans shall include an emergency discharge response plan to be followed in the event of a failure of the bypass pumping system.

All components of the bypass pumping system shall be sound attenuated and produce noise emissions in accordance with City noise ordinances. All pumps shall be set into or surrounded by spill containment devices.

Bypass pumping shall be done in such a manner as not to damage private or public property or create a nuisance or public menace. The pumped sewage shall be in an enclosed hose or pipe system that is adequately protected from traffic and shall be redirected into the sewer system.

The Contractor shall take all necessary precautions including constant monitoring of bypass pumping to ensure that no private residences or properties are subjected to sewage backup or spills. Dumping, leaks or free flow of sewage onto private property, gutters, streets, sidewalks, or into storm sewers or waterways is strictly prohibited.

Except as otherwise specified herein for testing purposes, the Contractor must receive written approval from the Engineer prior to the use of pneumatic test plugs or any other means for blocking sewer flows. The Contractor shall submit a flow blockage plan, for review by the Engineer, identifying at a minimum the following:

1. What devices and/or material will be used,
2. Depth of upstream manhole(s),
3. Location of existing lateral cleanouts and how they will be monitored,
4. Address of all parcels along with name and operating hours of all businesses located upstream of blockage to the next upstream manhole.

The Contractor shall also provide name and cell phone number of the employee(s) that will have the sole duty of monitoring all active blockages. If multiple lines are simultaneously blocked, the Contractor's submittal must show how each blockage is to be continuously monitored. For multiple blockages, and at no additional cost to the City, the Engineer may also require devices for each blockage to give audible and/or visual alarm of a pending overflow.

The Contractor shall be liable for all cleanup, damages and resultant fines in the event of a spill.

Subsequent to removal of bypass pumping and/or diversion system, the Contractor shall verify existing sewer flows are restored to pre-existing condition.

The Contractor shall allow up to 10 working days for response from the City for any request regarding sewer system flows.