

PART 00400 - DRAINAGE AND SEWERS

Section 00405 - Trench Excavation, Bedding, and Backfill

Description

00405.00 Scope - This Work consists of excavating trenches, constructing trench foundations, and placing bedding, pipe zone material and backfill.

00405.01 General - Excavate, backfill and dispose of excess excavated materials in connection with minor Structures and conduits such as subsurface drain, culvert, siphon, irrigation and sewer pipe of nominal inside diameters not exceeding 72 inches. Perform excavation for major Structures and conduits with a nominal inside diameter or width greater than 72 inches according to Section 00510.

Trench excavation does not include earthwork covered under any other Section, or any earthwork that may be specifically included and provided for other Pay Items of the Contract. Dispose of excess excavated materials and perform other matters not covered in this Section according to Section 00330.

00405.02 Definitions:

Boulder Excavation - The removal, without drilling, blasting or splitting, of masses of Rock having one or more dimensions of 3 feet or greater.

Common Excavation - The removal of all material not classified as Rock excavation.

Flexible Pipe - For the purpose of these Specifications, potable water pipes and pipes constructed of corrugated metal, PVC, and polyethylene are considered flexible pipes.

Pipe Bedding - Furnishing, placing and compacting specified materials on the trench foundation so as to uniformly support the barrel of the pipe.

Pipe Zone - The area from the top of the bedding to a point 8 inches, minimum, above the top outside of the pipe barrel for the full width of the trench.

Rigid Pipe - For the purpose of these Specifications, pipes constructed of concrete and ductile iron are considered rigid pipes.

Rock Excavation - Excavation of solid ledge Rock that, in the opinion of the Engineer, requires for its removal drilling and blasting, wedging, sledging, barring, or breaking up with power-operated tools. The term "Rock Excavation" indicates a method of removal and not a geological formation.

Surface Removal - The removal of surface material such as Topsoil, sod, Pavement, sidewalks, or gravel, that requires different Equipment or methods than those used for trench excavation.

Trench Backfill - Furnishing, placing, and compacting material other than Controlled Low-Strength Material (CLSM) in the trench, between the top of the pipe zone material and the bottom of the pavement base Rock, ground surface or surface material.

Trench Excavation - The removal of all material encountered in the trench to the depths as shown or as directed. Trench excavation is classified as either common or Rock excavation.

Trench Foundation - The bottom of the trench on which the pipe bedding is to lie and which provides support for the pipe.

00405.03 Lines, Grades, and Cross Sections - Excavate trenches to the lines, depths, grades and Cross Sections shown on the Plans or as established. Variations will be allowed only when necessary to ensure firm foundations and when such variations will not be detrimental to the Work.

Materials

00405.10 General - Materials may be native or imported, as specified.

00405.11 Trench Foundation - Where additional excavation is required due to groundwater or other unstable conditions so that the native material cannot support the pipe, furnish one of the following materials for trench foundation:

- Selected general backfill conforming to 00330.13.
- Selected granular backfill conforming to 00330.14.
- Selected stone backfill conforming to 00330.15.
- Other approved material.

00405.12 Bedding - If groundwater is present in the bedding zone, use 3/4" - 0 Aggregate bedding. If groundwater is not present, and unless otherwise specified, furnish one of the following materials for bedding the pipe:

- Commercially available 3/4" - 0 Aggregate.
- ~~• Reasonably well-graded, from maximum size to dust, sand with 100 percent passing the 3/8 inch sieve.~~
- ~~• Commercially available 3/8" - 0 or No. 10 - 0 sand.~~
- CLSM conforming to Section 00442.
- A continuous cradle of concrete conforming to Section 00440. Acceptance of the concrete will be by visual inspection.

00405.13 Pipe Zone Material - For flexible pipes, backfill the pipe zone with bedding material as described in 00405.12.

For rigid pipes, unless otherwise directed, furnish either:

- 1" - 0 or 3/4" - 0 base Aggregate conforming to 02630.10, or
- Commercially available 1" - 0 or 3/4" - 0 Aggregate.

00405.14 Trench Backfill - Furnish the following materials where shown or required:

(a) Class A Backfill - Use native or common material that, in the opinion of the Engineer, meets the characteristics required for the specific surface loading or other criteria of the backfill zone.

(b) Class B Backfill - Use Granular Material consisting of gravel or crushed Rock meeting the requirements of Section 00641. Designated size shall be 1" - 0 or 3/4" - 0.

~~**(c) Class C Backfill** - Use clean sand with no particle size larger than 1/4 inch.~~ Class C backfill is not allowed on Agency projects.

(d) Class D Backfill - Use pit run or bar run material, well-graded from coarse to fine. The maximum dimension shall be 3 inches.

(e) Class E Backfill - Use CLSM conforming to Section 00442. Class E material is required above the pipe zone in excavations where the Engineer determines that the use of mechanical compaction devices are impractical, ineffective or detrimental, and for vacuum-type excavations.

00405.15 Quality Control - Provide quality control according to Section 00165.

Labor

00405.30 Quality Control Personnel - Provide technicians having CEBC, CAgT, and CDT technical certifications.

Construction

00405.40 General - Perform all excavation and backfilling according to the following requirements:

(a) Limitation on Commencement - Do not commence excavation until the undisturbed or existing ground has been measured and the measurements have been approved by the Engineer.

(b) Natural Stream Protection - Hold to a minimum excavations in, or adjacent to, natural streambeds. Comply with 00290.30(a). Restore the streambed according to 00405.46(f).

(c) Partial Embankment Construction for Exposed Pipe - Construct partial embankment according to 00330.42(c)(6) and as shown, before excavating trenches.

(d) Temporary Handling of Water - Provide temporary measures according to 00405.43.

00405.41 Trench Excavation - Excavate trenches according to the following:

(a) Within Paved Areas to Be Preserved - Existing structures and pavements shall be cut full depth with a rotary saw. Excavate trenches for pipe installation by the open excavation method, unless otherwise directed. Do not disturb the adjoining Pavement more than necessary.

Cuts in Portland cement concrete for vacuum-type excavation may be square or round, but no greater than 24 inches wide (or in diameter). Cuts in asphalt concrete pavement for vacuum-type excavation shall be round and no greater than 12 inches in diameter.

(b) Open Trench Limit - Limit the length of open trench to 100 feet, or as allowed. Related resurfacing shall be completed within 800 feet of the open trench limit.

(c) Trench Width - Keep the trench width at the ground surface to the minimum necessary to install the pipe in a safe manner, but not less than 24 inches. In all cases, make trenches of sufficient width to allow for shoring and to permit proper jointing of the pipe and backfilling of material along the sides of the pipe. Refer to the Standard Drawings for minimum trench widths for various diameter pipes. Make excavations for manholes and other Structures wide enough to provide a minimum of 12 inches between the Structure surface and the sides of the excavation. Keep the top of the trench within Right-of-Way or permit limits.

(d) Trench Grade - Excavate trenches to the lines and grades shown or established, with proper allowance for pipe thickness, pipe bedding and foundation stabilization. Place pipe bedding on a firm, undisturbed, foundation, true to grade. If the trench is excavated below grade without authorization, restore to grade with material of the type specified for pipe bedding at no additional cost to the Agency. Place the material over the full width of the trench, in compacted layers not exceeding 6 inches.

(e) Disposal of Excess Material - Place excavated material at locations and in such a manner that it does not create a hazard to pedestrian or vehicular traffic, or interfere with the function of existing drainage facilities.

Make arrangements for and dispose of all excess material not required elsewhere on the Project in an approved manner, at no additional cost to the Agency, and according to 00330.41(a)(4).

(f) Trench Protection - Provide the materials, labor and Equipment necessary to protect trenches at all times. Provide safe working conditions in the trench and protect the Work, existing property, utilities, Pavement, and the public. The method of protection shall be according to the Contractor's

design, except if the Engineer determines that safe and adequate access to the trench has not been provided for testing and inspection, then the work will not be accepted.- The Contractor may elect to use any combination of shoring, overbreak, tunneling, boring, sliding trench shields or other methods of accomplishing the Work, provided the method meets with the approval of the Engineer and complies with all applicable local, state, and federal safety codes.

Be responsible for damages resulting from improper removal of shoring or from failure to shore.

Trenches in paved streets, alleys, bike paths, pedestrian ways and sidewalks open for public use shall not be left open overnight. Trenches shall be backfilled, compacted and surfaced the same day as excavated. Temporary patch surfacing shall be according to Section 00740 and a minimum of 2 inches thick. If approved by the Engineer, the Contractor may steel plate the trench overnight according to 00405.46(e).

(g) Existing Abandoned Facilities - Remove and dispose of existing abandoned pipe, Structures and other facilities as necessary to construct the trench according to 00310.41(c).

00405.42 Rock Excavation - Where Rock excavation as defined in this Section is required, remove the Rock to provide the minimum clearances shown on the Standard Drawings. Excavate and remove the overburden and expose the Rock to allow the Engineer to measure the Rock prior to removal.

If using explosives, comply with the requirements of 00170.94. Prior to blasting, obtain the approval of the Engineer and the appropriate permits. Provide all tools and devices required for loading and using explosives, blasting caps and accessories. When blasting Rock in trenches, cover the area to be shot with blasting mats or other protective material to prevent the scattering of Rock fragments outside of the excavation.

00405.43 Dewatering - Promptly remove and dispose of all water entering the trench during the time the trench is being prepared for the pipe laying, during the laying of the pipe and until the backfill at the pipe zone has been completed. Dispose of the water in an approved manner without damage to adjacent property.

Control groundwater to prevent softening of the bottom of excavations or formation of "quick" conditions or "boils". Design and operate dewatering systems to prevent removal of the natural Soils and so that the groundwater level outside the excavation is not reduced to the extent that would damage or endanger adjacent Structures or property.

When dewatering ~~near a river, lake, or stream,~~ conform to the requirements of 00290.30(a) and Section 00280. When the presence of water or other conditions in the excavated area would be detrimental to the purpose of the Work, obtain approval of the Engineer for the temporary measures required to correct or care for the condition.

If water or other conditions encountered require permanent correction or care not anticipated by the Contract and not due to the Contractor's neglect or method of operation, perform the Work according to 00140.60.

00405.44 Trench Foundation - Make the full length and width of completed trench bottoms firm. Do not place bedding material before the trench foundation is inspected and approved. If bell and spigot pipe is used, recess the trench bottom to accommodate the bell.

When, in the judgment of the Engineer, the existing material in the bottom of the trench is unsuitable for supporting the pipe, excavate below grade, as directed. Replace the excavated material with imported trench foundation material conforming to 00405.11. Place the trench foundation material in 6 inch layers and compact according to 00330.43 except compact selected stone backfill material in 12 inch layers. Bring the trench foundation material to the elevation established.

00405.45 Pipe Bedding - Spread the bedding smoothly to the proper grade so that the pipe is uniformly supported along the barrel. Excavate bell holes at each joint to permit proper assembly and inspection of the joint. Bedding under the pipe shall provide a firm, unyielding support along the entire pipe length.

00405.46 Backfilling - Backfill with material conforming to 00405.13 and the details shown, or as directed.

(a) General - Begin backfilling when:

- The foundation has been prepared, if required.
- The bedding has been prepared.
- The drainage facilities and fittings are installed.
- The installation has been inspected and approved.

Thoroughly tamp and compact all trench backfill with machine or pneumatic operated tampers of a size and type that will obtain the required density. ~~When fill is to the top of the pipe, c~~Compact the trench backfill in a manner to avoid damage to the installed pipe.

Test for density according to 00330.43.

Backfill either to the top of the trench, the surrounding ground level, or the upper limit of excavation, as directed. Dispose of excess excavated material not used in backfill Work according to Section 00330.

(b) Pipe Zone - Place the materials in the pipe zone in layers not greater than 6 inches thick and in a manner that equalizes pressure on the Structure and minimizes stress. Before placing backfill material, condition, aerate, or wet the material so that the moisture content of each layer is within minus 4 percent to plus 2 percent of optimum moisture content.

As required under the haunches of pipe and in areas not accessible to mechanical tampers or to testing, compact with hand methods to ensure intimate contact between the backfill material and the pipe or Structure. Place backfill material between corrugations when the pipe product is manufactured with external corrugations. Provide thorough compaction.

Ponding or jetting will not be allowed within the pipe zone.

(c) Trench Backfill - The following requirements apply in the trench backfill area and in the pipe zone, except where in conflict with the requirements of 00405.46(b):

(1) General - Use Class B trench backfill unless otherwise specified or approved. Class A backfill is allowed only in easement areas that are not or will not be paved. Class E material is required above the pipe zone in excavations with less than 2 feet of cover over the pipe or where the Engineer determines that the use of mechanical compaction devices are impractical, ineffective or detrimental, and for vacuum-type excavations.

The Engineer may sample excavated material to determine the suitability of the Class A material for use as backfill. If the material is approved, the Contractor may elect to use the material in place of the specified backfill. Prevent excavated material from becoming saturated beyond the critical moisture limits, and replace any saturated Class A material with Class B, C, or D material, as specified, at no additional cost to the Agency. ef E

(2) Class A, B, C, or D Backfill - Backfill the trench above the pipe zone in successive Lifts. Lifts not exceeding 24 inches in trench backfill area when more than 4 feet from final surface grade; do not exceed 12 inch lifts in the trench backfill area when less than 4 feet below final surface grade. Do not allow the backfill to free-fall into the trench until at least 3 feet of cover is provided over the top of the pipe. Modify the method of compaction as necessary to protect the pipe.

The Engineer will direct field testing of compaction at various lifts during the backfilling of the trench. Compact the trench backfill such that the arithmetic average of all tests taken in one day shall not be less than 95 percent of maximum density, and no individual test result shall be less than 93 percent within the rights-of-way.

~~Compact each layer of trench backfill material within the Roadway and Shoulders, and within a 2V:1H Slope line projected from each Subgrade Shoulder, to not less than 95 percent of maximum density. Compact all other trench backfill material to not less than 90 percent of maximum density.~~

Determine the maximum density by AASHTO T 99 Method D for material passing the 3/4 -inch sieve as corrected for oversize by AASHTO T-224 (1996 Manual) . If the specified compaction is not obtained, the Contractor may be required to use a modified compaction procedure or reduce the thickness of Lifts. If approved materials meeting the Specifications cannot be compacted to the required density regardless of compactive effort or method, the Engineer may reduce the required density or direct that alternate materials be used. Do not proceed with excavation and pipe laying operations until the backfill can be compacted to the satisfaction of the Engineer.

If the material is not density testable, the Engineer will observe each layer for deflection or reaction under the compaction Equipment to verify that no soft or pumping areas remain. Compact until there is no perceptible deflection under the compaction Equipment.

When the backfilling is complete, finish the surface area as specified. ~~In paved or graveled areas, maintain the surface of the trench backfill level with the existing grade with 3/4" - 0 crushed Aggregate material, or asphalt concrete if directed, until final Pavement replacement is complete and accepted.~~

(3) Class E Backfill - Backfill the trench above the pipe zone with CLSM material. If the CLSM is to be used as a temporary Surfacing, backfill the CLSM to the top of the trench and strike it off to provide a smooth surface. If the CLSM is not to be used as a temporary Surfacing, backfill the CLSM up to the bottom of the proposed resurfacing. No compaction of CLSM is allowed. Use steel plates to protect the CLSM from traffic a minimum of 24 hours. After 24 hours, the CLSM may be paved, or opened to traffic until permanent surface restoration is completed, if it has hardened sufficiently to prevent rutting.

(d) Ponding or Jetting of Backfill Materials - Ponding or jetting will not be allowed within Roadbed lateral limits. Ponding or jetting will be allowed outside Roadbeds when approved by the Engineer in writing.

Use Class ~~C-B~~ or D trench backfill material at no additional cost to the Agency. Provide drainage at the bottom of the trench to remove water from the jetting operation. Compact to the density and deflection requirements of 00405.46(c).

Furnish Equipment that provides a minimum gauge pressure of 35 psi at the discharge nozzle. Use a rigid pipe that will reach within 1 foot of the bottom of the backfill. Insert the pipe at intervals not exceeding 4 feet throughout the entire width and length of the trench backfill.

(e) Temporary Trench Plating - When temporary steel plates are installed over a street cut, they shall be capable of carrying at least an MS-18 loading. Place steel plates with a minimum of 12 inches bearing on all sides of a cut. Anchor steel plates to minimize shifting. Shim the edges of all steel plates with cold mix asphalt according to 00740 or other approved method to provide a smooth transition to the travel surface. Do not place temporary trench plating in bike lanes or pedestrian access routes.

(f) Restoration of Streambeds - Comply with 00290.30(a) and Section 00280. Upon completion of the Work:

- Restore the streambed to its former condition of resistance to scour.
- Remove all matter that has come into the stream due to the Contractor's activities.

00405.48 Surface Removal:

(a) General - For trench resurfacing, see Section 00495.

(b) Topsoil - Where trenches cross lawns, garden areas, pastures, cultivated fields or other areas on which Topsoil exists, remove the Topsoil to a minimum 12-inch depth and place the material in a stockpile. Do not mix the Topsoil with other excavated material. After the trench has been backfilled, replace the Topsoil.

In lieu of stockpiling the Topsoil, approved imported Topsoil may be substituted, to a depth specified or approved, at no additional cost to the Agency.

Maintain the finished grade of the Topsoil level with the area adjacent to the trench until final acceptance by the Engineer, and repair damage to adjacent Topsoil caused by the Contractor's operations. Remove all Rock, gravel, Clay and other foreign materials from the surface. Regrade and add Topsoil as required.

(c) Pavement, Curb, and Sidewalk - Use saws to cut portland cement concrete Pavement, curbs and sidewalks, regardless of thickness. In bituminous Pavement, when no Pavement overlay will occur, saw-cut the Pavement along each edge of the area to be removed. When Roadways will receive a Pavement overlay as part of the Project or following trench resurfacing, bituminous Pavement to be removed may be cut by wheel cutter, jack hammer, or other approved methods.

Upon completion of backfill and just prior to Pavement resurfacing, saw the Surfacing on both sides of the trench a minimum of ~~6~~12 inches wider than each top of the trench and as shown in the Standard Drawings. In areas of any undermined or damaged Surfacing, re-saw to a width outside these areas. When saw-cutting, follow lines parallel to the pipe centerline.

Where the width changes in areas of asphalt Pavement resurfacing, cut the transition between the different widths at 45 degrees. When the pipeline changes direction, or there is a connecting pipeline that requires the saw cut alignment to change at an angle greater than 60 degrees, make a minimum 24-inch transition saw cut. If there is damaged or undermined Surfacing at the transition point, make the transition saw cut beyond the damaged or undermined Surfacing. Make the transition saw cut angle half the angle change in the direction of the pipeline or connecting line.

If the asphalt Surfacing is to be overlaid, the second saw cut will only be required to firm Subgrade.

A second saw cut for concrete sidewalks, driveways and Pavements will not be required unless needed to reach firm Subgrade.

Remove and dispose of Pavement lying within the limits of the cuts and from any adjoining areas damaged by the cutting and removal operations according to Section 00310.

Measurement

00405.80 Measurement - Except for Rock excavation, boulder excavation, and trench foundation, no measurement of quantities will be made for Work performed under this Section.

Imported Topsoil will be measured according to 01040.80.

00405.81 Rock Excavation and Boulder Excavation - The quantities of Rock excavation and boulder excavation will be measured as follows:

(a) Rock Excavation - Rock excavation will be measured on the volume basis. Measurement will be of the actual dimensions of Rock removed within the following limits:

- **Length** - Length will be the horizontal distance measured along the centerline of the trench excluding manholes, inlets, and other Structures.
- **Width** - Width will be the width of the Rock removed but will not be greater than the outside diameter of the pipe bell plus 12 inches.
- **Depth** - Depth will be measured at 30-foot intervals, or as specified, along the centerline of the trench. The depth will not be greater than 6 inches below the outside bell of the pipe.

Rock excavation for manholes, inlets, and other Structures will be computed from the Rock excavated to a depth 6 inches below the bottom of the Structure and an area within a line parallel with, and 12 inches outside of, the actual dimensions of the manhole, inlet, or Structure.

No separate measurement will be made for the following:

- Soft or disintegrated Rock.
- Hardpan or cemented gravel that can be removed with a hand pick or power-operated excavator or shovel.
- Loose, shaken, or previously blasted Rock or broken stone in Rock fillings or elsewhere.
- Rock outside of the minimum limits of measurement allowed, which may fall into the excavation.

(b) Boulder Excavation - Boulder excavation will be measured on the volume basis. Measurement will be made in the field by the Engineer after removal of each boulder from the excavation but prior to removal from the site. Each boulder removed will be measured for length, width, and height. The volume of each boulder will be determined as the product of 85 percent of each of the three measured dimensions.

00405.82 Trench Foundation - The quantities of unsuitable trench foundation will be measured on either the weight basis or the volume basis as follows:

- **Weight Basis** - Trench foundation will be measured on the weight basis. The quantity of replacement foundation Material will be based on weigh tickets from scales meeting the requirements of Section 00190. Present weigh tickets to the Engineer for signature on the Day the Material is delivered.
- **Volume Basis** - Trench foundation will be measured on the volume basis, computed using the following dimensions:
 - **Length** - Length will be the horizontal distance measured along the centerline of the trench. Measurement will be continuous through manhole or Structure locations.
 - **Width** - Width will be the nominal inside diameter of the pipe plus two times dimension "B" from "Table A" shown on the Standard Drawings.
 - **Depth** - Depth will be the vertical distance from the top of the underlying surface (following excavation of Unsuitable Material) to the bottom of the pipe bedding. The depth will be measured at intervals of 30 feet, or as specified, along the centerline of the trench and the average depth between points will be used for the volume computation.

Payment

00405.90 Payment - The accepted quantities of Rock excavation, boulder excavation, and trench foundation will be paid for at the Contract unit price, per unit of measurement, for the following items:

Pay Item	Unit of Measurement
(a) Rock Excavation	Cubic Yard
(b) Boulder Excavation	Cubic Yard
(c) Trench Foundation	Ton or Cubic Yard

Item (c) includes removal of Unsuitable Material and replacement as necessary to provide a stable foundation for the pipe.

Payment will be payment in full for furnishing and placing all Materials, and for furnishing all Equipment, labor, and Incidentals necessary to complete the Work as specified.

Imported Topsoil will be paid for according to 01040.90.

No separate or additional payment will be made for:

- trench excavation
- trench backfill
- saw cutting
- trench protection
- pipe bedding
- pipe zone Material
- dewatering
- temporary patches and securing trenches

When the Contract Schedule of Items does not indicate payment for Work performed under this Section, no separate or additional payment will be made. Payment will be included in payment made for the appropriate items under which this Work is required.

Section 00406 - Tunneling, Boring, and Jacking

Description

00406.00 Scope - This Work consists of installing conduits, pipes, casings, linings, and sleeves by tunneling, boring, and jacking without excavating the overlying surface.

00406.01 Descriptive Terms:

Tunneling - Tunneling includes all methods by which an underground passageway is excavated and lining materials are brought in and placed.

Boring - Boring includes all methods by which a conduit, casing, pipe or sleeve is pushed or pulled into place and in which the excavation method precludes the stationing of a worker within the conduit without stopping or removing the excavation Equipment.

Jacking - Jacking includes all methods by which a conduit, casing, pipe or sleeve is pushed or pulled into place with one or more workers inside to excavate and assist in keeping the conduit on the required grade and alignment.

Materials

00406.10 Pipe Bedding and Pipe Zone Material - Furnish pipe bedding and pipe zone Material meeting the requirements of Section 00405.

00406.11 Pipe - Furnish pipe Materials meeting the strength, class, and type specified or shown.

00406.12 Casing - Furnish casing of a size to permit proper construction to the required lines and grades. Furnish casings that are made of smooth steel pipe or concrete pipe suitable for the purpose intended. Optionally, the casing may be constructed of galvanized, standard-offset, tunnel liner plate with gauge and section modulus as approved.

The class of casing specified is based on the superimposed loads and not on the stresses resulting from jacking or boring operations. Any increase in casing strength to withstand jacking or boring operations shall be the responsibility of the Contractor.

When pressure grouting is specified, equip jacked casings 36 inch diameter and larger with nipples installed at the springline and the crown, at 10 foot centers.

00406.13 Grout - Furnish grout for filling the annular space between the carrier pipe and the casing pipe of one part portland cement, five parts sand, and seven parts 3/8 inch maximum size rounded Aggregate by volume, or as approved.

Furnish grout for pressure grouting outside jacked carrier or casing pipe of one part portland cement and three parts sand by volume, or as approved.

00406.14 Sand - Furnish sand for filling the annular space between the carrier pipe and the casing pipe of clean, sharp, and well-graded so that 100 percent passes the No. 8 sieve, and between 10 percent and 35 percent passes the No. 50 sieve, or as approved.

Construction

00406.40 Excavation - Excavation for Work under this Section is unclassified and includes whatever materials are encountered to the depths shown or required.

00406.41 Required Submittals - Before beginning the Work, submit the following to the Engineer according to 00150.35:

(a) Tunneling - Submit the following stamped Working Drawings:

- Tunnel shaft bracing design and dimensions
- Tunnel support details
- Method of back-packing tunnel supports
- Design of bracing to prevent lining from shifting or flotation
- Backfill material or pressure concrete mix design, placement method and Equipment
- Poling plate dimensions and details, when required

(b) Boring and Jacking - Submit the following unstamped Working Drawings:

- Jacking pit construction
- Casing or conduit
- Jacking head
- Excavation method
- Tee or wye installation
- A substitute design for any part of the system that is changed as a result of the jacking or boring operation
- Bracing to prevent pipe shift and flotation, if placed in a casing, and the Materials, method and Equipment for backfilling
- Backfill material or pressure grout mix, placement method and Equipment

Submit for review the following stamped Working Drawings:

- Jacking pit bracing
- Any Structure that is required because of the particular method or procedure used by the Contractor

00406.42 Tunneling - Construct the pipe on a firm Subgrade, thoroughly compacted and true to grade. If the material in the bottom of the tunnel is ledge Rock, extend excavation of the tunnel to a depth below the bottom of the pipe, and provide a bedding of crushed Aggregate or concrete as specified in Section 00405. Restore to grade any excavation made below grade without approval by backfilling with approved bedding material, at no additional cost to the Agency.

00406.43 Boring and Jacking - Boring or jacking may be allowed in lieu of the open trench method or tunneling with approval of the Engineer. Jack or bore all conduit, casings, pipe or sleeves to the required line and grade.

Equip the leading section of pipe or casing with a jacking head. Perform all excavation entirely within the jacking head.

Should loss of surrounding material occur during the jacking or boring operation, backpack or grout the voids before the completion of the shift. Fill or backpack all voids with grout or Granular Material as approved.

00406.44 Concrete Pipe - Protect the driving ends of concrete pipe against spalling and other damage. Protect intermediate joints by the installation of sufficient bearing shims to properly distribute

the bearing stresses. Remove all sections of conduit showing signs of failure and replace with new sections, or with approved cast-in-place sections, that are adequate to carry the loads imposed on them.

00406.45 Smooth Steel Casing - Join sections of smooth steel casing to be jacked or bored by welding the joints with a continuous weld for the full circumference, or by other approved means. Provide joints capable of resisting the jacking or boring forces.

Brace pipe installed in casing to prevent shifting or flotation. Fill the void between the casing and the pipe with grout or other material, as specified or approved.

00406.46 Grouting Voids Outside Casing - On pipes 36 inches or larger, fill completely the void space between the tunnel and the casing or liner plate with approved grout. After the casing or carrier pipe has been jacked or tunneled into position, fill with grout under pressure, through the grout holes provided, to fill all voids outside the pipe using the following sequence:

- Grout at the springline hole at one end and pump the grout until it appears in the grout hole at the crown.
- Grout through the opposite springline hole until the grout appears at the hole in the crown.
- Grout through the hole at the crown until the grout appears in the next set of holes along the pipe.
- Plug the holes at the starting point and move to the next set of holes.
- Repeat the sequence until the full length of the pipe has been grouted.

Provide a continuous color video recording of the grout placement, to provide documentation that grout was properly placed according to the above Specifications. On the video, identify the location of the grouting operation in relationship to the end of the casing, tunnel or liner plate.

00406.47 Cradles for Cased or Tunneled Pipe - Where cradles are shown, provide a strapped cradle under the barrel of the carrier pipe. The barrel shall bear continuously on the cradles.

00406.48 Placing Fill in Casing - Where shown, completely fill the annular space between the pipe and the casing, tunnel liner or tunnel wall with approved grout or sand to prevent pipe flotation. Pour or pump the fill from the two ends and from intermediate points as necessary. Complete grouting in a continuous operation without stopping. Perform sand filling using a gunite machine or other approved Equipment.

00406.49 Railroad Crossings - Perform all Work in Railroad rights-of-way according to the railroad permit.

Measurement

00406.80 Measurement - No measurement of quantities will be made for tunneling, boring, or jacking Work, or for casing or conduit used to install pipe.

Where tunneling, boring, jacking, or open trench excavation is used at the Contractor's option in lieu of another specified method, measurement will be made as originally bid.

The quantities of pipe installed by tunneling, boring, or jacking will be measured according to the appropriate items under which this Work is required.

Payment

00406.90 Payment - The additional effort required to install conduits, pipes, casings, linings, and sleeves by tunneling, boring, or jacking (other than under a railroad) will be paid for at the Contract lump sum amount for the item "Tunneling, Boring, and Jacking".

If tunneling, boring, jacking, or open trench excavation is used at the Contractor's option in lieu of another specified method, payment will be made as originally bid.

Payment will be payment in full for furnishing and placing all Materials, and for furnishing all Equipment, labor, and Incidentals necessary to complete the Work as specified.

Tunneling, boring, or jacking under a railroad will be paid for according to 00445.91.

Pipe will be paid for according to the appropriate items under which this Work is required.

Section 00410 - Common Provisions for Pipe Lining

Description

00410.00 Scope - This Work consists of rehabilitating existing pipes by furnishing and installing pipe liners by pipe bursting and lining, slip lining, and cured-in-place lining as shown.

00410.01 Definitions:

Cured-In-Place Pipe (CIPP)- Inserting a resin impregnated tube into an existing pipe, expanding it, and curing it to form a new lined pipe.

Gravity Pipe - Pipe designed to convey fluids under conditions where the hydraulic gradient and free-water surface are coincident within the pipe.

Host Pipe - The existing pipe to be lined.

Obstruction - An object that protrudes into the host pipe that may impede the liner installation, create an unfavorable condition after the liner has been installed, and may not be removed by conventional cleaning Equipment. This may be a protruding service lateral tap, grout or mineral deposit, heavy roots, off set joint, broken or collapsed pipe, change in internal pipe diameter, or similar condition.

Pipe Bursting and Lining - Breaking and expanding the diameter of an existing pipe and inserting a new pipe inside the broken pipe.

Slip Lining - Inserting a new smaller diameter pipe into an existing pipe and filling the remaining annular space.

Point Repair - A localized repair of the host pipe to a condition suitable for pipe lining.

Service Line (Private) - A wastewater pipe that extends from a wastewater customer's facility to the public wastewater collection system.

Service Lateral – The portion of a wastewater pipe in the public right-of-way that extends laterally from a wastewater main to a wastewater customer's property.

Service Lateral Connection - A side or lateral pipe connection to the sewer main.

Sewer Connection Card – A written record or drawing of the location of the private service line connection to the public wastewater collection system.

Ultra-Violet Cured in Place Pipe - Inserting a resin-impregnated fiberglass-reinforced tube into an existing pipe, expanding it, and curing it using ultraviolet light (UV) to form a new lined pipe according to ASTM F2019 and ISO178.

00410.02 Information Available to Contractor - The following is a list of resources for the Contractor's reference:

- Video inspection reports are included within the bid documents to provide information on the host pipe condition, and approximate location of service line connections. Arrangements for viewing video recordings may be made with the Engineer.
- The Agency maintains sewer connection cards for most properties. Arrangements for accessing the Sewer Connection Cards may be made with the Engineer.

The Agency encourages all bidders to investigate the location of the pipes and manholes, and to view the Agency's video inspection recordings prior to bidding.

00410.03 Submittals -

(a) Pre-Bid Submittals: Include the following with the Contractor's sealed Bid:

- Completed Statement of Qualification (form included in the Bid documents).
- Completed Liner Product Information Sheet (form included in the Bid documents).

(b) Post-Bid Submittals: Submit the following to the Engineer 5 calendar days before the preconstruction conference:

- Installation plan that includes the method of installation, sequencing, host pipe preparation, temporary modification of existing Structures, Equipment by size, make, model and manufacturer.
- Manhole connection and repair plan.
- Service connection details and product information.
- Property notification fliers.
- Host pipe point repair plan, including methods and Equipment.
- Sewer cleaning methods and location of debris disposal facility.
- Bypass and flow diversion plan according to 00490.40.

Submit pre-installation video inspection and reports 7 Calendar Days before beginning pipe lining Work.

Submit for approval a complete and accurate pre-liner log according to 00415.41(d).

Submit post-installation video inspection reports. The installation of the liner system improvements shall not be considered substantially complete until the video inspection recordings are received, reviewed, and accepted by the Engineer.

Equipment

00410.20 By-pass Pumping Equipment - Provide pumps, hoses, manifolds, and associated Equipment meeting requirements of 00490.40.

00410.22 Pipe Cleaning Equipment - Provide Equipment specifically designed for cleaning sanitary and storm sewers. Provide special cutting and grinding attachments required to remove obstructions from host pipe before lining.

00410.23 Debris Transport Equipment - Provide Equipment specifically designed to contain and transport debris removed from sewers.

00410.24 Video Inspection - Provide video equipment meeting the requirements of 00415.

00410.25 Electronic Location Device - Provide electronic underground locating equipment according to 00415.21(c).

Construction

00410.40 General - Verify existing host pipe diameter, length, and condition before ordering materials. Field determination of the activity status and diameter of Service Laterals are the responsibility of the Contractor.

00410.41 Pipe Cleaning - No more than 2 hours before installing the liner, perform a final cleaning of the segment to be lined. Flush and clean all parts of the host pipe to remove debris and foreign material. Cleaning methods may include washing with high-pressure water, mechanical removal, sandblasting of the walls, entry with hand tools, or other methods as approved. Do not use chemicals without written approval of the Engineer.

Transport and dispose of all material removed from the host pipe to an approved disposal facility. Do not dispose of material back into the collection system.

Dispose of materials according to 00290.20(c). The Contractor may use the regional wastewater treatment plant for the disposal of solids removed from the host pipe if the required disposal permit is obtained. This permit takes approximately 10 working days to process. For specific questions regarding the permit and disposal process and notification requirements contact the Metropolitan Wastewater Treatment Facility at (541) 682-8603.

Conduct Work that prevents blockage and minimizes surcharging in the sewer manholes and connecting sewer pipelines.

00410.42 Dye Testing - Perform dye testing according to 00415.42.

00410.43 Preconstruction Video Inspection - After cleaning existing gravity pipe, perform preconstruction video inspection according to Section 00415.

00410.44 Host Pipe Preparation - Before installing the liner remove obstructions and perform pipe repairs as shown or as required by the lining method.

00410.45 Property Notification - Notify all affected properties in writing 1 week before installing the pipe lining. Notify all affected properties in writing 24 hours before any service interruption. When Work has been stopped for at least 7 Calendar Days, notify all affected properties again 24 hours before resuming Work. Make personal contact with any property that cannot be reconnected within the time stated in the written notice. Obtain permission from the property owner before entering private property.

00410.46 Bypass Pumping and Flow Diversion - Perform bypass pumping according to 00490.40. Contain or divert flows from Service Lines until reconnected. Install temporary connections as needed to prevent the spilling or pooling of raw sewage.

00410.47 Structure Restoration - Seal all holes and voids in manhole and Structure walls immediately surrounding the new liner. Provide a smooth transition between the existing Structure channel invert and the liner.

Reinstall manhole cones, slabs, grade rings, frames, covers, inverts, and reconstruct benches and channels after each pipe liner installation. Do not replace manhole steps removed for liner installation with new steps, as shown. Repair holes resulting from removal of existing steps as approved.

00410.48 Surface Restoration - Excavations must be filled within 48 hours. Install construction fencing around excavations and provide lighted barricades during hours of darkness.

Restore damaged Surfacing according to 00495 within 5 work days of the liner installation. If resurfacing of affected areas is not completed within 5 work days, the Engineer may limit or halt the work to allow surfacing crews to catch up. No additional contract time will be granted to the Contractor.

Where access is restricted by a fence, coordinate its removal with the individual property owners. Replace all fencing and posts removed or damaged by construction to original or better condition within 5 Work Days. Provide and install temporary fencing according to 00270 for fence openings that will remain overnight. Permanent repairs must be made within 5 work days.

Restore original ground profiles including reestablishing ditches to the original grade. Dispose of excess materials according to 00290.20.

Finishing, Cleaning Up, and Testing

00410.70 General - After completing each manhole to manhole section and before connecting service lines, flush and clean all parts of the system by removing all debris from the pipe.

00410.71 Testing - Conduct pipe testing according to 00445.72 and 00445.73.

00410.72 Post-Construction Video Inspection - After completing each manhole-to-manhole section of pipe liner installation, service reconnections, finish Work, and final cleaning, perform post-construction video inspections according to Section 00415.

00410.73 Repairs - Perform repairs according to 00415.70(c).

00410.74 Warranty Video Inspection - The Engineer will perform the warranty video inspection during the warranty period at a time of high ground water conditions. All defects will be recorded on a written report and given to the Contractor. Repair all defects as directed and according to 00170.85. The video inspection conducted during high ground water conditions and subsequent repairs do not provide for early termination of the warranty period

Section 00411 - Pipe Bursting and Slip Lining

Description

00411.00 Scope - This Work consists of furnishing and installing high density polyethylene (HDPE) pipe in gravity sewer pipe by the pipe bursting and slip lining methods.

00411.01 Submittals - In addition to the submittals described in 00410.03, Submit—submit the following at least 10 Calendar Days before the preconstruction conference.

- Method of pipe bursting, including listed Equipment by size, make, model and manufacturer.
- Method of slip lining, including listed Equipment by size, make, model and manufacturer.
- Certification that the HDPE pipe meets requirements in ASTM F714.
- Contingency repair plan including methods and Equipment to be used to repair or replace unacceptable defects.
- Stamped Working Drawings according to 00150.35 and include the structural design, final design and associated calculations.
- Installation plan that includes the method of installation, sequencing, host pipe preparation, lubricant, and temporary modification of existing Structures,
- Property notification fliers.
- Host pipe point repair plan, including methods and Equipment.
- Sewer bypass and flow diversion plan according to 00490.40.
- Complete Video Pipe Inspection per Section 00415.

Materials

00411.10 Pipe - Furnish high molecular weight, high-density polyethylene pipe and fittings that are made from virgin grade material, to the diameter specified, and to tolerances meeting the requirements of ASTM F714 with a minimum ratio of orthogonal diameters, before installation, of 0.95.

(a) Markings - Provide pipe Materials that are legibly marked, by the pipe manufacturer, with the following information:

- Name and trademark of manufacturer.
- Nominal pipe size.
- Dimension ratio.
- The letters PE followed by the polyethylene grade according to ASTM D1248, followed by the hydrostatic design basis in hundreds of psi.
- Manufacturing standard reference.
- A production code from which the date and place of manufacture can be determined.

(b) Pipe Color - Provide uniformly colored black or gray pipe.

(c) Dimension Ratio - Provide nominal 8 to 18 inch sized pipe having a minimum dimension ratio (DR) of 17.

00411.11 Service Connections - Furnish lateral service connections to the sewer main with ~~manufactured gasket tees,~~ electrofusion saddle tees, or approved equal that provide water-tight connections between the rehabilitated sewer main and the ~~service line connection~~ Service Lateral.

Equipment

00411.20 Pipe Bursting, Fusion, and Pipe Assembly Equipment - Use Equipment, approved by the pipe manufacturer and the Engineer, designed for pipe bursting, butt fusion, and saddle fitting welding. Use heating faces that have a non-stick coatings. Provide joining Equipment capable of attaining appropriate fusion temperature, alignment, and pressure.

Use manufacturer's recommended pipe bursting tools for the diameter of pipe to be installed, as well as the diameter and material of pipe to be replaced.

Labor

00411.30 Personnel Qualifications - Provide installers that are certified by the manufacturer and have at least 2 years of experience of butt fusion welding of 8-inch and larger diameter pipes. Provide a supervisor with the same certification as the installers in addition to having installation experience on at least 50,000 feet of 8-inch and larger diameter pipes.

Construction

00411.40 Pipe Joining - Perform joining methods meeting the requirements of ASTM F2620 and the pipe manufacturer's recommendations, or as approved.

Perform full penetration welds that provide a homogeneous material across the entire Cross Section of the weld. Remove fusion beads greater than 1/16 inch on the inside of the pipe using an approved cutting device.

Perform trial fusion welds in the field and provide samples before installation of the pipe. Use the same fusion machine that was used in the trial welds for the final welds incorporated into the Work.

Electrofusion may be used for field closures as necessary when fusion Equipment can be utilized in a trench type environment.

Other joining methods may be used if the pipe material is selected from the QPL.

00411.41 Receiving Pits and Insertion Pits - Locate all pits to suit the specified pipe lining or bursting operation. Use existing manholes where practicable. Remove manhole inverts, benches, and channels to permit access for installation Equipment. Enlarge the input and output pipe openings if required to accommodate the maximum outside diameter size of the insertion Equipment. Do not put undue stress on existing Structures. Reinstall inverts and reconstruct benches and channels after pipe liners have been installed.

In areas where new manholes are not being installed or existing manholes are not available, excavate and restore pits at no additional cost to the Agency.

00411.42 Installation:

(a) Pipe Bursting - Break existing pipe by utilizing a constant tension system with a hydraulic or pneumatic bursting device that breaks away the pipe. A static "cone cracking" method may be used if approved. Create a void of sufficient size to accommodate the pipe. Continue pipe bursting and lining without interruption for the entire pipe segment unless otherwise approved. Extend the pipe 12 inches into the manhole or concrete Structure to allow for contraction/relaxation after installation. Do not score or damage the liner pipe during the installation process.

Construct Service Line Connections immediately.

If cribbing is used, do not attach cribbing that pierces the surface more than 10% of the pipe wall thickness. Place cribbing at regular intervals as necessary to prevent sags.

(b) Slip Lining - Do not score or damage the liner pipe during the installation process. Fill annular space between the new liner and the host pipe as approved.

00411.43 Connections:

- (a) **General** - After completing the installation, allow the pipe to stabilize for at least 12 hours before making the final connections.
- (b) **Manholes** - Make all connections to concrete manholes, Structures, and pipelines using slip-on sanded adaptors. Seal the liner ends to the Structure using an approved method.
- (c) **Service Line Laterals** - Reconnect all ~~service lines~~ Service laterals as approved after the air tests have been performed and accepted.

Finishing and Cleaning Up

00411.70 Manhole Base Reconstruction - Reconstruct manhole bases by removing the existing base and constructing a new base with a finished surface no higher than 6 inches below the outside portion of the lowest pipe outflow. Shape new smooth, depression-free channels to the elevation shown. Remove the bottom manhole step as required for the new base. Do not damage existing manhole walls or existing pipes. Repair all cracks with non-shrink grout.

00411.71 Testing - Pressure test fused saddle connections prior to coring the HDPE pipe. Maintain 3.5 psi pressure for 30 seconds on the fused saddle. Failure to test each saddle will require testing the entire length of pipe from manhole to manhole per 0045.72.

- Conduct pipe testing according to 00445.72.

Measurement

00411.80 Measurement - The quantities of pipe bursting and the quantities of slip lining of the various kinds, types, and sizes will be measured on the length basis. The length will be measured, with no deduction for Structures or fittings, along the pipe flow line from center to center of manholes, inlets, Structures, special sections, or the ends of pipe, whichever is applicable.

The quantities of ~~service line~~ Service Lateral reconnections will be measured on a unit basis, regardless of size.

Payment

00411.90 Payment - The accepted quantities of Work performed under this Section will be paid for at the Contract unit price, per unit of measurement, for the following items:

Pay Item	Unit of Measurement
(a) Pipe Bursting, ____ Inch.....	Foot
(b) Slip Lining, ____ Inch.....	Foot
(c) Service Line <u>Lateral</u> Reconnections.....	Each
(d) Electrofusion Saddle Tee, ____ Inch.....	Each

In items (a), (b) and (d), the nominal size of the new ~~liner~~ pipe will be inserted in the blank.

Payment will be payment in full for furnishing and placing all Materials, and for furnishing all Equipment, labor, and Incidentals necessary to complete the Work as specified.

Section 00412 - Cured-in-Place Pipe Lining

Description

00412.00 Scope - This Work consists of rehabilitating existing pipes by furnishing and installing pipe liners by cured-in-place pipe (CIPP) lining methods as shown.

00412.01 Submittals - In addition of the submittals described in 00410.03, Submit—submit the following at least 10 Calendar Days before the preconstruction conference:

- Certification by the lining system manufacturer that the installer is licensed and certified as competent to perform the Work.
- Documentation showing the installer meets the qualifications listed in 00412.30, and a list of the key qualified personnel who are assigned to Work on this Project.
- Certification of test results confirming that the CIPP liner system meets the minimum chemical resistance requirements according to ASTM F1216 and ASTM F1743.
- ~~Catalog data, and manufacturer's technical data showing complete information on material composition, physical properties, and dimensions of system components of the tube and resin system. Include manufacturer's recommendation for handling, storage, insertion, curing, trimming, finishing, and repair of damaged liner.~~
- ~~Calculations for the volume of resin to be used for each segment and detailed description of the wet-out process. Include the tube and resin manufacturer's wet-out recommendations including the roller gap, material feed speed and vacuum requirements for each liner size and thickness.~~
- End seal material to be used, and method of installation. ~~If a grout sealing method is proposed or suggested, provide certification from the grout manufacturer or Supplier that the grout material for sealing Structures and service laterals is compatible with the proposed resin and liner system and is suitable for use in aqueous environments.~~
- Sampling and testing plan for physical properties according to ASTM F1216 and ASTM F1743, including name and location of laboratory performing testing on installed liner system. Provide certification that each test shall be performed by a laboratory with appropriate accreditation for the specific test to be performed.
- Installation plan describing project staging, liner shot plan and sequence, and the manufacturer's standard procedures for liner installation. Include allowable pulling forces, installation pressures, allowable curing temperatures, and temperature monitoring plan.
- Contingency repair plan including methods and equipment to be used to repair or replace unacceptable liner defects identified in 00412.73.
- Stamped design of the proposed liner according to 00150.35 and 00412.02.

Upon liner system delivery, submit wet-out logs documenting resin volumes used.

Pre-liner logs must be submitted and approved at least 5 Work Days before beginning liner installations.

00412.02 Design Parameters - Follow the design considerations of ASTM F1216 and meet the following:

Condition	Parameter
Service Life	Greater than 50 year
Pipe Conditions	Fully deteriorated
Load Conditions:	
Soil	125 lb/cf minimum
Traffic	LRFD HL- 93 live load
Groundwater Elevation above invert..... *	
<u>Height of Fill from invert....*</u>	
Pipe Ovality	5%2%
Modulus of Soil Reaction	700psi1000 psi
Enhancement Factor	7.0
Long-Term Flexural:	
Strength.....	50% of initial (ASTM D790)
Modulus of Elasticity.....	50% of initial (ASTM D790)
Maximum Deflection	5%
Minimum Factor of Safety.....	2.0
Soil Density.....	120 pounds per cubic foot
Trench Width	3.0 feet
Soil Type.....	Clay

* Parameters will be listed in the Special Provisions.

Materials

00412.10 Tube - Furnish tubing that consists of absorbent nonwoven felt fabric meeting the requirements of ASTM F1216, Section 5.1 and exhibits the following characteristics:

- A smooth, impermeable, bonded coating on the inside of the finished pipe.
- Sewn or bonded seams, stronger than non-seamed material, as recommended by the tube manufacturer.
- No allowable delamination in the cured CIPP.

Verify pipe lengths and pipe diameters before ordering tubing.

00412.11 Resin - Furnish resins meeting the requirements of ASTM F1216, Section 5.2, or ASTM F1743, Section 5.2.3. Comply with the structural requirements specified for the installed liner system.

Furnish thermosetting polyester, vinylester, or epoxy resin and a catalyst system compatible with the installation process, and is able to cure in the presence or absence of water. Color the resin with a pigment compatible with the resin system.

00412.12 Liner Properties - Furnish liners that have the minimum physical properties stated in ASTM F1216, ASTM F1743 and ASTM D2990, and are also resistant to chemical properties and flow characteristics typically found in municipal sanitary sewer flows. Fabricate the liner to a size that when cured, will tightly fit the pipe being rehabilitated. The finished liner system shall be homogeneous across the wall thickness containing no intermediate or encapsulated elastomeric layers.

Characteristic	Test Method	Epoxy/Vinylester	Polyester Resin
Initial Flexural Strength	ASTM D790	5,000 psi	4,500 psi
Initial Flexural Modulus of Elasticity	ASTM D790	400,000 psi	250,000 psi (min.)

00412.13 Liner End Seal - Furnish LMK Insignia End Seals or approved equal for all liner ends.

00412.14 Tapping Tees - Furnish tapping tees according to 00490.14.

00412.15 Saddle Tees – Furnish saddle tees according to 00490.15.

00412.16 Grout – Furnish non-epoxy, non-shrink grout according to 02080.20.

Labor

00412.30 Personnel Qualifications - Provide installers who:

- Are licensed, and certified by the manufacturer of the CIPP product system to be used on the Project.
- Have at least 3 years of active experience in the installation of CIPP.
- Have installed at least 50,000 feet of CIPP in similar conditions.

Contractors not meeting these qualifications shall have a representative of the CIPP manufacturer, who is qualified in installation of the approved material, present on site during the initial 5 days of the liner work.

Construction

00412.40 General - Handle and store all liner material to ensure that the material is not torn, cut, exposed to direct sunlight or otherwise damaged. Before installing the liner, verify its condition with the Engineer. If any part of the liner material becomes torn, cut, or damaged before or during insertion, repair or replace it at no additional cost to the Agency before proceeding further.

Before the pipe lining work, field verify all Host Pipes scheduled for rehabilitation for length and diameter.

00412.41 Pipe Cleaning - Clean the pipe by removing all debris, sediment, and other accumulated material. Do not use chemicals without the written approval of the Engineer. Remove and dispose of all debris according to 00290.20.

00412.42 Pre-Installation:

(a) Video Pipe Inspection - After cleaning the pipe, perform a pre-installation video inspection according to Section 00415, at least 5 Calendar Days before beginning pipe lining Work.

(b) Pre-Installation Point Repairs - If pre-installation video inspection reveals unanticipated obstructions, reduction in cross-sectional area, sags, previous repairs, or any structural defects in the pipe, submit a point repair plan to the Engineer for approval. All point repairs must restore the host pipe to a condition suitable for CIPP lining.

Approved unanticipated point repairs to restore the host pipe suitable for UV-CIPP lining will be paid for according to 00195.20.

00412.43 Installation - Install CIPP according to ASTM F1216 Section 7, ASTM F1743 Section 6, and the manufacturer's recommendations.

(a) General - Liners may be installed in continuous runs through manholes where there are two or more continuous host pipe segments requiring lining.

Provide temporary downstream dams or filtration measures in the pipeline to catch excess resin and construction debris.

Do not allow the temperature of water discharged from processing liners to exceed the level allowed by State or local requirements.

Provide a "back-up" robotic cutter assembly train and key spare components on-site during CIPP lining activities.

(a) ~~(b)~~ Pipe Liner End Seal - Install an end seal when reconnecting to the rehabilitated ~~host pipe~~ Host Pipe.

(b) ~~(e)~~ Verification of Installation Method – The Engineer may require the Contractor to verify their installation methods. If required, after the first two CIPP installations are completed, stop pipe lining work and perform a video inspection according to 00415. Submit the video to the Engineer for review.

As directed, repair all liner defects per 00412.72-3. If the Engineer determines that excessive defects were found, install two more CIPP segments, perform video inspections, and submit the video to the Engineer for review.

When the Contractor has successfully demonstrated their installation procedures, they may proceed with the pipe lining work. The Engineer may require the Contractor to perform the final video inspection on any installed CIPP at any time.

00412.44 Service Line Lateral Reconnection - Reinstate active service laterals using an internal cutter. Open hole to a minimum of 95 percent, but do not exceed 105 percent of the service lateral diameter. Make each connection free from burrs or projections, and with a smooth and crack-free edge.

Reconnect all Service Laterals as shown. If a permanent connection cannot be made by the end of the work day, install an approved temporary connection.

(a) Internal Service Reinstatement - Provide a primary and back-up robotic cutting device.

Before cutting any internal reinstatements, locate the liner dimples at the Service Laterals. Verify that the dimple locations correspond to the distances measured to the Service Laterals.

Core the CIPP at the Service Lateral from inside the CIPP. Use video inspection equipment according to 00415. Match the original Service Lateral invert with the new opening. Repair holes in the liner due to errors in determining the location of a Service Lateral or oversized holes according to 00412.72-3

(b) Service Lateral Replacements - As shown or directed, replace Service Laterals according to 00445. Excavate down to the Host Pipe and connect the new Service Lateral to the CIPP according to 00490.42.

00412.45 Structure Connections - All pipe liners entering a Structure shall be cut square at the invert. Pipe liners shall extend into the manhole a minimum of 1 inch and maximum of 2 inches.

After liner installation is complete, modify manhole channels using non-shrink, non-epoxy grout to provide a smooth and uninterrupted flow through the invert channel and over the ends of the new pipe liners. Prepare all surfaces to which the grout is applied by cleaning and applying a compatible bonding agent approved by the manufacturer. Allow the grout to set according to the manufacturer's recommendation before reintroducing flow to the invert channel.

Finishing, Cleaning Up, and Testing

00412.70 General - Remove temporary dams or filtration measures after Work is complete and pipe is clean and restored.

00412.71 Post Installation Video Inspection - After installation of the UV-CIPP perform a post-installation video inspection of the pipe according to Section 00415.

00412.72 Material Sampling and Testing - Obtain samples and perform material testing according to ASTM F1216 and ASTM F1743. Perform one physical properties test per 1,000 feet installed, or as specified.

Individually label and log each sample with the following information:

- Project name
- Name of Contactor
- Sampler's name
- Sample number
- Date and time of sample
- Location of sample
- Initial cure start date and time
- Name and location of third party laboratory

Flexural properties must meet or exceed the values according to 00412.12.

00412.73 Repairs - Before making repairs, provide the CIPP liner system manufacturer's recommendations for liner repairs, subject to approval by the Engineer. Repair or replace CIPP liners that have:

- Wrinkles, fins or other discontinuities in the lower one-third of the pipe that are perpendicular to the flow and exceed 1/2 inches in height, or are greater than 3 percent of the host pipe inside diameter.
- Wrinkles, fins or other discontinuities in the upper two-thirds of the pipe that are perpendicular to the flow and are greater in height than 5 percent of the host pipe inside diameter.
- Blisters or dry spots present.
- Leakage through the liner in excess of ASTM F1216 and ASTM F1743 standards.
- Separation of the liner from the host pipe.
- Delamination of CIPP layers.

00412.75 Contractor Warranty - The Contractor unconditionally warrants to the Agency the product and installation under this Section against failure, according to this Subsection and 00170.85(b)(1).

"Unconditionally warrant" means that the warranty covers all failures, regardless of the source or cause of the failure, including, without limitation, whether the source or cause is or may be related to workmanship, inspection, or choice of materials.

The Agency inspection of any portion of the Work during the Contract and during the product installation, the Agency acceptance of the Work, corrections under the warranty, or expiration of the warranty shall not relieve the obligations under this warranty.

(a) Warranty Period - The warranty period shall be for 1 year.

(b) Failure - For purposes of the warranty, failure is defined as one or more of the following:

- Wrinkles, fins or other discontinuities in the lower one-third of the pipe that are perpendicular to the flow and exceed 1/2 inch in height, or are greater than 3 percent of the host pipe inside diameter.
- Wrinkles, fins or other discontinuities in the upper two-thirds of the pipe that are perpendicular to the flow and are greater in height than 5 percent of the host pipe inside diameter.
- Blisters or dry spots.
- Leakage through the liner in excess of ASTM F1216 and ASTM F1743 standards.
- Separation of the liner from the host pipe.
- Delamination of CIPP layers.

(c) Remedy - Upon notification by the Engineer of a failure as defined above, provide the following remedy at no additional cost to the Agency:

- Liner repair plan and written timeline of when the Work will be completed within 10 Calendar Days of the Agency's written notification of failure.
- One of the following, as approved:
 - Install a second liner,
 - Remove the failed liner and install a full-thickness liner,
 - Construct a full pipe replacement, or
 - Install a liner repair.
- Complete one of the approved remedy's within 60 Calendar Days of the Agency's written notification of failure.
- Use materials and procedures meeting the Specifications.
- Coordinate timing of repair Work with the Engineer.

(d) Agency's Right to Make Repairs - If, in the opinion of the Engineer, a failure causes or may cause a hazard, the failure may be temporarily corrected by Agency or other forces at no additional cost to the Agency. Replace temporary repairs with permanent repairs at no additional cost to the Agency and according to the Specifications and within the time specified in 00412.75(c).

Measurement

00412.80 Measurement - The quantities of installed CIPP liners, of the various kinds, types, and sizes, will be measured on the length basis. The length will be measured, with no deduction for Structures or fittings, along the pipe flow line from center to center of manholes, inlets, Structures, special sections, or the ends of pipe, whichever is applicable.

The quantities of ~~service line reconnections~~ internal service reinstatements will be measured on the unit basis, regardless of size.

Payment

00412.90 Payment - The accepted quantities of Work performed under this Section will be paid for at the Contract unit price, per unit of measurement, for the following items:

Pay Item	Unit of Measurement
(a) CIPP Liner, ____ Inch	Foot
(b) Service Line Reconnections Internal Service Reinstatement	Each

In item (a), the nominal size of the ~~host pipe~~ Host Pipe will be inserted in the blank.

Payment will be payment in full for furnishing and placing all Materials, and for furnishing all Equipment, labor, and Incidentals necessary to complete the Work as specified.

00412.91 CIPP Price Adjustments

The CIPP will be considered Defective Work if the Actual Safety Factor is below the Design Safety Factor specified in 00412.02. The Agency may require removal and replacement of the liner, at its sole discretion. In lieu of rejecting defective CIPP with an Actual Safety Factor greater than or equal to 1.0 the Engineer may adjust the unit price. CIPP with an Actual Safety Factor less than 1.0 will be rejected.

The Actual Safety Factor will be calculated using the design equations from ASTM F1216-Appendix X1. The measured thickness, measured flexural strength and measured initial flexural modulus will be substituted for their respective design values while the remaining design parameters specified in 00412.12 are held constant.

Payment adjustments will be made according to the formula below.

$$\text{PRICE ADJUSTMENT} = (\text{INSTALLED LENGTH})(\text{UNIT PRICE}) \left(\frac{\text{ACTUAL SAFETY FACTOR}}{\text{DESIGN SAFETY FACTOR}} \right)$$

No additional payment will be made for liners exceeding the required Design Safety Factor.

Section 00413 – GFRP Cured-in-Place Pipe Lining & UV Cure

Description

00413.00 Scope - This Work consists of rehabilitating existing pipes by furnishing and installing ~~Glass Reinforced thermosetting Plastic (GRP) cured-in-place pipe (CIPP) liners as shown and using ultraviolet (UV) cure methods. The Contactor may choose to line pipes according to 00412 "Cured-In-Place Pipe Lining".~~

00413.01 Submittals - ~~Submittals shall conform to Section 00412.01~~

~~Submit the following at least 10 Calendar Days before the preconstruction conference:
 Certification by the lining system manufacturer that the installer is licensed and certified as competent to perform the Work.
 Documentation showing the installer meets the qualifications listed in 00413.30, and a list of the key qualified personnel who are assigned to Work on this Project.
 Manufacturer's technical data showing complete information on material composition, physical properties, and dimensions of system components of the tube and resin system. Include manufacturer's recommendation for handling and storage.
 Independent third party certification of test results confirming that the CIPP liner system meets the minimum chemical resistance requirements and initial structure properties according to ASTM F2019.
 Calculations for the volume of resin to be used for each segment and detailed description of the resin impregnation ("wet out") process. Include the tube and manufacturer's resin impregnation ("wet out") recommendations including the roller gap, material feed speed and vacuum requirements for each liner size and thickness. Upon liner system delivery, submit impregnation ("wet out") logs documenting resin volumes used.
 Detailed installation plan describing project staging, liner shot plan and sequence, and the manufacturer's standard procedures for liner installation. Include allowable pulling forces, installation pressures, allowable curing temperatures, temperature monitoring plan, and speed of the UV light train for proper curing of the installed liner.
 Liner shot and curing schedule for each installation. Include curing log and pressures at the upstream and downstream end of the pipe during the curing process.
 End seal material to be used, and method of installation. Hydraulic cements and quick set cement products are not acceptable.
 Field sampling and testing plan for physical properties according to ASTM F2019. Include the name and location of independent third party laboratory performing testing on the installed liner system. Provide certification that the independent third party laboratory has the appropriate accreditation for each specified tests to be performed.
 Contingency repair plan including methods and equipment to be used to repair or replace unacceptable liner defects identified in 00413.72.
 Stamped design of the proposed liner according to 00150.35 and 00413.02.~~

00413.02 Design Parameters - Follow the design considerations of ASTM F2019, ASTM F1216 Appendix X1, ASTM F1743, and meet the following:

Condition	Parameter
Service Life	Greater than 50 years
Pipe Conditions	Fully deteriorated
Load Conditions:	
Soil	125 lb/cf minimum
Traffic.....	LRFD HL-93 live load
Height of fill from invert.....	*
Groundwater Elevation above Invert. *	
Pipe Ovality	3% minimum <u>or as otherwise called out</u>
Modulus of Soil Reaction	700 psi
Enhancement Factor	7.0
Long-Term Flexural:	
Strength	50% of initial (ASTM D790)
Modulus of Elasticity	50% of initial (ASTM D790)
Maximum Deflection	5%
Minimum Factor of Safety.....	2.0
Poisson's Ratio of	0.3

* Parameters will be listed in the Special Provisions.

Materials

00413.10 Tube - Furnish tubing that consists of at least two separate tubes made of corrosion resistant (E-CR or equivalent) glass fibers according to ASTM D578 and ASTM F2019. Verify pipe lengths and pipe inside diameters before ordering tubing. Make allowance for circumferential or longitudinal stretching during installation. Provide flexible tubing that exhibits the following characteristics:

- Constructed to withstand pulling and installation forces and have sufficient strength to bridge missing pipe.
- Fabricated to a size that when installed, conforms to the internal circumference and length the of host pipe.
- Sewn or bonded seams, stronger than the non-seamed material, as recommended by the tube manufacturer.
- Includes an impermeable inner and outer foil layer to contain resin migration and contamination. The inner foil should release easily from the inside wall for removal after completion of installation or remain if fabricated as a permanent part of the system and an integral part of the fabric tube by bonding or fusing to the fabric tube.

- Includes an impermeable inner and outer foil layer to contain resin migration and contamination. The inner foil should release easily from the inside wall for removal after completion of installation or remain if fabricated as a permanent part of the system and an integral part of the fabric tube by bonding or fusing to the fabric tube.
- Homogeneous across the entire wall thickness containing no intermediate or encapsulated elastomeric layers.
- Do not include any material in the tube that may cause delamination in the CIPP.
- After installation the wall color of the interior pipe surface of CIPP is a light reflective color.

00413.11 Resin - Furnish resins meeting the requirements of ASTM F2019, Section 5.4 for UV-Light. Comply with the structural requirements specified for the installed liner system and the following:

- Compatible with the installation process.
- Chemically resistant UV cured isophthalic, polyester resin or vinyl ester resin.
- Capable of curing in the presence and absence of water.
- Resins created from recycled materials are not allowed.

Completely impregnate ("wet out") the liner with resin in the manufacturer's plant under quality controlled conditions. Attach certification (provided by the manufacturer), according to ASTM F2019, to the impregnated fabric tube. No onsite or mobile resin impregnation is allowed. The Engineer may inspect fabrication of the liner and resin impregnation at the manufacturer's facility to ensure compliance with these specifications.

00413.12 Liner Properties - Fabricate the liner to a size that when cured, will tightly fit the pipe being rehabilitated and meet the following requirements:

- Furnish liners that have the minimum physical properties stated in ASTM F2019 and tested according to ASTM D790 or approved equal.
- Be resistant to chemical properties

Characteristic	Test Method	Test Value
Initial Flexural Strength	ASTM D790	6,500 psi*
Flexural Modulus of Elasticity	ASTM D790	725,000 psi

*Minimum flexural strength in both the circumferential and longitudinal direction.

Installed liner will have a minimal nominal thickness of at least the calculated design thickness per ASTM F1216, as specified in 00413.03.

00413.13 Liner End Seal – Furnish liner end seal according to 00412.13.

00413.14 Tapping Tees – Furnish tapping tees according to 00412.14.

00413.15 Saddle Tees – Furnish saddle tees according to 00412.15.

00413.16 Manhole Channel Grout – Furnish grout according to 00412.16.

00413.17 Delivery and Storage - Deliver and store all product materials according to the manufacturer's recommendations and accompanied by the material safety data sheets. Store and transport the impregnated liner according to ASTM F2019, Section 6.4 and the manufacturer's recommendations. Use tubing material that is homogenous throughout, free from tears, holes, cracks, foreign materials and other surface defects.

Equipment

00413.27 UV Curing Equipment –

Provide UV Curin equipment with the following properties:

- Light train shall have a minimum of one camera for CCTV inspection of the liner.
- Light train shall be sized according to the pipe diameter to ensure the UV bulbs are in proper proximity to the liner wall circumference.
- Light train shall include sensors to record cure progress.
- Individual UV lights incorporated in the light train shall not exceed 80% of the logged hours of usage of the manufacturer's stated usage rate. Maintain light train usage log on-site and submit to Engineer upon request.
- UV curing lamps shall operate at a sufficient output and in a sufficient frequency range to ensure curing of resin.
- Multi-lamp UV curing lights and resin photo-initiator system shall be optimized for curing of the provided resin.

Labor

00413.30 Personnel Qualifications - Provide installers who:

- Are licensed, and certified by the manufacturer of the CIPP product system to be used on the Project.
- Have at least 3 years of active experience in the installation and UV curing methods of GRP CIPP according to ASTM F2019.
- Have installed at least 50,000 feet of UV-GRP CIPP according to ASTM F2019.

or

- Provide a manufacturer's representative with at least three years' experience with UV-GRP CIPP installation in pipes and has installed at least 50,000 feet of UV-GRP CIPP according to ASTM F2019.
- The Contractor is responsible to ensure the manufacturer's representative is on-site for a minimum of 5 full days during the initial installation. When the representative is not on-site, provide the telephone number of a manufacturer's representative who is available on a 24-hour basis throughout the Project duration.

Provide a supervisor for the UV-GRP CIPP installation who is assigned to the Project full time during the UV-GRP CIPP installation Work and has supervised at least 30,000 feet of UV-GRP CIPP according to ASTM F2019.

Crews and key personnel are not to work more than a maximum of 12 hours per 24-hour day, or as otherwise approved.

Construction

00413.40 General - Field verify pipe inside diameter(s) throughout the pipe, length(s), alignment, material and condition of the host pipe prior to ordering liner material and construction. Handle and store all liner material to ensure that the material is not torn, cut, exposed to direct sunlight or otherwise damaged. Before installing the liner:

- Verify the liners condition with the Engineer. If any part of the liner material becomes torn, cut, or damaged before or during insertion, repair or replace the liner at no additional cost to the Agency before proceeding further.
- Furnish, install, maintain and operate a flow diversion system as needed, and according to Section 00490.
- Furnish and supply generators or obtain temporary power to provide all electric power required for installation. Obtain a permit and pay all fees required for use of any hydrant. Obtain a Batch Discharge permit according to Section 405 to discharge water used for cleaning or other construction activities.

00413.41 Pipe Cleaning - Clean the pipe by removing all debris, sediment, and other accumulated material. Do not use chemicals without the written approval of the Engineer. Remove and dispose of all debris according to 00290.20.

00413.42 Pre-Installation:

(a) Video Pipe Inspection - After cleaning the pipe, perform a pre-installation video inspection of the pipe according to Section 00415. The inspection shall also be used to determine service connection locations for re-establishment and to determine the size of liner (diameter, length, and expansion) required. Provide the video and inspection report at least seven calendar days prior to beginning liner installation operations.

(b) Pre-Installation Point Repairs - If pre-installation video inspection reveals unanticipated obstructions, reduction in cross-sectional area, sags, previous repairs, protruding taps, or any structural defects in the pipe, submit a point repair plan to the Engineer for approval. All point repairs must restore the host pipe to a condition suitable for UV-CIPP lining. Where necessary, clean and video inspect prepared pipe to assure that shavings are removed prior to liner installation.

(c) Receiving and Insertion Locations – Locate all manholes and pits to suit the pipe lining operation. Use existing manholes where practical. Remove manhole cones, inverts, benches, and channels to permit access for installation equipment as necessary. Manhole modification and repair plan will be approved prior to proceeding with liner installation. Enlarge the incoming and outgoing pipe openings if required to accommodate the maximum outside diameter size of the insertion equipment. Do not put undue stress on existing structures. In areas where new manholes are not being installed or existing manholes are not available, excavate and restore pits at no additional cost.

Approved unanticipated point repairs to restore the host pipe suitable for UV-CIPP lining will be paid for according to 00195.20. No additional payment will be made for verification of pipe preparation.

Seal all active water infiltration into the pipe prior to application of the liner with an approved epoxy or resin mixture compatible with the GRP CIPP liner system used.

00413.43 Installation - Install liner system according to ASTM F2019 and the manufacturer's recommendations.

(a) General - Ship, store, and handle liner materials according to manufacturer's recommendations and in such a manner that it will not be damaged, exposed to direct sunlight or result in any public safety hazard. The Engineer reserves the right to reject liners without certification documentation, or liners that exceed the manufacturer's recommended shelf life. The Engineer may check, verify or inspect all phases of production and testing of materials from manufacturing, shipping, impregnation, installation, cure, to finished product. Any departure from the submitted procedures will be cause for rejection.

Where practicable, install liners in continuous runs through manholes where there are two or more continuous host pipe segments requiring lining. Provide temporary downstream dams or filtration measures in the pipeline to catch excess resin and construction debris.

Provide a "back-up" robotic cutter assembly train and key spare components on-site during CIPP lining activities.

(b) Pipe Liner End Seal - Install a continuous or properly trimmed end seal between the end of the new liner and the host pipe connection. Insert end seals at each structure opening centered with the host pipe. Butt the trimmed end seal edges against each other at the crown of the pipe using a ~~45 degree~~ miter cut. Seals, with any gap between the ends, will not be accepted.

(c) Installation - Prior to inserting the liner, install a slip sheet through the entire length of the host pipe to protect the liner from damage during installation.

Attach the liner securely to a constant tension winch and pull into place. Do not exceed the manufacturer's recommendations for pulling forces (tension) and speed. Should the overall elongation exceed the Manufacturer's recommendations, the liner will be rejected and replaced at no additional cost to the Agency.

Inflate the liner by air to an initial pressure, recommended by the manufacturer, until the liner fits tight against the wall of the existing host pipe. Ensure the pressure head used during the installation process is sufficient to hold the liner tight to the pipe wall, and prevent wrinkles in the cured liner. During the curing process use the same pressure head to prevent water infiltration from entering the pipeline. Maintain the pressure head long enough to allow pockets of water to exfiltrate through the host pipe and prevent lifts in the liner and resin washout.

Workers shall not be present in the manhole during pressurization of the liner. Packers and clamping straps shall be properly installed and attached. In constant positive pressure is specified, any internal pressure above the springline against the crown of the pipe must be maintained from insertion to final curing without any loss of pressure.

(d) UV Curing Method - Cure the liner according to ASTM F2019, Section 6.7, with the following modifications:

A camera must be located on the ultraviolet light assembly to view that the liner is properly inflated and identify any liner problems before curing begins.

Operate the ultraviolet curing lamps in a sufficient frequency range to ensure the curing of the resin.

Do not pull the UV light train in a downhill direction during the curing process unless otherwise approved. Approval will not be given where pipe slopes are greater than or equal to 3.0%.

Collect during data and CCTV inspection records during the installation and curing process. Submit copies to the Engineer for review. Where the curing data and the curing protocol differ, the Agency reserves the right to require additional "in-pipe" sampling and testing at no additional cost.

Submit a documented record of time, rate of travel of the ultraviolet light assembly, internal pressures, and the amount of lamps in operation during the curing process to the Engineer upon request.

00413.44 Service Line Reconnection – Reinstate all service lateral connections after the liner system has been accepted except as directed. Locate and re-establish service laterals according to the manufacturer's recommendations. Reconnect all service lines according to 00410.49 and this section. If a permanent connection cannot be made by the end of the work day, install an approved temporary service connection.

(a) Internal Service Reinstatement – As shown or directed perform an internal service reinstatement. Reinstate active service lines using an internal cutter. Provide a primary and back-up robotic cutting device.

Before cutting any internal reinstatements, locate the liner dimples at the service connections. Verify that the dimple locations correspond to the distances measured to the service lines. The internally reinstated lateral must be restored to at least 95% but not more than 100% of the original size and shape of the service opening. Make each connection free from burrs or projections, and with a smooth and crack-free edge.

Core the CIPP at the service line from inside the CIPP. Use video inspection equipment according to 00415 and a robotic cutting device. Match the original service line invert with the new opening. Remove all rough edges and burrs. Grout seal the service connection. Holes in the liner due to errors in determining the location of a service connection or oversized holes at service locations will be considered liner defects.

(b) Service Line Replacements - As shown or directed, replace service lines according to 00410.50. Excavate down to the host pipe and connect the service line to the CIPP using a tapping tee or saddle type connection.

(c) Tapping Tees - Remove a portion of the host pipe to expose the liner and provide adequate working space for installing the new tapping tee. Do not damage the new liner when removing the host pipe. Install the new tap at the hole cut for the internal reinstatement. If no hole was cut for internal reinstatement install the new tap 12 inches upstream or downstream of the liner dimple.

Use approved coring equipment to cut tap holes in the CIPP. Saw cutting with a non-circular device or dull coring bits will not be allowed. Wipe the surfaces clean, remove all burrs, and dry the mated surfaces of the liner and tap. Install the tapping tee following the manufacturers specifications. Bed each tapping tee using a single 60-pound bag of dry ready-mix concrete.

(d) Saddle Type Connections - Where a service line is larger than one half the diameter of the host pipe, install a saddle type connection. Full circumferential host pipe removal is required for these saddle type connections. Known 6-inch service lines are shown. Glue the saddle to the CIPP using IPS 810 Weld-On two-part epoxy or approved equal. Secure it with two stainless steel straps. Allow the epoxy to set before backfilling these connections.

(e) Limited Access Service Reconnection - A service line reconnection is considered to have limited access when it is impractical for typical heavy equipment to reach the site. Where construction access is limited, use an alternate excavation method to provide the service line connection. Hand excavate or use small excavating equipment.

All equipment including but not limited to cutter heads, crawlers, CCTV cameras, hydraulic drums, counters, etc. shall be suitable for the Work and in good working order. Use an approved internal cutting device and video camera to restore service connections to the full diameter of the service. Qualified individuals with experience in successful internal lateral reinstatement are to perform the work. Connections shall be water tight and provide a flush, smooth transition free of loose or abraded material. Repair overcuts or undercuts, punctures, and ragged edges due to poor cutting of liner material per 00413.73 at no additional cost.

Reinstate or correct, without any delay, all missed or faulty reconnections, as well as any damage to property owners caused by missed reconnections.

New lateral connections to the finished liner system will be made according to Section 00445.

00413.45 Structure Connection – After the cool-down period is complete, perform final trimming and sealing of the liner at access structures to provide watertight pipe and structure seals. Neatly and smoothly trim the finished ends of the liner to within one inch of access structure wall. Provide a smooth transition between the existing structure channel invert and the liner using cementitious or other approved material to prevent settling of sediments or debris from catching on the liner or ponding of any standing water in the access structure. Seal all holes and voids in manhole and structure walls immediately surrounding the new liner with a chemical grout, compatible with the resin mixture of the liner.

Reinstall manhole cones, slabs, grade rings, frames, covers, inverts, and reconstruct benches and channels after each pipe liner installation. Replace manhole steps removed for CIPP liner installation with new steps, as shown. Holes resulting from removal of existing steps shall be repaired as approved. Internal rehabilitation of manholes is not permitted until after the liner is installed and accepted.

Remove temporary dams after work is complete and pipe is clean and restored according to 00490.

(a) Manhole Drops – Where a lined segment with an external drop manhole has less than two vertical feet between the inlet and outlet flow lines, abandon the external drop in place. Seal the flow line stub using non-shrink grout and construct a concrete slide to direct flow smoothly into the channel and minimize turbulence and splatter onto the base.

Where exterior drops are greater than 2 vertical feet, reinstate the opening of the drop from inside the liner pipe using robotic cutting equipment as described in section 00412.42(e).

(b) Miscellaneous Manhole Work - All liner pipes entering a manhole shall be cut square at the invert. Liner pipe shall not extend into the manhole.

After liner installation is complete, modify manhole channels using non-shrink grout to provide a smooth and uninterrupted flow throughout the channel base and over the ends of the new pipe liners. Perform bypass pumping according to 00490.40. Prepare all surfaces to which the grout is applied by cleaning and applying a compatible bonding agent approved by the manufacturer. Allow the grout to set according to the manufacturer's recommendation before reintroducing flow to the channel.

Finishing, Cleaning Up, and Testing

00413.70 General - Ensure the cured liner is continuous and free from visual defects such as foreign inclusions, dry spots, pinholes, delamination, and wrinkles at any location. Verify the lining is impervious and free of any leakage from water infiltration into the lined pipe or exfiltration from the lined pipe.

Cut both ends of the cured liner flush at the inlet and outlet points of the pipe, and sealed with an epoxy or resin mixture compatible with the liner/resin system, providing a watertight seal.

Remove any temporary dams or filtration measures after Work is complete and pipe is clean and restored.

00413.71 Post Installation Video - After installation of the UV-CIPP, reconnection of service laterals, and final cleaning, perform a post-installation video inspection of the pipe according to Section 00415.

00413.72 Material Sampling and Testing - Prepare and immediately deliver to the Engineer two samples of each completed liner segment. Any sample removed from the project site without approval will be rejected. Prepare additional contractor-required samples without damaging the liner and at no additional cost. For each installed liner segment, Obtain obtain restrained samples and perform material testing according to ASTM F2019 Section 7 for UV cure with the following modifications: In the case where a single liner is installed in multiple consecutive pipe segments, only a single sampling location is required.

Samples for each type described below should be large enough to provide the recommended specimens for testing. For flexural properties, the full wall thickness of the liner samples will be tested. Sample size is based on installed liner thickness.

Individually label and log each sample with the following information:

- Project name and number

- Name of Contractor
- Sampler's name
- Sample number
- Date and time of sample
- Manhole-to-manhole segment number shown on plans
- Location of sample within the manhole-to-manhole segment
- Initial cure start date and time
- Type of sample (restrained, plate, or core)
- Name and location of third party laboratory

Flexural properties must meet or exceed the values according to 00413.12.

If core sample method was used, repair core hole samples using the same tube that was used in the installed liner, and an epoxy or resin mixture compatible with the GRP CIPP liner system used. Repair patches must fill the cores completely. Apply a second oversized 1.5mm thickness patch over the repaired hole to ensure a watertight seal.

(a) Restrained Samples – Form restrained samples during liner construction from a section of the UV-CIPP liner which has been inverted through a pipe the same diameter as the host pipe or other tubular restraining means, held in place to resist the curing pressures, or as otherwise approved.

Where the installation setup prevents successful restrained sample preparation at intermediate or terminal manholes, plate samples may be acceptable. Coordinate plate sampling procedure with the Engineer prior to installation.

(b) Testing – The Engineer will test samples per ISO 178, and will consider any residual UV-CIPP liner film material or pre-liner as non-structural. Certified copies of all test results will be provided to the Contractor upon request. Physical properties of the installed UV-CIPP will be confirmed in accordance with ASTM F2019 and per the following:

(1) Thickness: For restrained samples, thickness will be measured according to ASTM F2019, D5813, & D3567.

If restrained samples are deemed not representative of the required design thickness, an alternate method of measuring thickness may be approved to measure installed liner thickness by ultrasonic pulse echo per ASTM E797, by the Contractor at no additional cost. A minimum of eight (8) evenly spaced measurements should be made around the internal circumference of the installed UV-CIPP within the host pipe at a distance of 12 to 18 in. from the end of the pipe. For pipe diameters of fifteen (15) in. or greater, a minimum of sixteen (16) evenly spaced measurements shall be recorded.

The ultrasonic method to be used is the flaw detector with A-scan display and direct thickness readout, as defined in 6.1.2 of E797. Manufacture a calibration block from the identical materials used, to calibrate sound velocity through the installed liner. Calibrate the transducer daily in accordance with the equipment manufacturer's recommendations. The average thickness should be calculated using all measured values and shall meet or exceed minimum design thickness as agreed upon between purchaser and seller.

If restrained samples are not available and alternate methods of measuring thickness are not approved, and the configuration of the liner and host pipe prevent in-place measurement, take a minimum of three 1-inch core samples evenly spaced around the circumference a minimum of 12 inches from the wall of a manhole or structure. Thickness will be measured at three spots on each of three specimens. The resulting nine measurements will be averaged.

Repair core sample cavities using the same felt tube that was used in the installed liner, and an epoxy resin approved for use and compatible with the installed liner. Repair patches must fill the cores completely, and a second oversized patch of 1.5mm thickness must be placed over the repaired hole, to ensure a watertight seal. Proper surface roughening of the original liner surface must be performed prior to placement of the oversized patch.

(2) Physical Properties: Samples will be used tested to verify the modulus of elasticity and flexural strength properties of the cured liner.

If a non-restrained sample is used to determine initial flexural modulus according to 00413.70 (a) then a reduction factor of 20% will be applied to the measured value (measured value x 0.80).

(c) Retesting: If any test fails, collect and deliver additional samples to the Engineer for re-testing. If the second samples fail, bring the liner into compliance by methods described in 00413.73.

00413.73 Repairs - Before making repairs, provide the CIPP liner system manufacturer's recommendations for liner repairs, subject to approval. Install a second full-thickness liner, remove and re-install a full-thickness liner, construct a full pipe replacement, or install a liner repair as approved. ~~Repair or replace CIPP liners~~ at no additional cost to the Agency per the manufacturer's recommendations for liners that have:

- Wrinkles, fins or other discontinuities in the lower one third of the pipe that are perpendicular to the flow and exceed 1/2 inches in height, or are greater than 3 percent of the host pipe inside diameter.
- Wrinkles, fins or other discontinuities in the upper two thirds of the pipe that are perpendicular to the flow and are greater in height than 5 percent of the host pipe inside diameter.
- Holes, blisters, dimples, lifts or dry spots present.

- Tears or gouges.
- Leakage of water through the liner according to ASTM F2019 Section 7.3.
- Separation of the liner from the host pipe.
- Delamination of CIPP layers.
- Design thickness is less than 90 percent of submitted value as determined by ASTM F2019.
- Any space or gap between the outside surface of the liner and the inside surface of the existing pipe that exceeds 0.040 inches.

00413.75 Contractor Warranty - The Contractor unconditionally warrants to the Agency the product and installation under this Section against failure, according to this Subsection and 00170.85(b)(1).

"Unconditionally warrant" means that the warranty covers all failures, regardless of the source or cause of the failure, including, without limitation, whether the source or cause is or may be related to workmanship, inspection, or choice of materials.

The Agency inspection of any portion of the Work during the Contract and during the product installation, the Agency acceptance of the Work, corrections under the warranty, or expiration of the warranty shall not relieve the obligations under this warranty.

(a) Warranty Period - The warranty period shall be for 1 year.

(b) Failure - For purposes of the warranty, failure is defined as one or more of the following:

- Wrinkles, fins or other discontinuities in the lower one-third of the pipe that are perpendicular to the flow and exceed 1/2 inch in height, or are greater than 3 percent of the host pipe inside diameter.
- Wrinkles, fins or other discontinuities in the upper two thirds of the pipe that are perpendicular to the flow and are greater in height than 5 percent of the host pipe inside diameter.
- Holes, blisters, dimples, lifts or dry spots.
- Tears or gouges.
- Leakage of water through the liner according to ASTM F2019 Section 7.3.
- Separation of the liner from the host pipe.
- Delamination of CIPP layers.
- Design thickness is less than 90 percent of submitted value as determined by ASTM F2019.
- Any space or gap between the outside surface of the liner and the inside surface of the existing pipe that exceeds 0.040 inches.

(c) Remedy - Upon notification by the Engineer of a failure as defined above, provide the following remedy at no additional cost to the Agency:

- Liner repair plan and written timeline of when the work will be completed within 10 Calendar Days of the Agency's written notification of failure.
- One of the following, as approved:
 - Install a second liner,
 - Remove the failed liner and install a full-thickness liner,
 - Construct a full pipe replacement, or
 - Install a liner repair.
- Complete one of the approved remedies within 60 Calendar Days of the Agency's written notification of failure.
- Use materials and procedures meeting the Specifications.
- Coordinate timing of repair Work with the Engineer.

(d) Agency's Right to Make Repairs - If, in the opinion of the Engineer, a failure causes or may cause a hazard, the failure may be temporarily corrected by Agency or other forces at no additional cost to the Agency. Replace temporary repairs with permanent repairs at no additional cost to the Agency and according to the Specifications and within the time specified in 00413.75(c).

Measurement

00413.80 Measurement - The quantities of installed CIPP liners, of the various kinds, types, and sizes, will be measured on the length basis. The length will be measured, with no deduction for Structures or fittings, along the pipe flow line from center to center of manholes, inlets, Structures, special sections, or the ends of pipe, whichever is applicable.

The quantities of service line reconnections, internal service reinstatements, grout seal service connections, and service line connections will be measured on the unit basis, regardless of size.

The quantities of approved limited access excavations will be measured on the unit basis, regardless of depth. This item is measured at locations of service line reconnections and saddle connections and is in addition to that work if applicable.

Payment

00413.90 Payment - The accepted quantities of Work performed under this Section will be paid for at the Contract unit price, per unit of measurement, for the following items:

Pay Item

Unit of Measurement

- (a) CIPP Liner, ____ Inch Foot
- (b) Internal Service Reinstatement.....Each

In item (a), the nominal size of the host pipe will be inserted in the blank.

Payment will be payment in full for furnishing and placing all Materials, and for furnishing all Equipment, labor, and Incidentals necessary to complete the Work as specified.

No separate or additional payment will be made for:

- Temporary manhole modifications to provide access for performing work.
- Installation of end seal material or addressing deficient end seals.
- Removal of protruding taps, tree roots, controlling leaks, and other cleaning activities during host pipe preparation process.
- Removal, repair, or replacement of liners that are determined to be noncompliant with 00490.73.
- Additional testing, cleaning, and video inspection required as a result of correction of unsatisfactory work.

00413.91 Payment Deduction – Payment will be based upon the Contract Unit Price and test results acquired according to 00413.70. Should test results fail to meet the specified design parameters for thickness and initial physical properties, yet comply with Conformance Standards in 00413.72, a payment deduction will be made according to the Payment Formula below.

$Payment = Length\ Installed \times Contract\ Unit\ Price \times (Actual\ Safety\ Factor / Design\ Safety\ Factor)$

The Actual Safety Factor will be calculated using the governing design equations (i.e. equations yielding the greatest minimum thickness) from ASTM F1216-Appendix X1. The measured thickness, measured flexural strength and measured initial flexural modulus will be substituted for their respective design values while the remaining design parameters specified in 00413.03 are held constant. The Design Safety Factor is specified in 00413.03.

No additional payment is made for liners exceeding required design safety factor. The UV-CIPP will be considered Defective Work if the actual safety factor is below 1.0. The Agency reserves the right to require removal and replacement of the liner, at its sole discretion.

Section 00414 - Pipe Renewal - Spray Applied Pipe Structural Liner

Description

00414.00 Scope - This Work consists of lining existing pipes with a spray applied pipe structural liner (SAPL) that is a factory blended cementitious or geopolymer mortar Material. Apply the SAPL by spin cast method or spray by hand on metal, concrete, clay, and brick pipes only.

00414.01 Submittals - Submit the following at least 10 Calendar Days before the preconstruction conference:

- Certification by the lining system manufacturer that the installer is licensed and certified as competent to perform the Work.
- Documentation showing the installer meets the qualifications listed in 00414.30, and a list of the qualified personnel who are assigned to Work on this Project.
- Certification that manufacturing processes operate under a quality management system according to recognized industry standards.
- Manufacturer's technical data showing complete information on material composition and physical properties. Include manufacturer's recommendation for handling, storage, installation, curing, finishing, and for the repair of a damaged liner.
- Independent third party certification of test results confirming that the SAPL liner system meets the structure properties according to 00414.10.
- Field sampling and testing plan for physical properties according to 00414.10. Include the name and location of independent third party laboratory performing testing on the installed liner system. Provide certification that the independent third party laboratory has the appropriate accreditation for each specified tests to be performed.
- Contingency repair plan including methods and Equipment to be used to repair or replace unacceptable SAPL defects identified in 00414.72.
- Stamped design of the proposed liner according to 00150.35 and 00414.02.

00414.02 Design Parameters - Use the following design parameters for a fully deteriorated gravity pipe design:

Condition	Parameter
Soil modulus of Reaction	2,000 psi maximum
Load Conditions:	
Soil	120 lb/cf minimum
Traffic	LRFD HL-93 live load
Height of fill from invert	*
Groundwater Elevation above Invert.....	*
Minimum Factor of Safety	2.0

* Parameters will be listed in the Special Provisions.

The minimum liner thickness, independent of design for all structural applications:

- 1.0 inch for all pipes less than 48 inches in diameter or equivalent.
- 1.5 inches for all pipes greater than 48 inches in diameter or equivalent.

Materials

00414.10 Liner Properties - Furnish a cementitious or geopolymer mortar Material that meets the following minimum physical property requirements.

PropertyTest	Method	Duration	Test Value
Minimum Compressive Strength	ASTM C109	1 Day	3,000 psi
		28 Days	8,000 psi
Minimum Flexural Strength	ASTM C293	7 Days	850 psi
		28 Days	1,100 psi
Modulus of Elasticity	ASTM C469	28 Days	3,600,000 psi
Bond Strength	ASTM C882	28 Days	2,000 psi
Freeze Thaw Resistance	ASTM C666	300 Cycles	Min. 90%

00414.11 Delivery and Storage - Deliver and store all product Materials according to the manufacturer's recommendations and accompanied by the material safety data sheets.

Deliver all Materials in the manufacturer's original unopened packages. Check to ensure each package is labeled with the manufacturer's brand name, batch number and expiration date. Do not use Material that has exceeded the expiration date, or Material from defective, punctured or damaged packages.

Equipment

00414.20 Equipment - Use Equipment approved by the manufacturer to apply the SAPL and that meets the following requirements:

- (a) Spin Cast Nozzle** - Use spin cast nozzle capable of bidirectional operation and attached to a reciprocating head.
- (b) Pumps** - Use pumps equipped with multiple sensors that stop the pump if the lining Material runs out or overflows.
- (c) Mixer** - Provide a high shear mixer to ensure a uniform and thorough mix of the water and Material prior to pumping.

Labor

00414.30 Personnel Qualifications - Provide installers who:

- Are licensed, and certified by the manufacturer of the SAPL product to be used on the Project.
- Have at least 3 years of active experience in the spin cast installation of cementitious or geopolymer mortar liners.
- Have installed at least a cumulative of 5,000 feet of cementitious or geopolymer mortar by spin cast and hand application.

or

- Provide a manufacturer's representative with at least five years' experience with cementitious or geopolymer mortar SAPL.
- The Contractor is responsible to ensure the manufacturer's representative is on-site during the installation. When the representative is not on-site, provide the telephone number the manufacturer's representative, or alternate, who is available on a 24-hour basis throughout the Project duration to the Superintendent and the Engineer.

Provide a supervisor for the cementitious or geopolymer mortar liner Material installation who is assigned to the Project full time during the pipe structural liner Work and has supervised at least 15,000 feet of cementitious or geopolymer mortar liner by spin cast and hand application.

Construction

00414.40 General - Field verify pipe inside diameter(s) throughout the pipe, length(s), alignment, Material and condition of the host pipe prior to ordering liner Material and construction.

00414.41 Pipe Cleaning - Clean the pipe by removing all debris, sediment, and other accumulated Material. Do not use chemicals without the written approval of the Engineer. Remove and dispose of all debris according to 00290.20.

00414.42 Pre-Installation:

(a) Video Pipe Inspection - After cleaning the host pipe, perform a pre-installation video inspection of the pipe according to 00415, at least 5 Calendar Days before beginning pipe lining Work.

(b) Pre-Installation Repairs - Repair any deterioration or loss of Material of the pipe invert using a highly flowable lean concrete mix according to 00442. Seal all open joints with an approved hydraulic cement or geopolymer lining Material prior to the lining of the pipe.

Repair or restore the host pipe suitable for cementitious or geopolymer mortar lining as directed. Repairs will be paid for according to 00195.20

Seal all active water infiltration into the pipe prior to application of the SAPL by applying quick-setting mortars or chemical grouts approved by the Engineer.

When requested by the Engineer, perform a new or supplemental pre-construction video inspection of the pipe according to Section 00415 after the repairs have been completed.

00414.43 Installation - Install the SAPL according to the manufacturer's recommendations and control the temperature and humidity. The SAPL shall be smooth, uniform and free of any defects.

(a) Application Thickness - Apply the SAPL in a uniform thickness. The minimum uniform thickness per Pass is 1/2 inch and the maximum uniform thickness is 3/4 inches per Pass. During installation ensure the corrugation troughs are completely filled.

Plastic indicator tabs may be attached on the Structure to verify the design thickness is achieved. Position the tabs height just below the specified liner thickness.

Verify Material thickness at three various random locations around the pipe perimeter a minimum of once every 10 linear feet along the pipe profile. Measure the Material thickness over the corrugation crests using a depth gauge. Ensure the Material thickness over projecting bolts on structural plate culverts is a minimum of 1/2 inch. Apply additional Material at locations less than the design thickness using the rotating applicator head.

(b) Curing - Cure the Material in moist and moderate conditions according to the manufacturer's recommendations.

(c) General - Submit a daily written report of:

- Time, calibration and rate of travel of the applicator to achieve the specified design thickness.
- Verified Material thickness according to 00414.43(a).
- The outside ambient air temperature and the temperature and humidity inside the host pipe.

Finishing, Cleaning Up, and Testing

00414.70 General - Ensure the cured cementitious or geopolymer mortar is continuous and free as from visual defects such as foreign inclusions, delamination, and cracking at any location. Verify the SAPL is impervious and free of any leakage from water infiltration or exfiltration from the lined pipe.

Remove temporary dams or filtration measures after Work is complete and pipe is clean and restored.

00414.71 Post Installation Video - After installation of the applied Material perform a post-installation video inspection of the pipe according to Section 00415.

00414.72 Material Sampling and Testing:

(a) Pre-Placement Samples - Obtain two samples of Material the first and last day of construction, for a total of four samples. Additional samples during the application may be taken at the request of the Engineer. Employ an independent third party ACI certified testing agency to properly obtain and transport the test samples and perform Material testing according to 00414.10.

Individually label and log each sample with the following information:

- Project Name
- Name of Contractor
- Sampler's name
- Product batch number(s)
- Sample number
- Liner installation date
- Date and time of sample
- Location of sample within culvert
- Name and location of third party laboratory

(b) Core Samples - When requested by the Engineer, core the liner at three different clock positions at established intervals through the pipe at no additional expense to the Agency. The measurement of the actual liner thickness will equal the average core thickness of all core samples taken. Repair the core holes in the pipe liner according to the manufacturer's recommendations at no additional cost to the Agency.

00414.73 Repairs - Repair defective areas to meet the requirements of the Plans and Specifications. Before making repairs, provide the manufacturer's recommendations for liner repairs, subject to approval by the Engineer. Repair or replace liners that have:

- Installed thickness less than 90 percent of the specified design thickness.
- 28 Day compressive strength less than 8,000 psi, as determined by ASTM C109.
- 28 Day minimum flexural strength less than 1,100 psi as determined by ASTM C293.
- Infiltration or exfiltration of water through the liner.

- Cracks larger than 0.032 inches wide.
- Separation of the liner from the host pipe.

If repairs are necessary perform an additional post-installation video inspection of the repaired areas of the pipe according to Section 00415.

00414.75 Contractor Warranty - The Contractor unconditionally warrants to the Agency the product and installation under this Section against failure, according to this Subsection and 00170.85(b)(1).

"Unconditionally warrant" means that the warranty covers all failures, regardless of the source or cause of the failure, including, without limitation, whether the source or cause is or may be related to workmanship, inspection, or choice of Materials.

The Agency inspection of any portion of the Work during the Contract and during the product installation, the Agency acceptance of the Work, corrections under the warranty, or expiration of the warranty shall not relieve the obligations under this warranty.

(a) Warranty Period - The warranty period shall be for 1 year.

(b) Failure - For purposes of the warranty, failure is defined as one or more of the following:

- Infiltration or exfiltration of water through the liner.
- Cracks larger than 0.032 inches wide.
- Separation of the liner from the host pipe.

(c) Remedy - Upon notification by the Engineer of a failure as defined above, provide the following remedy at no additional cost to the Agency:

- Provide a liner repair plan and written timeline of when the Work will be completed within 10 Calendar Days of the Agency's written notification of failure.
- One of the following, as approved:
 - Remove the failed liner and install a full-thickness liner,
 - Construct a full pipe replacement, or
 - Install a liner repair.
- Complete one of the approved remedy's within 60 Calendar Days of the Agency's written notification of failure.
- Use Materials and procedures meeting the Specifications.
- Coordinate timing of repair Work with the Engineer.

(d) Agency's Right to Make Repairs - If, in the opinion of the Engineer, a failure causes or may cause a hazard, the failure may be temporarily corrected by Agency or other forces at no additional cost to the Agency. Replace temporary repairs with permanent repairs at no additional cost to the Agency and according to the Specifications and within the time specified in 00414.75(c).

Measurement

00414.80 Measurement - The quantities of installed spray applied pipe structural liner will be measured on the length basis. The length will be measured, with no deduction for Structures or fittings, along the pipe flow line from center to center of manholes, inlets, Structures, special sections, or the ends of pipe, whichever is applicable.

Payment

00414.90 Payment - The accepted quantities of Work performed under this Section will be paid for at the Contract unit price, per unit of measurement, for the following items:

Pay Item	Unit of Measurement
(a) SAPL Liner, ____ Inch	Foot

In item (a), the nominal size of the host pipe will be inserted in the blank.

Payment will be payment in full for furnishing and placing all Materials, and for furnishing all Equipment, labor, and Incidentals necessary to complete the Work as specified.

Section 00415 - Video Pipe Inspection

Description

00415.00 Scope - This Work consists of inspecting pipes by video accompanied by a recorded narrative and written report of the findings.

Equipment

00415.20 Mainline Inspection Equipment - Use the following Equipment unless otherwise approved.

It is the intent of the Agency by these specifications that the equipment used provide a bright, distinct picture of the inside of the pipe. The camera must record directly to a digital storage device. If the picture quality is inadequate, the Agency may not accept the pipe installation and may require additional video inspections at no additional cost.

(a) Video Camera - Use a digital color video camera with the ability to rotate 360 degrees, tilt to a 90 degree angle to the axis of the pipe and a zoom ratio of at least 40:1. A light source that provides a clear image of the full pipe circumference and all areas of concern. Provide a camera and lighting system capable of operating in 100% humidity conditions.

(b) Transporter - Use an all-wheel drive or track mounted transporter capable of inspecting pipes ~~ranging in size from 12 to 60 inches~~ and that does not obstruct the camera view. Use a vertical and horizontal adjustable camera to maintain the camera along the approximate center of the pipe at all times. The transporter will have an adjustable operating speed while recording not to exceed 30 feet per minute.

(c) Recording Device - Provide a device capable of recording video with the pipe identification, a remote meter counter displaying length along the profile in tenths of feet and indicating the camera's position from the starting point. Calibrate the meter counter to be accurate within 0.5 percent over the length of pipe being inspected. The device must be capable of recording a digital video with a minimum resolution of 720 x 480.

00415.21 Service Line-Lateral Inspection Equipment - Use the following Equipment unless otherwise approved.

(a) Push Camera - Provide a portable camera system that can be manually inserted into ~~Sservice line~~ laterals. The imaging capabilities and illumination requirements for the push camera system are similar to 00415.20(a). Provide a hand-held push camera on site at all times.

(b) Lateral Launch Camera - Provide a camera component as part of the mainline video inspection system that can be launched into a ~~Sservice line~~ lateral connection while inspecting mainline. The lateral launch camera ~~is~~ shall be capable of inspecting the length of the lateral from the mainline connection to beyond the edge of the Right-of-Way. The imaging capabilities and lighting requirements for the lateral launch camera system are similar to 00415.20(a).

(c) Electronic Location Device - Provide a radio transmitter that can be attached to the video camera system that can be detected from the surface to determine the horizontal and vertical position of the pipes below ground. This locating equipment shall be capable of locating the transmitter to within 2 feet horizontally and 1 foot vertically to a depth of at least 10 feet. Provide a locator device on site at all times.

~~**00415.22 Mainline Inspection Equipment with Laser Profiler** - Use Equipment that meets the following requirements.~~

~~**(a) Laser Profiler** - Use non-rotating laser projector, certified "eye safe", laser light source and internal optics capable of projecting a 360 degree narrow beam of laser light onto an internal pipe wall and meets the following requirements:~~

- ~~• Pipe profile from 12 to 60 inches in diameter.~~
- ~~• Capable of measuring deflection and deformities to an accuracy of 0.5 percent and provide a repeatability of 0.12 percent or better.~~
- ~~• Measurement accuracy of at least 0.1 inch for cracks and other defects.~~
- ~~• Show calibration procedure on video display at each measurement.~~

~~**(b) Software** - Use software meeting the technical requirements of ASTM F3080 and the current supported version as provided by the manufacturer.~~

~~**(c) Equipment** - Use a transporter, camera, and recording device according to 00415.20.~~

00415.23 Manual Inspection - For pipes larger than 48 inches and when the entire length of the pipe is accessible, a handheld video camera and a light source may be used. The video camera and lighting must meet the requirements of 00415.20(a). A digital camera may be used as a supplement for taking photographs. Use a light source that provides a clear, focused and high quality photograph of the culvert surface under all conditions.

Construction

00415.40 Video Inspection:

(a) Notice and Access - Notify the Engineer a minimum of 48 hours before beginning cleaning or video inspection. Allow the Engineer access at all times, to observe the video monitor and all other operations.

(b) Cleaning - Clean the pipe by removing all debris, sediment, and other accumulated material that would prevent the video camera and laser profiler from moving through the pipe or adversely affect the accuracy of the survey. Remove and dispose of all debris according to 00290.20.

(c) Inspection - After cleaning, pre-charge the pipe with clean water to assist in locating bellies and deformations of the pipe. Control the flow into the segment to be inspected. If required, perform bypass pumping according to Section 00490. Perform continuous video inspection while pipe remains clean. Video inspect pipes one segment at a time. Do not move the camera at a speed greater than 30 feet per minute. Move the camera through the line in either direction stopping, panning or tilting as necessary to permit documentation of the pipe's condition including the location of all lateral connections, additional connections to the mainline and other characteristics. Stop and inspect joints as directed in the Special Provisions.

Perform deflection testing for flexible pipe concurrently with video inspection according to section 00445.73. When standing water is found, halt the forward progress of the camera for a minimum of three seconds at each three foot increment through the limits of the standing water. Relax the pulling cable if necessary so that the depth of the water may be measured from the water depth gauge.

If, during the inspection operation, the camera will not pass through the entire segment, set up Equipment so that the inspection can be performed from the opposite access point back to the obstruction.

Make note of all defective joints, all lateral connections, and other conditions within the pipe.

(e) Footage Metering - Begin all video inspection with the footage meter set to zero and begin video inspection from the middle of the access point. Provide accurate on-screen distance measurements in the video recording. Ensure that the footage information on the recorded video corresponds to the footage references in the written inspection report. Video recording footage which misrepresents actual footage by more than 3 feet will be rejected. Perform another video inspection at no additional cost to the Agency.

(f) Recording Format and Labeling - Record the video inspection using an approved file format.

Furnish recordings on an approved media storage device including a text file to indicate the Project number and name, date of inspection, pipe segment number, Contractor's name and whether it is a pre-construction or post-construction video, filenames, and description of file contents.

(g) Continuity, Image and Audio - Record video continuously, without editing or starts and stops, in color from the beginning to the end of each pipe segment. Ensure that the pipe image is free of visual distortions and appears level and centered in the pipe being inspected. Ensure that the audio portion of the composite video recording is sufficiently free from electrical interference and background noise to provide complete clarity of the narrative description.

(h) Video Inspection Recording and Written Inspection Report - Furnish one copy of all preconstruction and post-construction video inspection reports and video recordings within three days after completing the inspections, or as specified. All accepted video recordings, inspection reports, and any related information become the property of the Agency.

Include in the written report the location in relation to an adjacent access point for each feature observed during inspection. Include other points of significance including locations of building pipes, unusual conditions, roots, location and depth of pipe sags, all connections, pipe material and size, and broken pipe. Ensure that the footage information on the recorded video corresponds to the footage references in the written inspection report. If the report or video is incomplete or missing any Service Lateral Connection details, perform an additional video inspection according to these specifications at no additional cost to the Agency.

00415.41 Pre-Installation Video Inspection - Perform a pre-installation video inspection at least 5 Calendar Days before beginning Work. Begin Inspection at one end of the pipe and proceed through the entire pipe length at a speed not greater than 30 feet per minute. Move the camera through the pipe and provide a continuous 360 degree pan of each pipe joint. Stop and record all cracks, deformities and defects to document the pipe condition, including the location of all lateral connections to the mainline.

Provide a verbal narrative on each video inspection recording. Include the company name, operator's name, date and time of the inspection, site location, description of the pipe type, size and length, and direction of travel. As part of the recorded audio portion of the video, include a description of all observed defects, deformities, location of lateral connections and locations where digital photographs are taken.

If, during the inspection operation, the camera will not pass through the entire segment, set up Equipment so that the inspection can be performed from the opposite access point back to the obstruction.

(a) Mainline Inspection - Use video inspection equipment meeting the requirements of 0415.20. Each video inspection will display and record an on-screen header containing: location, pipe type, size, date and time of inspection, direction of travel, distance and owner.

(b) Manual Inspection - Use video inspection equipment meeting the requirements of 00415.23.

Measure crack widths using a feeler gauge or crack comparator ruler capable of measuring 0.01 inches. Use a tape measure to measure the widest opening at each joint at least to the nearest 1/2 inch.

00415.42 Post Installation Video Inspection - Perform post construction video inspection according to 00415.40 and 00415.41.

Perform post construction deflection testing for all plastic, metal, and aluminum pipe using one of the approved following methods.

Video inspect the pipe interior no sooner than 30 Days after the trench backfill and compaction have been completed. If the Contract duration does not permit a 30 Day waiting period the Engineer may adjust the duration period.

~~(a) Remote Video Inspection with Laser Profiler - Use video inspection equipment meeting the requirements of 00415.21. Calibrate the laser profiler according to the manufacturer's specifications and ASTM F3080 Section 9.~~

~~Advance the transporter with camera and laser profiler at a speed appropriate with the software's capacity to accurately measure and digitally record 30 individual light ring images per second. Advance the transporter with camera and laser profiler at a speed not greater than 30 feet per minute. A minimum, five full laser ring images shall be taken every inch.~~

(b) Manual Inspection Deflection - Physical Testing

In addition to 00415.41(b):

Measure the deflection of the pipe using either a metal or fabric tape and read at least to the nearest 1/2 inch. Measure the smallest inside diameter three times for each pipe section in the run. Take the first measurement vertically from the crown to invert (12 o'clock to 6 o'clock positions). Take the second measurement by rotating 60 degrees from vertical (2 o'clock to 8 o'clock positions). Take the third measurement by rotating 120 degrees from vertical (4 o'clock to 10 o'clock positions). For all measurements, stretch tape to full extent across the inside of the pipe.

Calculate percent deflection using the following formula:

$$\text{Percent Deflection} = [(D1 - D2) \div D1] \times 100$$

where:

D1 = Initial measurement according to AASHTO Nominal Diameter

D2 = Most deflected measurement in each pipe run after construction

Finishing and Cleaning Up

00415.70 Video Inspection Recording and Written Inspection Report - Furnish two copies of all preconstruction and post construction inspection video and reports within three Calendar Days after completing the inspections. If inspection video or audio recording quality is poor, the Engineer has the right to reject the recording and request new video inspection at no additional cost to the Agency.

(a) Inspection Report - Provide an inspection report that includes each defect, deformity, and joint along with the distance from the inspection starting point. Provide still digital images in the report along with a reference and description of each defect, deformity and joint.

(b) Deflection Report - Provide an inspection report and include a report generated from the laser profiler software. If a manual inspection was performed according to 00415.41(b) then provide all measurements and calculations.

00415.71 Corrections to Deficiencies in Work - Submit a repair plan to the Engineer for approval of all detrimental pipe deficiencies that are revealed in the recording and written report. Repair all deficiencies within 48 hours after receiving notification. Re-perform the video inspection, submit the new video, and update the written report at no additional cost to the Agency.

Where the pipe deflection is in excess of 5 percent of the nominal diameter submit a remediation plan to the Engineer. The remediation plan must be a stamped Working Drawing according to 00150.35. Replace pipe where the deflection exceeds 7.5 percent of the nominal diameter at no additional cost to Agency.

Measurement

00415.80 Measurement - The quantities of Work performed under this Section will be measured according to the following:

(a) Mainline Video Inspection - Mainline video inspection will be measured on the length basis. The length will be measured, with no deduction for Structures or fittings, along the pipe flow line from center to center of manholes, inlets, special sections, or the ends of pipe, whichever is applicable. Pipes with sloped ends will be measured from the top of the sloped end section.

(b) Service Line-Lateral Video Inspection - Service line-Lateral video inspections, regardless of length, will be measured on the unit basis. When multiple service line laterals are connected to the mainline by a single shared connection, each service line lateral will be counted separately.

~~**(c) Mainline Video with Laser Profile Inspection** - Mainline video with laser profile inspection will be measured on the length basis. The length will be measured, with no deduction for Structures or fittings, along the pipe flow line from center to center of manholes, inlets, special sections, or the ends of pipe, whichever is applicable. Pipes with sloped ends will be measured from the top of the sloped end section.~~

(d) Manual Inspection - Manual inspection regardless of length, will be measured on the unit basis.

(e) Dye Testing and Connection Verification – The quantities of dye testing and connection verification will be measured on a unit basis per each address. More than one dye test at each address may be necessary to determine the activity and connection location of a service. . Conclusive results of the dye test will be the basis of acceptance

Payment

00415.90 Payment - The accepted quantities of Work performed under this Section will be paid for at the Contract unit price, per unit of measurement, for the following items:

Pay Item	Unit of Measurement
(a) Mainline Video Inspection	Foot
(b) Service Line-Lateral Video Inspection, <u>Launch Camera</u>	Each
(c) Service Lateral Video Inspection, Push Camera	Each
(e) Mainline Video with Laser Profile Inspection	Foot
(d) Manual Inspection	Each
(e) <u>Dye Testing and Connection Verification</u>	<u>Each</u>
(f) Video Inspection	Lump Sum

Payment will be payment in full for furnishing all Equipment, labor, and Incidentals necessary to complete the Work as specified.

Items (b) (c), and (e) include all costs for coordinating access to private properties.

Item (e) includes all costs for the verification of service connections using dye testing and video inspection equipment.

Item (f) includes all pre-construction and post-construction video pipe inspection. Progress payments will be made according to 00195.50

No separate or additional payment will be made for:

- providing the hand-held push camera and locator device on site at all times
- excavation Work
- restoration Work

Section 00430 - Subsurface Drains

Description

00430.00 Scope - This Work consists of constructing subsurface drains to the lines and grades shown or established using drain pipe, special filter material or granular drain material, and drainage geotextile.

00430.01 Descriptive Terms - The terms used in designating drain pipe or when referring to them on the Plans are as follows:

Aluminum - The base metal for aluminum sheets.

Concrete, Steel, Aluminum, Polyethylene, Polyvinyl Chloride - The basic material of the pipe.

Drain Pipe - Perforated pipe of specified material.

Metal - Aluminum and steel.

Steel - The base metal for galvanized or aluminum coated sheets.

Subsurface Drain - Drainage system beneath the Base, usually with a perforated drain pipe, to collect and drain groundwater.

00430.02 Contractor's Options - If the Contractor has an option of using different kinds of pipe, the option and its limitations will be shown.

The limiting factors and requirements shown are minimums. The Contractor may substitute stronger, larger, and higher quality material at any installation site, provided the substitution meets the approval of the Engineer and is made at no additional cost to the Agency.

00430.03 Size Determination - The nominal size of pipe will be determined according to AASHTO tolerances for pipe dimensions for the appropriate kind or class of pipe.

Materials

00430.10 Materials - Furnish materials meeting the following requirements:

Commercial Grade Concrete.....	00440
Delineators	00840
Drainage Geotextile.....	02320
Perforated Concrete Pipe	02410.10
Perforated Corrugated Aluminum Alloy Pipe.....	02420.50
Perforated Corrugated Polyethylene Pipe	02415.10
Perforated Corrugated Steel Pipe	02420.30
Perforated Polyvinyl Chloride Pipe	02415.50
Protective Coatings	02420.20
Special Filter Materials	02610.10

Furnish wire mesh that is commercial quality 1/4 inch galvanized metal screening.

00430.11 Granular Drain Backfill Material - Furnish granular drain backfill material of 1 1/2" - 3/4", 1 1/4" - 3/4", or 3/4" - 1/2" crushed or uncrushed Rock or gravel meeting the requirements of 02690.20(c) and the following gradation requirements:

Sieve Size	Percent Passing (by weight) Designated Sizes		
	1 1/2" - 3/4"	1 1/4" - 3/4"	3/4" - 1/2"
2"	100		
1 1/2"	95 - 100	100	
1 1/4"	–	90 - 100	
1"	–	–	100
3/4"	0 - 15	0 - 15	90 - 100
1/2"	0 - 2	0 - 2	0 - 15
1/4"	–	–	0 - 3

Construction

00430.40 General - Excavate trench, prepare bedding, backfill, except as noted in 00430.46, according to Section 00405 and dispose of excavated materials according to Section 00330. If required, place geotextile according to Section 00350 before backfilling.

Install a Type W-1 delineator at each outlet protection block as shown.

00430.41 Foundations in Unyielding Material - Excavate Rock, hardpan or other unyielding materials a minimum of 3 inches below established grade of the pipe exterior to place special filter material or drain backfill material.

00430.42 Laying Pipe - Lay the pipe according to Section 00445. Place pipe with perforations down unless otherwise directed.

00430.43 Joining Pipe - Fasten pipes together with appropriate coupling fittings or bands as specified for the type of pipe used. Close upstream end of pipe with plugs suitable to prevent entry of Soil materials.

00430.44 Contact Surfaces, Aluminum to Concrete - Coat aluminum pipe and aluminum coated steel pipe that contacts portland cement concrete with asphalt mastic according to Section 00445.

00430.45 Inspection - The installation will be inspected after the pipe is laid and joined and before backfilling. Remove and reinstall or replace any pipe found to be out of alignment, unduly settled or damaged.

00430.46 Backfilling:

(a) Special Filter Material - After the pipe is installed and inspected, place up to 12 inches of uncompacted special filter material above the top of the pipe. Above this, place approved backfill material or special filter material, as directed, and compact according to Section 00405.

(b) Granular Drain Backfill Material - Drainage geotextile is required when using granular drain backfill material. Place granular drain backfill material according to (a) above and as shown.

Measurement

00430.80 Measurement - The quantities of subsurface drain pipes of the various kinds, types, and sizes will be measured, with no deduction for fittings and special sections, along the pipe flow line from end to end of pipe.

The quantities of subsurface drain outlets will be measured on the unit basis.

Drainage geotextile will be measured according to 00350.80.

Delineators will be measured according to 00840.80.

Trench resurfacing will be measured according to 00495.80.

Payment

00430.90 Payment - The accepted quantities of Work performed under this Section will be paid for at the Contract unit price, per unit of measurement, for the following items:

Pay Item	Unit of Measurement
(a) ____ Inch Drain Pipe	Foot
(b) Subsurface Drain Outlets	Each

In item (a), the nominal diameter of pipe will be inserted in the blank.

Item (b) includes furnishing and installing pipe, constructing outlet protection blocks, connecting pipe to inlets, and excavating and disposing of excess materials.

Payment will be payment in full for furnishing and placing all Materials, and for furnishing all Equipment, labor, and Incidentals necessary to complete the Work as specified.

Drainage geotextile will be paid for according to 00350.90.

Delineators will be paid for according to 00840.90.

Trench resurfacing will be paid for according to 00495.90.

No separate or additional payment will be made for trench excavation, backfill, special filter Material, or granular drain backfill Material or for fittings and special pipe sections.

SECTION 00435 - PREFABRICATED VERTICAL DRAINS

Description

00435.00 Scope - This Work consists of furnishing and installing prefabricated vertical drains at locations and according to details shown or directed.

Materials

00435.10 Drains - Furnish new prefabricated vertical drains from the QPL or that meet the requirements of the Specifications.

00435.11 Core - Furnish a continuous plastic core Material with grooved channels, a pattern of protruding studs, or mesh-type materials fabricated to promote drainage along the axis of the vertical drain. Furnish vertical drain Material meeting the requirements of ASTM D638 and ASTM D4716.

00435.12 Jacket - Furnish the jacket Material meeting the following requirements:

- Be a synthetic, nonwoven geotextile capable of resisting all bending, punching and tensile forces imposed during installation.
- Not crack, peel or otherwise become damaged during installation.
- Be sufficiently rigid when embedded to withstand lateral earth pressures and to ensure vertical flow capacity through the core.
- Allow free passage of pore water to the core without passage of Soil material or piping.

Test the jacket material in both saturated and dry conditions. It shall conform to the following:

<u>Test</u>	<u>Requirement</u>	
	<u>Specification</u>	<u>Minimum Value</u>
Grab Tensile	ASTM D4632	80 pounds
Trapezoidal Tear	ASTM D4533	25 pounds
Puncture Strength	ASTM D4833	50 pounds
Burst Strength	ASTM D3786	130 psi
Permeability	ASTM D4491	0.05 mm/sec.

00435.13 Assembled Drain - Furnish assembled drains meeting the following requirements:

- Be resistant against wet rot, mildew, bacterial action, insects, salts, acids, alkalis, solvents and any other significant ingredients in the groundwater.
- Be band-shaped (rectangular Cross Section) with an aspect ratio (width divided by thickness) not exceeding 50.
- Have a minimum equivalent diameter of 2 inches using the following definition of equivalent diameter:

$$d_w = \frac{(a+b)}{2}$$

Where:

d_w = diameter of a circular drain equivalent to the band shaped drain

a = width of the band shaped drain

b = thickness of the band shaped drain

00435.14 Acceptance Requirements - Each shipment of prefabricated vertical drain materials shall be accompanied by a manufacturer's Quality Compliance Certificate according to 00165.35.

Submit three samples of any proposed splices for approval at least 21 Calendar Days before the installation of any drains.

Identify the drain materials with labels or tags that include the manufacturer's name, lot or control number, individual roll number and date of manufacture.

Equipment

00435.20 General - Install prefabricated vertical drains using a mandrel or sleeve that:

- Has a maximum cross-sectional area of 10 square inches.
- Is sufficiently stiff to prevent wobble or deflection during use.
- Protects the prefabricated vertical drain material from tears, cuts and abrasion during installation.
- Has an anchor plate or similar arrangement at the bottom to prevent Soil from entering the drain during its installation, and to anchor the drain tip at the required depth at the time of withdrawal. Use anchors conforming to the dimensions of the mandrel or sleeve.

Construction

00435.40 Prefabricated Vertical Drain Installation Requirements:

(a) Acquisition and Storage - During shipment and storage, wrap the drain in heavy paper, burlap or similar heavy-duty protective covering and protect it from sunlight, mud, dirt, dust, debris and other detrimental substances.

Material damaged during shipping, unloading, storing or handling will be rejected.

(b) Proposed Installation Details - Submit full details on the material, Equipment, sequence and method proposed for prefabricated vertical drain installation to the Engineer for review at least 14 Calendar Days before beginning trial prefabricated vertical drain installation.

(c) Trial Installation - Before production installation of prefabricated vertical drains, demonstrate that material, Equipment and methods produce a satisfactory installation, at permanent installation sites. Install at least 5 trial drains totaling approximately 250 feet at locations designated.

(d) Production Installations - The Engineer's approval of the method or Equipment used to install the trial drains does not necessarily constitute acceptance for the remainder of the Project. If at any time the Engineer determines that the method of installation or Equipment does not produce satisfactory prefabricated vertical drains, alter the method or Equipment as directed to comply with the Plans and Specifications.

(e) Installation Procedure - Prefabricated vertical drains will be located, numbered and staked by the Engineer.

- Preserve stakes and protect field instrumentation Equipment. Stakes and instrumentation damaged by the Contractor will be repaired or replaced by Agency forces. The cost of repair or replacement will be deducted from monies due the Contractor. Do not work in the affected area until repair or replacement has been made.
- Locate the prefabricated vertical drains within 6 inches of the staked locations. Prefabricated vertical drains more than 6 inches from the staked locations, damaged or improperly installed, will be rejected and abandoned in place without payment. Replace rejected drains at no additional cost to the Agency.
- Install prefabricated vertical drains in the presence of the Engineer's representative.
- Provide the Engineer with a suitable means to determine the depth of the drains at any time during installation and the final length installed at each location.
- Plumb Equipment for installing prefabricated vertical drains before installing each drain. Do not deviate from the vertical more than 0.2 foot in 10 feet during installation of the drains.
- Install prefabricated vertical drains using a mandrel or sleeve inserted into the Soil using a continuous push static weight or vibration while keeping disturbance of the subsoil to a minimum. Installation by driving will not be allowed. Jetting techniques will be allowed only after receiving written approval from the Engineer. The mandrel or sleeve penetration rate shall normally be between 0.5 and 2 feet per second.
- Install the prefabricated vertical drains from the designated working surface to the depth shown or as directed.
- Perform the installation without damaging the drain while advancing or retracting the mandrel or sleeve. Alternately raising or lowering the mandrel while advancing will not be allowed. Retract the mandrel or sleeve after each drain is installed. Raising the mandrel will be allowed only after completing a drain installation.
- Cut off completed prefabricated vertical drains neatly 1 foot above the designated working surface.

(f) Obstruction Clearance Procedures - Satisfactory installation may require clearing man-made or natural obstructions that prevent the proper insertion of the mandrel or sleeve and installation of prefabricated vertical drains.

Where obstructions are encountered:

- Immediately notify the Engineer before completing the drain and before installing other drains.
- Upon the Engineer's approval, attempt to install a drain adjacent to the obstructed location.
- Based on the results of this attempt and when directed, attempt to install a second offset drain within 2 feet horizontally of the obstructed drain, or if directed, implement obstruction clearance procedures and install the drain at the specified location.

The Contractor may use augering, spudding or other approved methods to loosen the Soil and remove any obstruction material before installing prefabricated vertical drains. Do not penetrate more than 2 feet into the underlying compressible Soil.

If augering, use augers with a minimum outside diameter equal to the largest horizontal dimension of the mandrel sleeve, shoe or anchor, whichever is greatest. The maximum outside diameter of the auger shall not be more than 3 inches greater than the minimum outside diameter.

00435.41 Splicing - Splice prefabricated vertical drain material by stapling to ensure structural and hydraulic continuity of the drain. Overlap the jacket and core a minimum of 6 inches at each splice.

A maximum of one splice per drain installed is allowed.

Measurement

00435.80 Measurement - The quantities of prefabricated vertical drains and obstruction clearance will be measured on the length basis as follows:

(a) Prefabricated Vertical Drains - The length of drains will be the distance the installation mandrel tip penetrates below the specified surface plus the required cutoff length above the designated working surface.

(b) Obstruction Clearance - The length of obstruction clearance will be the length from the designated working surface at the time of installation to the depth penetrated by the auger or spud, or if directed, to the bottom of the obstruction.

Obstruction clearance will be measured for payment only when authorized by the Engineer.

Payment

00435.90 Payment - The accepted quantities of Work performed under this Section will be paid for at the Contract unit price, per unit of measurement, for the following items:

<u>Pay Item</u>	<u>Unit of Measurement</u>
(a) Prefabricated Vertical Drains	Foot
(b) Obstruction Clearance	Foot

Item (a) includes trial installations and splices.

Item (b) includes pre-augering, spudding or performing other acceptable methods to clear obstructions so that prefabricated vertical drains may be satisfactorily installed, including disposing of any surplus preaugered or obstruction clearance materials.

Payment will be payment in full for furnishing and placing all Materials, and for furnishing all Equipment, labor, and Incidentals necessary to complete the Work as specified.

No separate or additional payment will be made for:

- unacceptable trial drain installations
- drains that are not installed and anchored to the required depth
- clearing obstructions caused by the Contractor or obstructions within 2 feet of the specified surface
- prefabricated vertical drains placed in excess of the designed length unless additional lengths are directed by the Engineer
- prefabricated vertical drains installed more than 6 inches from the staked location, damaged or improperly installed

Section 00440 - Commercial Grade Concrete

Description

00440.00 Scope - This Work consists of furnishing, placing and finishing Commercial Grade Concrete (CGC).

Materials

00440.10 Materials - Furnish Materials meeting the following requirements:

Admixtures	02040
Aggregates.....	02690
Bonding Agents.....	02070
Cement.....	02010
Curing Materials	02050
Grout	02080
Supplementary Cementitious Materials.....	02030
Water.....	02020

00440.11 Proportions - Prepare and submit either pre-approved mix design or a new mix design for each class of concrete required according to Section 02001. ~~Furnish, in writing to the Engineer, the proportions by weight of the following Materials before using any CGC:~~

~~air-entraining admixtures
cement
each size of Aggregate
fly ash
other admixtures
water~~

00440.12 Properties of Commercial Grade Concrete - Furnish a workable CGC mixture that is uniform in composition and consistency, and unless otherwise shown or specified, has the following characteristics:

- **Entrained Air** - 4.0 to 7.0 percent
- **Slump** - 5 inches or less
- **Compressive Strength** – ASTV minimum of 3,000 psi at 28 days
- **Temperature** - Minimum 50 °F to maximum 90 °F

00440.13 Field-Mixed Concrete - CGC mixed Work items listed in 00440.14(a) may be field-mixed conventionally, or by volumetric/mobile mixers conforming to ASTM C685. When approved, concrete sidewalks, concrete curb ramps, concrete driveways, and other flat concrete surfaces may be field-mixed using volumetric/mobile mixers conforming to ASTM C685.

Pre-packaged dry blended concrete from the QPL may be used for Work items listed in 00440.14(a).

00440.14 Acceptance Sampling and Testing:

(a) General - Acceptance sampling and testing will be based on samples obtained at the site of placement from the discharge of the delivery vehicle. All sampling and testing shall be performed by a QCT.

CGC mixture may be accepted visually for the following items of Work:

Work Item	Section
Bollards	00815
Electrical Conduit Backfill	00960
Fence Post Footings	01050
Hydrant Thrust Blocks	01160
Irrigation System Thrust Blocks.....	01120
Mailbox Support Footings.....	01070
Outlet Protection Blocks	00430
Perforated Steel Square Tube Sign Support Footings	00920

(b) Delivery Tickets - Send a delivery ticket with each load of CGC recording the Agency approved mix design identification, source, Day, time of batch, size of load, and quantity of individual constituents in the load. Delivery tickets are not required for field-mixed concrete except when volumetric/mobile mixers are used.

(c) Plastic CGC - Acceptance of plastic CGC will be based on tests performed by the QCT according to the MFTP and 00440.12.

(d) Hardened CGC - The ASTV at 28 Days is the average compressive strength of the three cylinders tested. Discard all specimens that show definite evidence, other than low strength, of improper sampling, molding, handling, curing, or testing. The average strength of the remaining cylinders shall then be considered the test result. ~~Acceptance of the hardened CGC will be according to 00440.12. Cast one set of cylinders per 20 cubic yards, with a maximum of one set per Day.~~

00440.15 Quality Control - Provide quality control according to Section 00165.

Labor

00440.30 Quality Control Personnel - Provide technicians having CSTT and QCT technical certifications.

Construction

00440.40 General:

(a) Mixing - Mix CGC to the extent that ensures a uniform distribution of materials throughout the mixture.

(b) Placing - Place CGC according to the appropriate Sections in which CGC is required and the following:

- Place using the best common practices to avoid segregation.
- Vibrate and spade to achieve a dense homogeneous concrete, free of voids and Rock pockets.
- Place within 90 minutes after batching and mixing.
- Place through pumps, chutes, or trunks conforming to 00540.22, when placement requires dropping concrete more than 5 feet. Place the bottom of pump hose, chutes, pipes, or trunks as close to final placement positions as practicable
- When haul time or placement conditions warrant exceeding the time of discharge, submit a detailed breakdown of the estimated time needed from batching to discharge of a load along with the measures that will be taken to ensure slump, temperature and uniformity will be maintained. Submit in advance to establish a new time limit at the Engineer's discretion.

(c) Forms - Provide forms for CGC according to the appropriate Sections in which CGC is required and best common practices. Place to the lines and grades shown or directed.

(d) Weather - Coordinate all operations involved in placing CGC so the work will result in a finished structure conforming to the Specifications regardless of the daily or seasonal variations in weather, temperature and humidity under which the work is permitted to proceed.

Do not place CGC during periods of rain. Do not place CGC on frozen bases. Do not place CGC when the air temperature is below 35 °F without approval.

Protect the pavement from weather damage. Protect unhardened CGC from precipitation with protective material. When CGC is placed during cold weather, protect ~~Protect~~ CGC from freezing if the air temperature is expected to drop below 35 °F during the first 5 Calendar Days after placement.

Remove and replace weather-damaged pavement at no additional cost to the Agency.

(e) Curing - Cure CGC by covering with wet burlap, canvas, sand, or other acceptable material, and keep moist for a minimum of 7 Calendar Days.

Curing compounds may be used except on concrete surfaces or reinforcement that will come in contact with adjacent concrete pours. Use curing compounds according to the following:

Section	Item	Type 1 or 1-D (Clear)	Type 2 (White-Pigmented)
00480	Drainage Curbs	<u>Yes</u> *	<u>No</u> *
00599	Slope Paving Curbs and Berm Paving	Yes	No
00759	Walks, Curb Ramps, Driveways, Surfacing, Curbs, and Islands	<u>Yes</u> *	<u>No</u> *
* Use Type 2 except when the Engineer requires Type 1 or 1-D			

Apply curing compounds at a rate of not be less than 1 gallon per 150 square feet.

00440.41 General Surface Finish - Give concrete surfaces a general surface finish, according to 00540.53(a), in addition to the finish specified for a particular item of Work.

00440.42 Replacement or Price Reduction - Remove concrete represented by cylinders that fail to meet the minimum strength requirement and replace at no additional cost to the Agency. If the Engineer determines that the low-strength concrete is suitable for the purpose intended, the Contractor may accept a price reduction established by the Engineer instead of removal and replacement.

Measurement

00440.80 Measurement - No measurement of quantities will be made for CGC.

Payment

00440.90 Payment - No separate or additional payment will be made for CGC. Payment will be included in payment made for the appropriate items under which this Work is required.

Section 00442 - Controlled Low Strength Materials

Description

00442.00 Scope - This Work consists of furnishing and placing controlled low-strength materials (CLSM).

00442.01 Definition - Controlled low-strength material is highly flowable lean concrete mix; a mixture of fly ash, cement, fine Aggregates, water and admixtures, if necessary.

Materials

00442.10 Materials - Furnish Materials meeting the following requirements:

Admixtures	02040
Fly Ash	02030.10
Portland Cement	02010.10

00442.11 Fine Aggregates - Furnish fine Aggregates that are commercial quality concrete sand.

00442.12 Proportioning of CLSM Mixture - Prepare and submit either pre-approved mix design or a new mix design for each class of concrete required according to Section 02001. Furnish the following, to the Engineer, prior to using any CLSM on the Project:

- Written certification of proposed CLSM materials proportions and compressive strength.
- 28-Day cylinder reports from a trial CLSM batch based on above certification. Include evidence that compressive strength requirements for specific applications are met. In addition to cylinder tests, mortar cube tests per ASTM C1019 using metal plates as a bond breaker are acceptable

00442.13 Compressive Strength - CLSM shall attain a 28-Day compressive strength of ~~400 psi~~ - 200 psi - 300 psi.

00442.14 Acceptance - Acceptance will be based on the Engineer's review and approval of written certification and trial batch cylinder reports or mortar cube as required by 00442.12.

Measurement

00442.80 Measurement - No measurement of quantities will be made for CLSM.

Payment

00442.90 Payment - No separate or additional payment will be made for CLSM. Payment will be included in payment made for the appropriate items under which this Work is required.

Section 00445 - Sanitary, Storm, Culvert, Siphon, and Irrigation Pipe

Description

00445.00 Scope - This Work consists of constructing or reconstructing culvert, siphon, sanitary sewer, storm sewer, and irrigation pipes in the kinds, sizes, and lengths and at the locations shown or as directed to the lines and grades established. The Work includes furnishing and constructing joints and connections to other drainage Structures or systems, as necessary, for complete installation.

00445.01 Definitions and Descriptive Terms - The following terms have the meanings presented below when used in this Section:

Aluminum, Concrete, Steel and Polyethylene - The basic material of the pipe

Concrete Block - Encasements, thrust blocks, anchor blocks, plugs and cutoff diaphragms

Culvert - Concrete, corrugated metal, ductile iron, polyethylene, steel reinforced polyethylene, or polypropylene pipe

Flexible Pipe - Pipes constructed of corrugated or spiral rib metal, PVC, polyethylene, steel reinforced polyethylene, or polypropylene. For the purposes of these Specifications, all potable water pipes are considered to be flexible pipes.

HDPE - High Density Polyethylene, includes solid wall polyethylene and solid wall HDPE

Irrigation Pipe - Gravity or low-pressure transmission pipe. Refer to Section 01120 for sprinkler-type irrigation pipe.

Joint - The place where the ends of sections or modified sections of pipe contact one another

Metal - Aluminum and steel

Pavement - Pavement as defined in Section 00110, as well as driveways, curbs, gutters, walks, dikes, walls and other similar asphalt or portland cement concrete Structures

Pipe - All pipe, regardless of kind, size, shape or use

PVC - Polyvinyl Chloride

Rigid Pipe - Pipes, other than potable water pipes, constructed of concrete and ductile iron

Sanitary Sewer (Wastewater) Pipe - Pipe used to collect and convey wastewater from plumbing systems to the wastewater treatment plant. Concrete, PVC, solid wall HDPE or ductile iron pipe

SDR (Standard Dimensional Ratio) - The pipe's minimum outside diameter divided by its wall thickness

Section - The individual pieces in which the furnished pipe is manufactured

Siphon, Storm Sewer, Storm Drain, and Irrigation Pipe - Pipe used to collect and convey storm water, street run-off and other surface waters to discharge points.
Concrete, PVC, HDPE, ductile iron or metal pipe

Steel Reinforced Polyethylene - Steel reinforced ribbed high density polyethylene

00445.02 Contractor's Options - If the Contractor has an option of using different kinds of pipe, the option and its installation and other limits will be shown on the Plans or on a "Pipe Data" sheet in the Plans.

The limiting factors and requirements shown on the Plans or on the Pipe Data sheet are minimums. The Contractor may substitute stronger, larger, and higher quality material at any installation site, provided the substitution is approved and is made at no additional cost to the Agency.

00445.03 Size Determination - The nominal size of pipe will be determined according to AASHTO tolerances for pipe dimensions for the appropriate kind or class of pipe.

Materials

00445.10 General - The manufacturer or fabricator shall furnish appropriate certification, based on the manufacturer's quality control tests, that the materials used in the production of the pipe meet the Specifications. Materials and strength shall be as specified for the particular kind of pipe and fittings required.

Use flexible elastomeric gasket joints on all pipes and fittings. Furnish caps or plugs with each fitting, outlet or stub as required, with the same type gasket or joint as the pipe.

For sanitary sewers provide tee or wye fittings in the main of the same materials as the pipe. All fittings shall be of sufficient strength to withstand all handling and load stresses encountered. Material joining the fittings to the pipe shall be free from cracks and shall adhere tightly to each joining surface.

Cap or plug all fittings and provide with gaskets of the same material as used in the pipe joint. Fit with an approved mechanical stopper, or install an integrally cast knockout plug. The cap or plug shall be capable of withstanding test pressures without leaking and, when later removed, shall permit continuation of piping with jointing similar to joints in the installed line.

00445.11 Materials - Furnish Materials meeting the following requirements:

Commercial Grade Concrete in Blocks	00440
Corrugated or Spiral Rib Aluminum Alloy Pipe	02420.40
Corrugated or Spiral Rib Steel Pipe and Pipe Arches	02420.10
Corrugated Polyethylene Pipe	02415.10
Ductile Iron Pipe	02420.11
Metal Reinforcement in Blocks	02510.10
Nonreinforced Concrete Pipe	02410.10
Polypropylene Pipe	02415.40
Polyvinyl Chloride Pipe	02415.50
Protective Coatings	02420.20
Reinforced Concrete Pipe	02410.10
Rubber Gaskets	02440.40
Solid-Wall Polyethylene Pipe	02415.20
Steel Reinforced Polyethylene Pipe	02415.30

(a) Pipe Anchors - Use pipe anchors conforming to the Standard Drawings and as shown. Metal bands shall conform to the material Specifications for the metal pipe to which they are attached.

(b) Slip Joints - Construct slip joints according to the details shown. The outer sleeve and tapered section shall conform to the material Specifications for the metal pipe with which they are installed.

(c) Safety End Sections - Use safety end sections conforming to 02420.10 and the Standard Drawings. Provide safety bars unless otherwise indicated on the Plans.

(d) Cleanouts - Construct cleanouts of the same materials as the adjacent pipe.

(e) Tracer Wire - Use 12-gauge stranded or solid copper insulated high molecular weight polyethylene (HMW-PE) tracer wire or 12-gauge copper clad steel reinforced insulated HMW-PE tracer wire. The HMW-PE insulated cover shall be green and a minimum 45 mil thick. The wire shall be UL rated for 140 °F.

(f) Fittings for Concrete Pipe - Where fittings are fabricated by inserting a stub into a hole cut in the pipe, grout with a non-shrinking grout. Coat surfaces to receive grout with an epoxy bonding agent prior to grouting. Fitting stubs shall not protrude inside of the sewer pipe.

(g) ~~HDPE, Corrugated or Solid-Wall Polyethylene Pipe~~ - ~~Use solid wall polyethylene pipe with a minimum SDR of 26. Use of polyethylene pipe is not allowed.~~

(h) ~~Steel Reinforced Polyethylene and Polypropylene Pipe~~ - ~~Use of steel reinforced polyethylene and polypropylene pipe is not allowed.~~

(i) ~~Concrete Pipe~~ - ~~Use of concrete pipe is not allowed for new wastewater pipe installations.~~

(j) Sanitary Sewers Adjacent to Water Mains and Services - Wastewater lines which a) cross above or, b) cross less than 1.5 feet beneath, or c) run parallel to existing water mains with less than 10 feet of horizontal separation shall be constructed of pressure rated ASTM 2241 PVC Class 125 (SDR 32.5) gasketed IPS pipe, AWWA C-900 PVC gasketed pressure pipe or approved equal. When connecting pressure pipe to standard 3034 PVC sewer pipe or fittings, use solid PVC gasketed couplers for the specific need.

00445.12 Asphalt Mastic - Furnish the asphalt mastic specified in 00445.47 for aluminum and concrete contact surfaces that consists of a mixture of asphalt, mineral stabilizer, and fillers meeting the requirements of AASHTO M 243 or ASTM D4586. An approved product from the QPL may be used.

00445.15 Quality Control - Provide quality control according to Section 00165.

Labor

00445.30 Quality Control Personnel - Provide technicians having CEBT and CDT technical certifications.

Construction

00445.40 General - Construct culvert, siphon, sanitary sewer, storm sewer, and irrigation pipe according to the following:

(a) Trench Work - Excavate trench, prepare bedding, pipe zone material and trench backfill, and dispose of excavated material according to Section 00405 for pipes 72 inches and less in diameter and Section 00510 for pipes over 72 inches in diameter.

(b) Line and Grade - Centerline and grade control will be established by the Agency prior to the start of construction. ~~The Special Provisions will indicate whether it will be done by the Agency or the Contractor.~~

Do not vary from established line and grade by more than 1/32 inch per inch of pipe diameter. Variance shall not exceed 1/2 inch, subject to the following limitations:

- The variation does not result in a level or reverse sloping invert.
- The variation in the invert elevation between adjoining ends of pipe, due to non-concentricity of joining surface and pipe interior surfaces, does not exceed 1/64 inch per inch of pipe diameter, or 1/2 inch maximum.

(c) Pipe Distribution and Handling - Unload pipe only by approved means.

Inspect the pipe and fittings prior to lowering into the trench to ensure no cracked, broken or otherwise defective materials are used. Clean the ends of the pipe thoroughly, remove foreign matter and dirt from the inside of the pipe, and keep the pipe clean during laying and joining.

(d) Laying Pipe on Curves - Lay pipe on horizontal or vertical curves as shown or approved. When deflecting the pipe from a straight line, either in the vertical or horizontal plane, or when long radius curves are shown, the amount of deflection allowed shall not exceed that recommended by the pipe manufacturer.

(e) Concrete Closure Collars - Use concrete closure collars only when approved, and only to make connections between dissimilar pipe or where standard rubber gasketed joints or transition couplings are not available. Place the collars using an approved commercial concrete bonding agent applied to all surfaces in contact with the collar. Where concrete closure collars are necessary to join PVC pipe, first prepare the PVC surface for bonding to the concrete by applying a dense coating of clean mortar sand to the pipe using PVC solvent cement. After the cement has cured, apply an approved commercial concrete bonding agent to the sand surface prior to placement of the concrete.

(f) Installation of Sanitary Sewer Service Tees and Wyes - Provide a compacted Base of pipe bedding material under all tees, wyes and branch fittings, extending to the springline of the fittings.

For lateral connections to new flexible mains, use manufactured tees and wyes. Make all other lateral connections according to 00490.42.

Cap all service lines for sanitary sewers with watertight plugs or caps suitable for resisting the pressures of hydrostatic or air testing.

The maximum line or grade change accomplished with any one fitting shall not exceed 45 degrees and shall be accomplished with long radius curves or bends.

(g) Pipe Anchors - Construct metal or concrete pipe anchors as specified or as shown. Install anchors on runs of pipe located on Slopes 20 percent or greater.

(h) Service Connection Marker – Provide a service connection marker for sanitary service laterals that are not connected to the property.

(i) Cleanouts – Install cleanouts as shown. Construct the riser to finished grade, install mechanical plug and construct concrete collar.

00445.41 Installing Pipe under Railroad - Prior to beginning any under-track Work, submit plans of construction, and details of the methods and Equipment proposed to be used, to the Engineer for submittal to the Railroad. Do not begin under-track Work until Railroad approval is obtained.

Within the limits indicated on the Plans, do not install the pipe under the railroad tracks by the open trench method. Within these limits install the pipe by tunneling, jacking, boring or similar methods, approved by the Railroad, as the Contractor elects, according to Section 00406. Install the pipe to the lines and grades established and backfill completely all voids around the installation with specified material, to the satisfaction of the Railroad.

00445.42 Laying Pipe - Begin pipe laying at the downstream end of the pipeline with the lower segment of the pipe in contact with the shaped bedding throughout its full length and as follows:

- **Elliptical Pipe** - Place with the major axis within 5 degrees of a vertical plane through the longitudinal axis of the pipe.
- **Flexible Pipe** - Place with longitudinal laps or seams at the sides. At circumferential lap joints, place pipe so that the downstream piece is outside.
- **Paved Invert or Partially Lined Pipe** - Place with longitudinal centerline of paved segment coinciding with flow line.
- **Rigid Pipe** - Place with bell or groove ends facing upstream.
- **Round Elliptically Reinforced Concrete Pipe** - Place so that the manufacturer's marks designating the top and bottom of the pipe are within 5 degrees of a vertical plane through the longitudinal axis of the pipe.

00445.43 Placing and Joining Pipe:

(a) General - Lay pipe proceeding upgrade with spigot ends in the direction of flow. Assemble joints according to the recommendations of the manufacturer for the type of joint used. The trench bottom shall form a continuous and uniform bearing and support for the pipe at every point between joints.

Prevent excavated or other foreign material from getting into the pipe. Plug or close off pipes that are stubbed off for future connection. When cutting or machining of the pipe is necessary, use only the tools and methods recommended by the pipe manufacturer. All field joints shall:

- Provide equal or greater strength than the adjoining pipe.
- Fit close and tight.
- Provide a smooth and uniform interior surface.
- Secure and hold adjoining sections to each other.
- Fasten securely to adjoining Structures and special sections.
- Connect new pipes to existing pipes using materials from 00490.13.

(b) Concrete Pipe - Lay elliptical reinforced pipe so that the top or bottom marks are not more than 5 degrees from vertical. Provide all rigid pipe entering or leaving manholes with flexible joints within 18 inches of the manhole Structure and placed on firmly compacted bedding.

(c) Polyvinyl Chloride Pipe - Install PVC pipe and fittings according to the manufacturer's recommendations.

Cut the pipe in a neat manner, at right angles to the axis of the pipe, and dress the cut end.

(d) Polyethylene Pipe - Install solid-wall HDPE and corrugated polyethylene pipe and fittings according to the manufacturer's recommendations.

Assemble and join solid-wall HDPE pipe at the site using the thermal butt fusion method to provide a leak-proof joint. Threaded or solvent-cement joints are not allowed. All Equipment and procedures used shall be in strict compliance with the manufacturer's recommendations. Use personnel certified as fusion technicians by the manufacturer of the pipe or fusing Equipment to accomplish the fusing.

Provide joints for corrugated polyethylene pipe made with either bell-and-bell or bell-and-spigot coupling.

(e) Steel Reinforced Polyethylene Pipe - Install steel reinforced polyethylene pipe and fittings according to the manufacturer's recommendations.

(f) Polypropylene Pipe - Install polypropylene pipe and fittings according to the manufacturer's recommendations.

Provide joints made with bell-and-spigot coupling.

When the ambient air temperature is less than 10 °F, do not install, move, cover, bury, or otherwise handle the polypropylene pipe. All polypropylene pipe handled at temperatures below 10 °F will be rejected and not allowed to be used on the Project

(g) Metal Pipe - Install metal pipe and fittings according to the manufacturer's recommendations. Tees and wyes installed on metal pipe may be field-welded or shop-welded onto the mainline pipe, or may be saddle type fittings, gasketed, and banded or bolted in place.

Connections to ends of metal tees and wyes shall be made with approved mechanical connectors, concrete collars, or as otherwise recommended by the manufacturer.

Damaged bituminous and zinc coatings shall be repaired prior to installing and backfilling the pipe. Zinc coatings shall be repaired in accordance with 02420.10(d). Bituminous coatings shall be repaired with a bituminous material equivalent to that applied at the factory.

(h) Pipe Joints - Wastewater joints shall be air tight and water tight. Stormwater joints shall be water tight. Construct field joints, suitable for testing, for siphons, sanitary sewers, irrigation, and other installations as specified.

~~Construct watertight field joints for storm sewers and culverts with elastomeric joint material. Test joints according to 00445.72.~~

(i) Inspection - After the pipe is laid and joined, and before any backfilling over it, the installation will be inspected. Take up and relay or replace any pipe found to be out of alignment, unduly settled, or damaged.

00445.44 Strutting Metal Pipe - When the Plans or Special Provisions call for metal pipe to be installed in a tied or strutted condition, place the ties or struts before backfilling, conforming to the details shown. Strutting with timber is not allowed in pipe furnished with paved invert or with centrifugally applied bituminous inner linings. Remove the ties and struts after the embankment over the pipe is completed and compacted.

00445.45 Backfilling:

(a) General - After the pipe is installed and inspected, backfill pipe zone and trench according to Section 00405 for pipes 72 inches and less in diameter, and according to Section 00510 for pipes over 72 inches in diameter.

(b) Exposed Pipe - When the top 25 percent of the pipe is exposed above the top of the trench, place and compact embankment materials in layers according to the requirements of the Plans for the pipe zone.

Do not cross any pipe with tractors or other heavy Equipment until it has been bedded and backfilled as specified, and is protected by at least a 4-foot cover of compacted fill.

(c) Elliptical Pipe - Where elliptical shaped metal pipe is furnished, place backfill in a manner that will maintain a vertical elongation between 4 and 6 percent greater than the indicated normal diameter, and fill up to the minimum cover above the top of the pipe indicated on the fill height table included with the Plans.

When elliptical shaped metal pipe 48 inches and larger in size is furnished, install and maintain suitable tell-tales throughout the length of the pipe at intervals not exceeding 14 feet. Hang the tell-tales from the crown of the pipe and use as a progressive check on the pipe deflection during backfilling and filling.

Remove tell-tales after the entire fill over the pipe has been completed.

00445.46 Concrete Blocks - When called for by the Plans or directed, construct concrete blocks, with Commercial Grade Concrete according to Section 00440.

00445.47 Contact Surfaces, Aluminum to Concrete - Where uncoated aluminum pipe or aluminum coated steel pipe will be touching portland cement concrete, give the contact surfaces of the pipe a coating of asphalt mastic applied at a rate which will give a minimum dry film thickness of 50 mils.

Do not place concrete on contact surfaces until the mastic coating has dried to practical hardness. The coating is considered to have reached practical hardness when firm pressure between the thumb and fingers shows a slight tacky condition, but the film is not ruptured, and none of the coating adheres to the fingers.

00445.48 Tracer Wire - Install tracer wire in all trenches for sanitary and storm sewers. Place the tracer wire directly over the pipe centerline and on top of the pipe zone material. Place a branch tracer wire over each pipe connected to the main sewer.

Make tracer wire splices using a solderless connection kit that effectively moisture-seals two or more conductors for direct burial and securely join the wires both mechanically and electrically. Insulate splices to be moisture-proof and waterproof. Splices wrapped with tape will not be accepted as waterproof. Have all splice kits approved prior to installation.

Test all tracer wire with locating Equipment prior to acceptance.

Finishing, Cleaning Up, and Testing

00445.70 General:

(a) Storm Sewer and Culvert Installations - Inspect storm sewer systems and culverts to ensure that the lines are free of obstructions and leakage. Perform video and deflection testing.

(b) Siphon, Irrigation and Sanitary Sewer Installations - After laying and joining pipe for siphons, irrigation and sanitary sewers, and backfilling trenches, test the installations for watertightness, including inlet and outlet connections, to the Engineer's satisfaction. Perform video, deflection, hydrostatic, and low-pressure air testing.

00445.71 Requirements Prior to Tests:

(a) General - All sanitary gravity systems, siphon systems and irrigation systems and appurtenances shall successfully pass a hydrostatic or air test prior to acceptance and shall be free of visible infiltration of water. Test manholes as specified in Section 00470.

On pipe 30 inches in diameter and larger, individual joints may be tested by an approved joint testing device. All details of the testing procedure shall meet the approval of the Engineer.

(b) Plugging Tees, Wyes, Stubs and Service Connections (Sanitary Only) - Plug all wyes, tees, stubs and service connections with gasketed caps or plugs securely fastened or blocked to withstand test pressures.

(c) Testing Equipment - Furnish all necessary testing Equipment and perform the tests in a manner that provides observable and accurate measurements of either air or water leakage under the specified conditions. Calibrate and certify gauges at the direction of the Engineer. Provide the certification with the gauge.

(d) Cleaning — Withing 24 hours Pprior to the testing and inspection of the system, flush and clean all parts of the system and remove all debris.

00445.72 Pipe Testing:

(a) General - After completing installation of the system, including all service connections, backfilling and compaction, and prior to wearing surface paving, conduct a low-pressure air test or a hydrostatic test. Provide all Equipment and personnel for the test. Conduct tests during normal working hours. The Engineer may require testing of manhole-to-manhole sections as they are completed in order to expedite the acceptance of the system and allow connections.

The method, Equipment and personnel used in testing shall be subject to approval of the Engineer. The Engineer may, at any time, require a calibration check of the instrumentation used.

(1) Safety Precautions - Only qualified personnel will be allowed to conduct the test. All plugs used to close the system for the testing shall be capable of resisting the expected internal pressures. Securely brace plugs, if necessary.

(2) Groundwater - The presence of groundwater will affect the results of the test. Determine the average height of groundwater over the lines immediately before starting the test, using an approved method.

(b) Hydrostatic Testing - Pipe and joints shall sustain losses not exceeding 0.04 gallons per hour per inch diameter per 100 feet of pipe when field-tested by exfiltration methods, except 0.3 gallons per hour may be used in arid climate zones if approved by the Engineer.

The hydrostatic head for test purposes shall exceed the maximum estimated groundwater level in the section being tested by at least 72 inches of water column and in no case shall be less than 72 inches of water column above the inside top of the highest section of pipe in the test section, including service connections. The Engineer will make the final decisions regarding test height for the water in the pipe section being tested. The length of pipe tested by exfiltration shall be limited so that the pressure on the invert of the lower end of the section shall not exceed 28 feet of water column.

The pipe test section may be filled 24 hours prior to time of exfiltration testing, if desired, to permit normal absorption into the pipe walls to take place.

All service connection footage shall be taken into account in computing allowable leakage.

(c) Air Testing - The pressure gauge used in air testing shall have minimum divisions of 0.1 psi and an accuracy of 0.0625 psi. All air testing shall be by the Time Pressure Drop Method. The test procedure is as follows:

(1) The Contractor may wet the lines prior to testing.

(2) Determine the average height of the groundwater over the line. The test pressures required shall be increased 0.433 psi for each foot of average water depth over the exterior crown of the pipe.

(3) Add air slowly to the section of system being tested until the internal air pressure is raised to 4 psi greater than the average back-pressure due to groundwater.

(4) After the test pressure is reached, allow at least 2 minutes for the air temperature to stabilize, adding only the amount of air required to maintain pressure.

(5) After the temperature stabilization period, disconnect the air supply.

(6) Record the time in seconds that is required for the internal air pressure to drop from 3.5 psi to 2.5 psi greater than the average backpressure due to groundwater.

The tested section will be acceptable if the time recorded in paragraph (6) above is not less than the time in seconds (T) computed by the formula:

$$T = K/C$$

Where:

K = the sum of the computations (0.011 d²L) for each size of pipe and its length in the section

C = the sum of the computations (0.0003882 dL) for each size of pipe and its length in the section, except that the minimum value for C shall be 1

d = inside diameter of the pipe in inches

L = length of pipe in feet

(d) Individual Joint Testing:

(1) General - The Contractor may test each individual joint for leakage using a pneumatic joint testing apparatus. The method, Equipment and personnel used in individual joint testing shall be as approved. The Engineer may, at any time, require a calibration check of the instrumentation used. The pressure gauge used shall have minimum divisions of 0.1 psi and have an accuracy of 0.0625 psi. All air used shall pass through a single control panel.

(2) Method - All air testing shall be by the Time Pressure Drop Method. The test procedure is as follows:

- a. Determine the average height of the groundwater over the line. The test pressures required below shall be increased 0.433 psi for each foot of average water depth over the exterior crown of the pipe.
- b. Add air slowly to the section being tested until the internal air pressure is raised to 4 psi greater than the average backpressure due to groundwater.

(3) Acceptance - The joint shall be considered acceptable if the pressure drops less than 1 psi within 5 seconds.

00445.73 Deflection Testing for Flexible Pipe - Conduct deflection tests of sanitary and storm sewers constructed of flexible pipe prior to wearing surface paving. Conduct the testing by pulling an approved mandrel through the completed pipeline. Use a mandrel having at least 6 vanes and a diameter 95 percent of the pipe's initial inside diameter. For C900 pipe, conduct deflection tests by pulling a water depth gauge visible in the video recording through the completed pipeline. A mandrel is not required for deflection testing of C900 pipe.

Conduct testing on a manhole-to-manhole basis after the line has been completely flushed out with water. Conduct the tests ~~not less than 30 days~~ after the trench backfill and compaction have been completed. Tests ~~may be conducted sooner if approved by the Engineer. The tests may shall~~ be conducted concurrently with video inspection. If conducted concurrently, pull the mandrel in front of the camera so that the deflection testing is clearly recorded on the video tape unless approved by the Engineer. Provide a water depth gauge, located on the video camera side of the mandrel with the following characteristics:

- Graduated with marks at 0.50-inch increments clearly visible during video inspection.
- Capable of measuring water depth in 0.50-inch increments from 0.50 inch to 2.50 inches.
- Designed so that it will remain plumb regardless of the rotation of the mandrel or video camera.

00445.74 Video Inspection of Sanitary and Storm Sewers - For all existing culverts being extended, perform preconstruction video pipe inspection of the existing culvert according to Section 00415. For all existing sanitary sewer and storm sewers being altered or repaired, perform preconstruction video pipe inspection, according to Section 00415, between the nearest upstream manhole where Work is not being performed and the nearest downstream manhole where Work is not being performed, including all lateral runs between end manholes.

When constructing a new run, an extension, or a repair of sanitary sewer, storm sewer, or culvert pipe, perform post-construction video pipe inspection, according to Section 00415, of all joints, including the location where new pipe meets existing pipe. Conduct the post-construction video pipe inspection after backfill and compaction are complete, but before any finish Surfacing or final paving is performed.

For pipe sections being replaced, video pipe inspection is not required prior to replacement. Video pipe inspection is not required for pipe sections that are being abandoned.

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00445.75 Repairs - Locate and repair any sections failing to pass the required tests and inspections. Repeat the specified tests and inspections on those sections at no additional cost to the Agency.

When repairing PVC pipe, a solid repair coupling shall be used. The coupling shall be manufactured to ASTM 3034 PVC. Flexible boot and band couplers are not allowed.

Approval by the Engineer is required when making repairs using dissimilar pipe materials. If approved, inside diameter dimensions shall be similar. Commercially manufactured shear restrained couplers shall be used. Bolts for commercial adapters shall be stainless steel.

Following a successful hydrostatic or air test, visible infiltration of groundwater in any section will be considered evidence that the original test was in error or that failure of the section has occurred. Correct such failures and retest the repaired sections, at no additional cost to the Agency.

Measurement

00445.80 Measurement - Pipes and related Work performed under this Section will be measured according to the following:

(a) Pipes - The quantities of pipe of the various kinds, types, and sizes, will be measured on the length basis, and will be determined by the length and depth of installation as follows:

- **Length** - The length will be measured, with no deduction for Structures or fittings, along the pipe flow line from center to center of manholes, inlets, or special sections; or the ends of pipe or end sections, whichever is applicable.
- **Depth** - The depth will be used to determine the maximum depth range and Pay Item for each pipe. The maximum depth range, to the flow line, for each pipe will be "5 feet", "10 feet", "20 feet", and "over 20 feet" as applicable.

The depth in excavation areas will be the maximum measured vertical distance between the pipe flow line and the surface of the original ground or Subgrade, whichever is less, or the slopes of other areas outside the Subgrade limits.

The depth in embankment areas will be the maximum measured vertical distance between the pipe flow line and the surface of the constructed embankment as determined in 00330.42(c)(6).

(b) Tee and Wye Fittings - The quantities of tee and wye fittings will be measured on the unit basis. No deduction will be made from measurement of pipe for the length of the fitting.

(c) Slip Joints - The quantities of slip joints will be measured on the unit basis.

(d) Sloped and Skewed Ends - The quantities of sloped ends, skewed ends, or sloped and skewed ends will be measured on the unit basis.

(e) Safety End Sections - The quantities of safety end sections will be measured on the unit basis.

(f) Concrete Pipe Anchors - The quantities of concrete pipe anchors will be measured on the unit basis.

(g) Concrete Closure Collars - The quantities of concrete closure collars will be measured on the unit basis.

(h) Concrete in Blocks - The quantities of concrete used in blocks will be measured on the volume basis, in place.

(i) Reinforcement - The quantities of reinforcement used in blocks will be measured on the lump sum basis or on the weight basis according to 00530.80.

(j) Installation Under Railroad - No measurement will be made for additional Work necessary to install pipe under railroads. Pipe installed under railroads will be separately measured according to 00445.80(a).

(k) Deep Connections – The quantities for deep connections will be measured on the unit basis.

(l) Cleanouts – The quantities of cleanouts will be measured on the unit price basis.

Excavation and backfill for pipes greater than 72 inches in diameter will be measured according to Section 00510.

Video pipe inspection will be measured according to 00415.80.

Trench resurfacing will be measured according to 00495.80.

Payment

00445.90 General - The Contract unit price for each Pay Item reflects Plan requirements or the Contractor's choice from the applicable options listed on the Pipe Data Sheets (if shown).

00445.91 Payment - The accepted quantities of pipe and related Work items performed under this Section will be paid for at the Contract unit price, per unit of measurement, for the following items:

Pay Item	Unit of Measurement
(a) ____ Inch ____ Pipe, ____ Depth.....	Foot
(b) ____ Inch ____ Pipe.....	Foot
(c) Pipe Tees, ____ Inch.....	Each
(d) Pipe Wyes, ____ Inch.....	Each
(e) Slip Joints, ____ Inch.....	Each
(f) Sloped End Sections, ____ Inch.....	Each
(g) Safety End Sections, ____ Inch.....	Each
(h) Concrete Pipe Anchors.....	Each
(i) Concrete Closure Collars.....	Each
(j) Concrete in Blocks.....	Cubic Yard
(k) Reinforcement in Blocks.....	Lump Sum or Pound
(l) Installing ____ Inch Pipe Under Railroad.....	Lump Sum
(m) Deep Connections.....	Each
(n) Cleanouts.....	Each

In item (a), the nominal pipe diameter will be inserted in the first blank. The type of pipe will be inserted in the second blank. The appropriate flow line depth range will be inserted in the third blank.

Item (a) includes pipe 72 inches and smaller in diameter.

In item (b), the nominal pipe diameter will be inserted in the first blank. For arch type pipe, the nominal diameter of circular metal pipe from which the pipe arch is formed, or reformed, will be inserted in the first blank. The type of pipe will be inserted in the second blank.

Item (b) includes pipe larger than 72 inches in diameter.

In items (c) and (d), the nominal pipe size will be inserted in the blank.

In item (e), the outer sleeve slip joint size will be inserted in the blank. The inner sleeve will be included in payment made for the smaller pipe.

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Item (f) includes all sloped end sections, whether manufactured as a sloped unit or cut in the field.

In items (f) and (g), the nominal pipe diameter will be inserted in the blank.

Item (g) includes safety bars when required.

Item (j) includes reinforcement if there is no item listed for reinforcement in blocks in the Contract Schedule of Items.

In item (l), the nominal pipe diameter will be inserted in the blank.

Item (l) includes all additional Work involved in placing pipe under existing railroad tracks as specified within the limits shown.

Item (n) is for the construction of cleanouts in conjunction with the construction of new Service Laterals and includes fittings, riser pipe, plugs and concrete apron as required.

Payment will be payment in full for furnishing and placing all Materials, and for furnishing all Equipment, labor, and Incidentals necessary to complete the Work as specified.

Excavation and backfill for pipes greater than 72 inches in diameter will be paid for according to Section 00510.

Video pipe inspection will be paid for according to 00415.90.

Trench resurfacing will be paid for according to 00495.90.

No separate or additional payment will be made for:

- trench excavation, bedding, pipe zone Material, and trench backfill for pipes 72 inches and less in diameter
- pipe plugs, stoppers, and other required fittings
- metal pipe anchors
- tracer wire
- hydrostatic, air, joint, and deflection testing

Payment will be made for pipe in place only after the pipe has successfully passed the air or hydrostatic test, and the video inspection recording and report has been submitted and accepted.

When the Contract Schedule of Items does not indicate payment for pipes or other Work under this Section, no separate or additional payment will be made. Payment will be included in payment made for the appropriate items under which this Work is required.

Section 00446 - Trench Drains

Description

00446.00 Scope - This Work consists of constructing trench drain systems and constructing joints and connections to other drainage Structures at locations shown or directed.

00446.01 Definitions:

Type 1 Trench Drain - A trench drain installation in which any part is constructed in a Traveled Way.

Type 2 Trench Drain - A trench drain installation that is constructed in a paved Shoulder and paved or unpaved Multi-Use Path.

Materials

00446.10 Materials - Furnish Commercial Grade Concrete meeting the requirements of Section 00440.

00446.11 Trench Drains - Furnish trench drains from the QPL or that meet the following requirements:

- Trench drains that have smooth interior surfaces below the level of the frame, grate, and associated connections.
- Trench drain sections, excluding the frame and grate, that are manufactured of monolithic polymer concrete composed of Aggregate and polyester resin or vinyl ester resin that when complete, meet the following requirements:

Property	ASTM Test Method	Value
Tensile Strength (min. psi)	C 307	1,500
Compressive Strength (min psi)	C 579	12,000
Bending Strength (min psi)	C 580	2,900
Moisture Absorption (max. %)	C 140	0.5
Chemical Resistance	C 267	Pass
Freeze/Thaw (min. number of cycles without weight loss)	C 666	1,600

00446.12 Frames and Grates - Furnish frames and grates from the QPL or that meet the following requirements:

- One piece frames and grates for type 1 trench drains meeting the requirements of AASHTO M 306, H25 loadings. Secure them to the surrounding concrete to provide a minimum pullout resistance of 500 pounds per foot of length of trench drain.
- Either one-piece or removable grate type frames and grates for type 2 trench drains meeting the requirements of AASHTO M 306, H20 loadings. Provide tamper resistant locking devices for removable grates.

Provide Americans with Disabilities Act certified grates that are placed within designated pedestrian paths of travel.

Construction

00446.40 General - Construct trench drains according to the following:

(a) Trench Work - Excavate trench and prepare bedding according to the manufacturer's recommendations. Provide an additional minimum of 4 inches on both sides and the bottom of the trench drain system for the Commercial Grade Concrete.

(b) Line and Grade - Establish the centerline and grade control prior to the start of construction.

Do not vary from established line and grade by more than 1/32 inch per inch of inside trench drain width, subject to the following limitations:

The variation does not result in a level or reverse sloping invert.

The variation in the invert elevation between adjoining sections of trench drain does not exceed 1/64 inch per inch of inside trench drain width.

(c) Trench Drain System Installation - Install trench drain systems according to the following:

- Follow the manufacturer's installation recommendations.
- Locate maintenance access for Type 1 trench drains outside of the Traveled Way.
- Securely support all channel units at the correct line and grade during the concrete pour. Texture the surface of concrete with a broom or burlap drag to produce a skid-resistant surface.

Finishing and Cleaning Up

00446.70 General - Remove all debris from the finished trench drain then flush with water.

Measurement

00446.80 Measurement - The quantities of trench drains will be measured on the length basis. Measurement will be from the beginning of the trench drain to the center of the receiving Structure.

Payment

00446.90 Payment - The accepted quantities of trench drains will be paid for at the Contract unit price, per foot, for the item "Trench Drain, Type ____".

The type of trench drain will be inserted in the blank.

Payment will be payment in full for furnishing and placing all Materials, and for furnishing all Equipment, labor, and Incidentals necessary to complete the Work as specified.

Section 00450 - Structural Plate Shaped Structures

Description

00450.00 Scope - This Work consists of constructing structural plate pipe, pipe arches, plate arches, horizontal ellipses, vehicular underpasses and special shaped Structures.

00450.01 Definitions:

Structural Plate Pipe - Built-up pipe with a circular Cross Section of the type, thickness and diameter specified. It is fabricated with the vertical diameter about 5 percent greater than the nominal diameter shown on the Plans.

Structural Plate Pipe Arch - Built-up pipe with a Cross Section made up of a multi-centered shape of four circular arcs, tangent to each other at their junctions, symmetrical about the vertical axis, and of the type, thickness and span specified. The size is designated by span and rise, measured from the inside crests of corrugations.

Structural Plate Arch - Single or multiple radius Structures comprised of a number of curved metal plates that form an arch shape when assembled. The Structure is designed to be supported along its lower edges on separately constructed reinforced concrete foundations, and of the design, type, thickness and span as shown. This size is designated by span and rise measured from the inside crests of corrugations.

Structural Plate Horizontal Ellipse - Built-up pipe in an elliptical shape with the horizontal diameter approximately 20 percent greater than the nominal diameter. The size is designated by span and rise, measured from the inside crests of corrugations.

Structural Plate Vehicular Underpass - Built-up pipe in a high arch shape with large radius sides and invert, and small radius corners between sides and invert. The size is designated by span and rise, measured from the inside crests of corrugations.

Materials

00450.10 Materials - Furnish Materials meeting the following requirements:

Aluminum Alloy Structural Plates	02430.20
Bolts, Nuts, and Washers	02430.90
Commercial Grade Concrete.....	00440
Galvanized Structural Plates	02430.10
Reinforcement	00530

Construction

00450.40 Trench Work - Excavate trench, prepare bedding, backfill and dispose of excavated material according to Section 00510 and the following:

(a) Trenches In Unstable Areas - Excavate unstable materials under the pipe or pipe arch and to a width of at least one-half the diameter or span width on each side of the Structure, to depths below the established elevation for the bases or foundation of the Structure, as directed. Unless otherwise directed, backfill with granular structure backfill. Bring the backfill material to the moisture content required for compaction and place in 6 inch layers. Compact each layer according to 00330.43. Bring the backfill material to the elevation established.

(b) Trenches in Unyielding Material - When Rock, hardpan or other unyielding material is encountered, remove it below the designated grade, as ordered, to a depth under the pipe or pipe arch equal to at least 1/2 inch per foot of fill height over the top of the pipe, but not less than 8 inches, nor more than three-fourths the vertical dimension of the Structure. Unless otherwise directed, backfill with granular structure backfill.

00450.41 Installation in Paved Areas - If Structures are installed within paved areas to be preserved, resurface according to Section 00495.

00450.42 Erection:

(a) General - Assemble corrugated metal plates at the site of installation to the lines and grades shown or directed. Connect the plates at longitudinal and circumferential seams with bolts. Stagger joints so that no more than three plates come together at any one point. Each plate shall be curved to one or more circular arcs as required, and according to 02430.10, to provide an assembled Structure of specified dimensions and design.

Retain any Camber specified for the invert when assembling and erecting the Structures. Do not create an adverse grade in the Structure.

(b) Plate Thickness - The thickness of the respective top, corner and bottom plates in any one Structure shall be as shown.

(c) Bolts - Use at least 4 bolts per foot of longitudinal seam. Space bolts and bolt holes according to AASHTO M 167. Use additional bolts for special conditions of installation if called for in the Special Provisions or by the Plans. Unless otherwise allowed, place all bolts with nuts on the inside of the Structure.

(d) Assembly - Assemble structural plate Structures according to the manufacturer's assembly instructions and the following:

- Hold the unsupported edges of all plates in position by temporary props.
- Extend each row of side plates far enough to support the plate above until the first complete ring has been assembled.
- Progressively install enough bolts to hold the plates in position. Do not tighten bolts until tightening will not interfere with adjusting and matching of additional plates and sections.
- Do not damage the galvanizing or other protective coating when using drift pins or pry bars. Repair any damage at no additional cost to the Agency.
- After all plates are in place, progressively and uniformly tighten the bolts from one end of the Structure to the other end of the Structure.
- Tighten bolts to at least 100 foot-pounds of torque for plates 0.188-inch thick or less, and 150 foot pounds of torque for plates more than 0.188 inch thick.
- Recheck and retighten as necessary before backfilling.
- Do not torque bolts above 300 foot-pounds during tightening.

(e) Damaged Coating - Repair damaged galvanizing according to 02420.10(d).

00450.44 Arch Substructures and Headwalls - Rest each side of each arch in a groove formed in the concrete, or rest on a galvanized angle or channel securely anchored to or embedded in the Substructure. If the span of the arch is greater than 15 feet or the skew angle is more than 20 degrees, provide a metal bearing surface having a width at least equal to the depth of the corrugation.

Metal bearings may be either rolled, structural, or cold-formed galvanized angles or channels, and shall be at least 3/16 inch thick. Anchor the horizontal leg securely to the Substructure on 24-inch centers or less. When the metal bearing is not embedded in a groove in the Substructure, punch one vertical leg and bolt to the bottom row of plates.

00450.45 Strutting - If strutting is required, place and remove according to 00445.44.

00450.46 Backfilling - Backfill and compact the trench according to 00510.48(d) and the following:

(a) General - Perform backfilling so that a vertical elongation between 4 and 6 percent greater than the indicated normal diameter is maintained. Place backfill material evenly on both sides of the Structure at least up to the three-quarter point of the Structure. Fill above the top of the pipe with minimum cover as indicated on the fill height table included with the Plans.

(b) Exposed Pipe - Place and compact embankment materials at exposed pipes according to Section 00445.

(c) Tell-Tales - Install and remove tell-tales according to Section 00445.

(d) Arches And Horizontal Ellipses - In addition to the other provisions of this Subsection, exercise care as follows:

(1) Before Headwalls Are Placed - If backfilling pipes before headwalls are built, place the first backfill material midway between the ends, forming as narrow a ramp as possible until the top of the pipe is reached. Build the ramp evenly from both sides, and compact the backfill material as it is placed. After the ramps have been built to the top on each side of the pipe, deposit the remainder of the backfill evenly on both sides from the top of the pipe both ways from the center to the ends.

(2) After Headwalls Are Placed - If headwalls are built before the pipe is backfilled, place the first backfill material adjacent to one headwall until the top of the pipe is reached. Then deposit backfill material evenly on both sides from the top of the pipe toward the other headwall.

In multiple installations, follow the above procedures. Use care to place and bring the backfill up evenly on each side of each pipe to avoid unequal pressure.

Compact the backfill material thoroughly, but not excessively. Using water to hydraulically consolidate the backfill by ponding or jetting the backfill material is not allowed.

00450.47 Footings and Headwalls - Construct footings and headwalls for arches according to the design shown and the requirements of Sections 00440 and 00530.

00450.48 Contact Surfaces, Aluminum to Concrete - Where uncoated aluminum pipe will be in contact with portland cement concrete, give the contact surfaces of the aluminum pipe a coating of asphalt mastic according to 00445.47.

00450.49 Work Quality - The following defects constitute poor Work and the presence of any in an individual culvert plate or in a shipment will be cause for rejection:

- Dents or bends in the metal itself
- Illegible brand
- Loose or unevenly lined or spaced bolts
- Ragged edges
- Unrepaired, bruised, scaled or broken spelter coating

- Uneven laps
- Variation from the specified alignment
- Wrong plate location

Measurement

00450.80 Measurement - The quantities of structural plate pipes, pipe arches, arches, horizontal ellipses, and vehicular underpasses will be measured on the length basis, excluding overlaps and the lip of plates at Structure ends. Pipe arches and arches will be measured along the bottom centerline of the Structures. The length of structural plate pipes, horizontal ellipses, and vehicular underpasses will be the average of the top and bottom centerline measurements.

Concrete for footings and headwalls will be measured on the volume basis, and will be the volume within the Neat Lines of the Structure as shown or directed.

Excavation and backfill for pipes greater than 72 inches in diameter will be measured according to Section 00510.

Trench resurfacing will be measured according to 00495.80.

Reinforcement for footings and headwalls will be measured on the weight basis according to 00530.80.

Payment

00450.90 Payment - The accepted quantities of Work performed under this Section will be paid for at the Contract unit price, per unit of measurement, for the following items:

Pay Item	Unit of Measurement
(a) ____ Inch Structural Plate Pipe.....	Foot
(b) ____ Inch x ____ Inch Structural Plate Pipe Arch.....	Foot
(c) ____ Inch x ____ Inch Structural Plate Arch.....	Foot
(d) ____ Inch x ____ Inch Structural Plate Ellipse.....	Foot
(e) ____ Inch x ____ Inch Structural Plate Vehicular Underpass	Foot
(f) Structural Plate Concrete Footings and Headwalls.....	Cubic Yard

In item (a), the nominal size diameter of the pipe will be inserted in the blank.

In items (b), (c), (d) and (e), the size of the span and rise of the Structures will be inserted in the applicable blanks.

Payment will be payment in full for furnishing and placing all Materials, and for furnishing all Equipment, labor, and Incidentals necessary to complete the Work as specified.

Excavation and backfill for pipes greater than 72 inches in diameter will be paid for according to Section 00510.

Trench resurfacing will be paid for according to 00495.90.

Reinforcement for footings and headwalls will be paid for according to 00530.90.

No separate or additional payment will be made for trench excavation, bedding, pipe zone Material, or trench backfill for pipes 72 inches and less in diameter.

Section 00460 - Paved Culvert End Slopes

Description

00460.00 Scope - This Work consists of constructing portland cement concrete paved culvert end slopes at locations indicated on the Plans or where designated.

Materials

00460.10 Materials - Furnish Materials meeting the following requirements:

Commercial Grade Concrete.....	00440
Curing Compound	02050
Welded Wire Fabric.....	02510.40

Construction

00460.40 General - Construct paved culvert end slopes according to Section 00440 and the following:

- Shape the Base on which the concrete is to be placed to the lines and grades established. Water and compact the areas before placing concrete.
- Finish the surface of the paved culvert end slopes to a smooth, uniform texture by troweling and floating and then brush the surface with a broom or burlap, as directed.

Measurement

00460.80 Measurement - The quantities of paved culvert end slopes will be measured on the area basis. Measurement will be based on the paved end slope area table identified on the Plans. No actual field measurement will be made, except to check the Work, unless changes are ordered. No allowance will be made for paved culvert end slopes which are constructed on a skew.

If changes are ordered and made in the Work, those paved culvert end slopes that are changed will be measured in the field. Measurements will be based on the actual surface area of the paved culvert end slope (not including the culvert opening) plus the face area of the cut-off wall.

Payment

00460.90 Payment - The accepted quantities of paved culvert end slopes will be paid for at the Contract unit price, per square foot, for the item "Paved Culvert End Slopes".

Payment will be payment in full for furnishing and placing all Materials, and for furnishing all Equipment, labor, and Incidentals necessary to complete the Work as specified.

Section 00470 - Manholes, Catch Basins, and Inlets

Description

00470.00 Scope - This Work consists of constructing manholes, catch basins, inlets, siphon boxes, slope protectors, and other similar Structures. Construct the Structures of Commercial Grade Concrete, corrugated metal, or other material, with necessary frames, covers, gratings, and other fittings and hardware.

References to manholes, inlets, siphon boxes, and slope protectors refer to standard Structures of specific design and use, and are identified on the Plans. The term "concrete" refers to Commercial Grade Concrete.

00470.01 Cast-in-Place and Precast Construction - Concrete manholes shall be cast-in-place or precast, as shown or specified. Concrete inlets and siphon boxes may be either cast-in-place or precast.

Materials

00470.10 Materials - Furnish Materials meeting the following requirements:

Commercial Grade Concrete.....	00440
Concrete Drain Tile	02410.10(i)
Corrugated Metal Pipe	02420.10, 02420.40
Joint Material.....	02440.40, 02440.50, 02440.60
Metal Frames, Covers, Grates, and Steps	02450.30
Nonreinforced Concrete Pipe	02410.10
Polyethylene Pipe	02415.10
Polyvinyl Chloride Pipe, Schedule 40.....	02415.50
Precast Concrete Manholes, Catch Basins and Inlets.....	02450
Reinforcement.....	02510.10, 02510.40

00470.11 Precast Concrete Manholes and Bases - Furnish cones with the same wall thickness and reinforcement as riser sections.

Prior to delivery of precast manhole sections to the Project Site, yard permeability tests may be required at the point of manufacture. The precast sections to be tested will be selected at random from the stockpiled material to be supplied to the Project. All test specimens will be mat tested, and shall meet the permeability test requirements of ASTM C497.

Precast manhole sections shall consist of circular sections in one of the following standard nominal inside diameters:

42 inch	54 inch	72 inch	96 inch	132 inch
48 inch	60 inch	84 inch	120 inch	144 inch

Select heights of sections that provide the least number of joints for the manhole structure.
~~Heights of sections shall be multiples of 6 inches, except heights of manhole sections 72 inches through 96 inches in diameter shall be as required to fit site conditions.~~

00470.12 Cap Screws - Cap screws and washers for watertight manhole covers shall be stainless steel with 60,000 psi minimum tensile strength conforming to the requirements of ASTM A453.

00470.13 Inside Drop Manhole Connectors - Furnish stainless steel anchor bolts and anchor straps for inside drop pipe connections.

00470.14 Pipe and Fittings - Furnish pipe and fittings as specified and conforming to the applicable portions of Section 00445. Use tees, ells and other fittings for drop manholes made from the same material as the pipe connecting to the manhole. When connecting flexible pipe to a manhole with a flexible adapter, furnish adapters in conformance with 00490.12.

00470.15 Pipe Stubouts for Future Sanitary Sewer Connections - Pipe stubouts shall be the same type and strength classification as approved for use in the lateral, main or trunk sewer construction. Where there are two different classes of pipe at a manhole, the higher strength pipe will govern strength classification. Furnish watertight plugs with each stubout and adequately brace against hydrostatic or air test pressures.

00470.16 Sanitary Sewer Manhole Carry-Through - All sanitary sewer carry-through pipes and fittings through storm sewer manholes shall be ductile iron conforming to Section 02420.

00470.17 Base Drain Backfill - Furnish Aggregate base or selected granular backfill material that is free from silts or other fines.

Construction

00470.40 General:

(a) Excavation, Backfill and Foundation Stabilization - Excavate and backfill according to Section 00405. When specified, or as directed, remove unstable material that will not support the manhole or other Structure, excavate below grade and backfill with trench foundation stabilization material according to Section 00405.

(b) Pipe Connections - Place connecting pipe at the required alignment and grade. Set the connecting pipe through the full thickness of the wall flush with the inner face of the wall. Ensure that pipe connections to the Structure are completely watertight. Connect all pipe to manholes according to the manufacturer's recommendations.

Grout ~~rigid concrete~~ pipe connections to manholes so they are watertight, using non-shrink, non-epoxy grout conforming to 02080.2002440.50. When grouted into the structuremanhole section, the pipe section shall not extend more than 18 inches outside the structuremanhole. If an approved flexible connection for concrete pipe is provided at the structuremanhole, full or partial pipe sections may be stubbed into the structuremanhole as required.

Connect flexible pipe to structuresmanholes using an adapter specifically manufactured for the intended service. Flexible pipe adapters are required to be watertight after installation. Follow the manufacturer's recommendations. Do not use field-fabricated water stops or improvised adapters. Adapters requiring the use of grout for installation shall be anchored and finished using non-shrink grout conforming to 02080.2002440.50.

00470.41 Precast Concrete Manholes - Precast manhole components may be used to construct standard, drop and carry-through manholes.

(a) Bases - If bases are cast in place, consolidate the concrete by mechanical vibration. Scream off the concrete so that the first manhole section to be placed has a level, uniform bearing for the full circumference.

If bases are precast, carefully place the Base section on the prepared bedding so as to be fully and uniformly supported at true grade and alignment.

Construct the invert to match that of the sewer pipe. Where the size of the sewer pipe is changed at the manhole, construct the invert to form a smooth transition without abrupt breaks or unevenness of the invert surfaces. Where a full section of concrete sewer pipe is laid through the manhole, break out the top to the springline of the pipe for the full width of the manhole, and

completely cover the exposed edge of the pipe with mortar. During construction divert existing flows of water or sewage away from new concrete or mortar surfaces to prevent damage to the fresh concrete or mortar until the initial set has been achieved.

(b) Precast Manhole Sections - The construction and use of lift holes is not allowed. If steel loops have been provided for lifting, the loops shall be removed flush with the inside wall surface after the manhole has been completed. No sharp protrusions will be permitted. If concrete spalling occurs as a result of the loop removal, repair the area with a nonshrink grout to a uniform smooth surface. Thoroughly wet all lift holes, completely fill with non-shrink grout, and smooth and point both inside and out to ensure watertightness.

(1) Sanitary Manholes - Use preformed plastic or rubber gaskets on all joints between manhole sections.

(2) Storm Manholes - ~~Non-shrink grout is allowed on joints, and on extension rings above the cone. In Roadways and other areas intended for traffic, a minimum of one 24-inch diameter precast riser is required between the cone and manhole cover frame.~~

~~When grout is used, do the following:~~

- ~~• Clean and wet the surfaces to be joined with water.~~
- ~~• Apply non-shrink grout to the lower portion of the bell or groove of the section already laid and to the upper portion of the spigot or tongue of the section being laid.~~
- ~~• Clean the joint recesses, fill completely with non-shrink grout and wipe to a smooth finish both inside and out.~~
- ~~• Do not allow free water to come in contact with grout joints within 24 hours after the mortared joints are finished.~~
- ~~• Protect the completed joints against rapid drying.~~

(c) Grates, Frames, Covers and Fittings - Set metal frames for manholes on full non-shrink grout beds to prevent infiltration of surface water or groundwater between the frame and the concrete of the manhole section. ~~If concrete is to be poured around the frames, coat the portion of the frame that will contact the concrete with hot asphalt before placing the concrete.~~ Set frames, covers and grates true to the locations and grades established. Clean bearing surfaces and provide uniform contact. Measure the existing structures for making ring adjustments. The adjustment height shall be controlled by the compacted finish grade.

For asphalt concrete paving, adjust the manholes frames to the final paving grade after top lift paving.

All asphalt joints shall be constructed according to 00495.40(e).

~~Secure all fastenings. Construct all mortared, sanitary sewer manhole necks and all riser ring joints made with non-shrink grout using an approved commercial concrete bonding agent applied to all cured concrete surfaces being grouted.~~

00470.42 Precast Concrete Catch Basins and Inlets - The construction and use of lift holes is not allowed. Install precast catch basins and inlets to the specified line and grade.

00470.43 Cast-in-Place Concrete Construction:

(a) General - Construct cast-in-place manholes, inlets, siphon boxes and concrete slope protectors according to Section 00440. Finish all inside surfaces smooth and free of depressions or protrusions. Form exterior surfaces with steel, plywood or other approved materials. Form other surfaces with matched boards, plywood, or other approved material. Do not cast directly against trench walls, Rock, or earth.

(b) Cast-in-Place Catch Basins and Inlets - Construct forms for both the inside and outside walls of cast-in-place catch basins. Forms shall be tight and well braced, with chamfered corners. Remove all water and debris prior to placing concrete.

Consolidate the concrete immediately after placement with an approved vibrator. Limit vibration time to that necessary to produce satisfactory consolidation without causing segregation. Screed the top surface and trowel exposed surfaces to a smooth finish, free from marks or irregularities. Radius exposed edges with a steel edging tool. After forms are removed, patch any defects in the concrete with an approved mortar mix.

Immediately after removal of forms and final finishing, cure according to 00440.40(e).

(c) Stamped Logo at Catch Basins and Inlets - During placement of the curb and gutter and aprons, stamp the concrete while the concrete is still plastic, with the phrases "DUMP NO WASTE" and "DRAINS TO STREAMS", and fish symbols.

The City may make stamps available for the use by the Contractor upon a request made on the business day prior to need. Requests will be considered in the order requests are received, however requests made more than one day prior to need will not be considered. Requests must be made in person or by phone call directly to either the inspector or the construction lead. Requests made via voice mail, e-mail, memo or other indirect communication will not be considered. The Contractor must make a request for each day of use. If the City stamps are available, a City representative will deliver the stamps to the job site for the day and collect the cleaned stamps at the end of the day. Lack of available stamps will not be cause for delay or time extension.

Stamps will not be left in the Contractor's possession for more than one work day. If the stamps are not returned clean and in good condition, the City will deduct the cost to clean, repair or replace the stamps from payments due the Contractor for City contracts. For PEPI projects, the Contractor will be required to reimburse the City for expenses before the project will be issued Third Notification. Failure to reimburse the City will also disqualify the Contractor from being allowed to work on other PEPI projects. The City may choose to discontinue this loaning program at any time or to disallow individual contractors from borrowing the stamps due to failure to return the stamps clean and in good condition and/or on time.

00470.45 Steps - ~~Steps shall not be cast or installed in manholes. Fasten steps to the manhole walls according to the manufacturer's recommendations and as shown.~~

00470.46 Corrugated Pipe Slope Protectors - Construct corrugated metal slope protectors according to the Plans and the applicable requirements of Section 00445.

00470.47 Concrete Inlet Base Drains - Provide concrete inlets with base drains leading from abutting Aggregate base or selected granular backfill material.

Use nonreinforced concrete pipe, concrete drain tile, polyethylene pipe or polyvinyl chloride (PVC) plastic pipe for basin drains. Place and compact backfill without damaging pipe or inlet.

00470.48 Concrete Manhole Installation Requirements:

(a) **Locator Posts** - Construct locator posts as shown.

Finishing, Cleaning up, and Testing

00470.70 Cleaning - Upon completion, clean each Structure of accumulated silt, debris or foreign matter of any kind and keep clean until final acceptance of the Work.

00470.71 Sanitary Manhole Acceptance Testing - Field-test all sanitary sewer manholes for acceptance by either hydrostatic or vacuum testing after completion of backfilling, compaction and surface restoration, including paving. If the manhole fails the test, make necessary repairs by an approved method, and retest the manhole. Repair and retest the manhole until a satisfactory test is obtained.

(a) **Hydrostatic Testing** - Perform hydrostatic testing according to ASTM C497. Plug all inlets and outlets and fill the manhole with water. Fill each manhole to the rim at the start of the test. Leakage in each manhole shall not exceed 0.3 gallons per hour per foot of head above the invert. Determine leakage by refilling to the rim using a calibrated container. Manholes may be filled 24 hours prior to the time of testing to permit normal absorption into the manhole walls.

(b) **Vacuum Testing** - Perform vacuum testing according to ASTM C1244. Plug and brace all pipes entering the manhole. Place the test head in or on top of the manhole ring. Draw a vacuum of 10 inches of mercury on the manhole, close the valve on the vacuum line of the test head, and shut off the vacuum pump. Measure the time for the vacuum to drop to 9 inches of mercury. The manhole is acceptable if the time for the vacuum reading to drop from 10 inches of mercury to 9 inches of mercury meets or exceeds the values in the following table:

Minimum Test Times For Various Manhole Diameters

Depth * (feet)	Diameter (inches)								
	30 or less	33	36	42	48	54	60	66	72
8 or less	11	12	14	17	20	23	26	29	33
10	14	15	18	21	25	29	33	36	41
12	17	18	21	25	30	35	39	43	49
14	20	21	25	30	35	41	46	51	57
16	22	24	29	34	40	46	52	58	67
18	25	27	32	38	45	52	59	65	73
20	28	30	35	42	50	53	65	72	81
22	31	33	39	46	55	64	72	79	89
24	33	36	42	51	59	64	78	87	97
26	35	39	46	55	64	75	85	94	105
28	39	42	49	59	69	81	91	101	113
30	42	45	53	63	74	87	98	108	121

* Depth is measured from the top of the manhole to the lowest invert.

** Test times for manhole depths between those shown in this table may be calculated by interpolation.

Measurement

00470.80 Measurement - The quantities of manholes, inlets, catch basins, siphon boxes, slope protectors, and other Structures will be measured on the unit basis.

Payment

00470.90 Payment - The accepted quantities of Work performed under this Section will be paid for at the Contract unit price, per unit of measurement, for the following items:

Pay Item	Unit of Measurement
(a) Concrete Sanitary Sewer Manholes.....	Each
(b) Concrete Storm Sewer Manholes	Each
(c) Concrete Manholes, _____	Each
(d) Concrete Inlets, Type _____	Each
(e) Concrete Siphon Boxes	Each
(f) Concrete Diversion Boxes.....	Each
(g) Concrete Irrigation Boxes.....	Each
(h) Concrete Junction Boxes	Each
(i) Concrete Monument Boxes.....	Each
(j) Manhole Slope Protectors.....	Each
(k) Catch Basins, _____	Each

In items (c), (d) and (k) the type of Structure will be inserted in the blank.

Item (a) will be paid as follows:

- When the structure is installed50%
- When the structure is brought to final grade and passes testing per 00470.7150%

Items (b)-(d) and (k) will be paid as follows:

- When the structure is installed50%
- When the structure is brought to final grade.....50%

Payment will be payment in full for furnishing and placing all Materials, and for furnishing all Equipment, labor and Incidentals necessary to complete the Work as specified.

No separate or additional payment will be made for:

- earthwork not covered as trench or ditch excavation
- pipe connections
- Rock backfill
- Aggregate base backfill
- drain tile
- acceptance testing
- locator posts

Section 00480 - Drainage Curbs

Description

00480.00 Scope - This Work consists of constructing mechanically extruded curbs using either Commercial Grade Concrete (CGC) or asphalt concrete material.

Construct the curbs at the locations and to the lines, grades and dimensions shown, or as directed.

Materials

00480.10 Materials - Furnish Materials meeting the following requirements:

Commercial Grade Concrete.....	00440
Emulsified Asphalt.....	00730.11
Epoxy Bonding Agent.....	02070.10
Preformed Expansion Joint Filler	02440.10

00480.11 Asphalt Concrete - Furnish commercial asphalt concrete Pavement meeting the requirements of Section 00740. The mixture may be varied when conditions require it, if approved by the Engineer.

Construction

00480.40 Preparation of Base - Clean Pavements upon which drainage curbs are to be constructed so that they are free of dirt, dust, oil, grease or other extraneous matter.

00480.41 Bonding Material Application:

(a) CGC Curbs - Bond CGC curbs to underlying Pavements with an epoxy bonding agent from the QPL or conforming to 00480.10. Apply according to the manufacturer's recommendations and at a rate that provides a thorough coating to the surface with all voids and depressions filled. Place the new curb on the epoxy bonding agent within 15 minutes after spreading, or before it loses its tackiness, whichever is sooner.

(b) Asphalt Concrete Curbs - Bond asphalt concrete curbs to underlying Pavement with either:

- An epoxy bonding agent meeting the requirements of 00480.10 or from the QPL, applied in the manner specified in 00480.41(a), or
- An Emulsified Asphalt of the type designated by the Engineer and conforming to 00480.10. Apply Emulsified Asphalt at a rate of 0.05 to 0.10 gallons per square yard of curb. Place the new curb on the Emulsified Asphalt after the asphalt separates from the water (breaks), but before it loses its tackiness.

00480.42 Commercial Grade Concrete Curbs:

(a) Placing and Finishing - Feed concrete into the extruding machine at a uniform rate and operate the machine under sufficient uniform restraint to forward motion to produce a well compacted mass of concrete. Perform finishing Work as required to present a smooth, dense surface.

Remove and replace honeycombed sections. Repair of honeycombed and other defective sections by plastering will not be allowed.

(b) Transverse Expansion Joints - Space expansion joints as shown. The width of the joint and thickness of the filler shall not be less than 1/2 inch. Construct each expansion joint at right angles to the curb alignment, normal to the surface of the curb and provide complete separation of new concrete.

Firmly support the adjacent portions of the curb with close fitting shields if expansion joints are sawed before the concrete has hardened.

Mortar the joint filler in place if sawing is performed after the concrete has hardened.

(c) Transverse Contraction Joints - Space contraction joints as shown. Form the joints by grooving, by inserting and removing plates or other devices, by inserting and leaving in place preformed expansion joint fillers or by other approved means.

Make joints no wider than 1/4 inch, and deep enough so that at least one-third of the cross-sectional area of the curb is severed. Tool the edges of joints. Clean unfilled grooves and fill with joint filler flush with the surface of the concrete.

(d) Curing - Begin curing curbs immediately after completing machine or hand finishing of the fresh concrete, according to 00440.40(e).

00480.43 Asphalt Concrete Curbs - Construct asphalt concrete curbs by the mechanical extrusion method. Produce a well compacted mass of asphalt concrete with a uniform texture finish.

00480.44 Line and Grade - Place a 12-foot straightedge on the top or face of curb. The curb surface shall not vary more than 1/4 inch from the edge of the straightedge, except at grade changes or curves.

Measurement

00480.80 Measurement - The quantities of drainage curbs will be measured on the length basis, for each continuous run measured along the line and grade of the curb.

Payment

00480.90 Payment - The accepted quantities of drainage curbs will be paid for at the Contract unit price, per foot, for the item "Drainage Curbs".

Payment will be payment in full for furnishing and placing all Materials, and for furnishing all Equipment, labor, and Incidentals necessary to complete the Work as specified.

Section 00490 - Work on Existing Sewers and Structures

Description

00490.00 Scope - This Work consists of joining new Work to existing work, repairing or abandoning of sewer lines and Structures, and adjusting existing manholes, inlets, boxes and other similar Structures. Remove and dispose of pipe, manholes and catch basins that are scheduled for removal according to Section 00310.

00490.01 Descriptive Terms:

Adjust - To raise, lower or reconstruct Structures to a new top elevation flush with the surrounding surface.

Box - Valve box, meter box, monument box or other similar Structure with a removable cover.

Bypass Pumping - The process of pumping sanitary sewer or storm flows around a manhole or pipeline during the construction or rehabilitation of those facilities.

Inlet - Structure designed to receive surface water through a grate or orifice and to discharge water through pipes.

Manhole - Manhole or similar Structure designed to permit entry and working space, usually at intersections of sewer pipes.

Manhole Neck - The upper portion of a manhole, having vertical walls and a uniform diameter or dimension just sufficient to receive and support the metal frame.

Pipe Repair – The excavation and replacement of a segment of pipe, whether jointed or unjointed, that is under six foot in length.

Materials

00490.10 Materials - Furnish Materials of either existing materials in a condition suitable for reuse and meeting current design, or new Materials meeting the following requirements:

Commercial Grade Concrete.....	00440
<u>Sanitary, Storm Pipe</u>	<u>00445</u>
Joint Materials	02440.40, <u>02080.20</u> 02440.50, 02440.60
Metal Frames, Covers, Grates, and Steps	02450.30
Precast Concrete Sections.....	02450
Reinforcement.....	02510.10

00490.11 High Early Strength Concrete - Furnish high early strength concrete meeting the requirements of Commercial Grade Concrete, except it shall contain a minimum of 705 pounds per cubic yard of Type III or Type IIIA cement or an approved Type C or Type E admixture with a minimum of 592 pounds per cubic yard of Type I or Type II cement.

00490.12 Manhole Connections - PVC pipe shall be connected to sanitary manholes using an approved adapter specifically manufactured for the intended service. PVC pipe adapters shall be Fernco CMA, Romac LCT, Tylox Manhole Adapters, Vassally Series 32850, Kor-N-Seal, Sealtite, Z-Lok-XP, or approved equal. Use non-epoxy, non-shrink grout according to 02080.20. Field-fabricated water stops or improvised adapters shall not be used for sanitary manholes.

0490.13 Pipe Connections - For connecting dissimilar pipe materials, use a stainless steel shielded flexible transition coupling. Furnish couplings with one piece bushings, 300 series stainless steel shear bands with minimum thickness of 0.012 inches, and 316 stainless steel clamps with nut and bolt take up.

When connecting new sewer pipe to existing sewer pipe of similar material, use solid slip couplers.

00490.14 Tapping Tees - For external Service Lateral Connections furnish an Inserta Tee three-piece lateral connection or approved equal. No tapping tee will be accepted if the hub protrudes greater than 1/4 inch into the liner or the hub is rotated more than 45 degrees.

00490.15 Saddle Tees – Furnish GPK Saddle Tee G molded skirt x SDR 26 HWS G Branch, or approved equal.

Construction

00490.40 General - Excavate and backfill according to Section 00405. Remove and dispose of old concrete and other materials according to Section 00310.

Obtain approval before reusing salvaged metal frames, covers, grates and fittings on Structures to be adjusted.

~~When concrete is poured around frames, paint the portion of the frame that will contact the concrete with hot asphalt before the concrete is poured.~~

Provide high early strength concrete when shown on the Plans, or when traffic is required to traverse the Structure due to staging requirements. The Engineer will determine the length of curing time. If the contractor uses steel plates to protect the concrete, steel plating shall be in accordance with 00220.40(e)00225.02 and 00405.46(e).

New construction shall conform to Section 00470.

Repair, replace or restore to existing condition any manhole or similar structure backfill, inlet base drain, Aggregate Base or Pavement disturbed or fouled by the adjustment Work as directed.

Install pipe and test pipe repairs according to Section 00445. Place, compact and prepare pipe bedding immediately prior to performing repair. Replace damaged pipe section using rigid or flexible pipe as directed.

Furnish and install temporary plugs according to Section 00280, or other approved sediment barrier, for the inlets and outlets to structures before adjusting or repairing. If the structure has active flow, follow bypass pumping requirements. Prevent sediment, rock and construction-related debris from entering the sewer system during the work. Prior to removing the temporary barrier, vacuum out liquids and debris from the structure and structure sump. Dispose of waste materials (liquids and solids) according to 00290.

Bypass pump sanitary sewer and stormwater flows around the pipe section or manhole being repaired or replaced by plugging an existing upstream manhole and pumping the flow around the Work to a downstream manhole. Submit a bypass pumping plan to the Engineer at least 48 hours before beginning bypass pumping. Use a pump with adequate capacity to handle existing flows and additional flow due to rain. Pumps shall not exceed a noise level of 86 dB at a distance of 50 feet. Do not operate bypass pumps at night except in an emergency. Do not discharge raw sewage onto private property or city streets, or into storm drain systems.

00490.41 Manholes over Existing Sewers:

(a) General - Construct manholes according to Section 00470. Test all sanitary sewer manholes according to Section 00470.

Prevent material or debris from entering the line.

When required, provide all diversion facilities and perform all Work necessary to maintain flow in existing lines. Obtain the Engineer's approval prior to diverting flows.

(b) Manholes over Existing Rigid Pipe Sewers - Construction of manholes over Existing Rigid Pipe Sewers is not allowed. Construct manholes according to Section 00470 when installation of a new manhole over existing rigid sewer is required. Construct manholes over existing rigid sewers after first cleaning and applying an approved commercial concrete bonding agent to all surfaces of the pipe that will be in contact with the manhole.

If the top of the existing rigid pipe is to be cut out, cut it to the springline for the full width of the manhole. Smooth and point the exposed edge of pipe with mortar.

Make rigid sewer pipe connections using an acceptable pipe connection according to Section 00470.

(c) Manholes over Existing Flexible Pipe Sewers - Construct manholes over existing flexible sewers systems with approved water stops, watertight fittings or boots at connections with the existing flexible sewer.

If approved, manholes may be constructed over existing PVC sewers and sealed at the manhole wall using the following method:

- Apply a coating of PVC solvent to the pipe that will be in contact with the manhole.
- Apply a dense coating of clean mortar sand over the PVC solvent cement.
- After the cement has cured, apply a commercial concrete bonding agent to the sand prior to placement of concrete.

(d) Manhole Connections - Core or sawcut openings in the existing manhole base or barrel as required. Construct connections that are watertight and that will provide a smooth flow into and through the manhole. All ~~sanitary sewer~~ pipe connections, including those at invert level as well as penetrations for drop connectors, conduits and carry-throughs, shall conform to the requirements of Section 00470.

00490.42 ~~Service Line Lateral~~ Connections to Existing Sanitary Sewers - ~~Make connections of service lines~~ to existing sewers watertight. Make connections, where possible, to existing tees or wyes that have been previously installed and plugged. Remove the plug and make the connection according to Section 00445. Make transition couplings between dissimilar pipe materials using approved commercial adapters with ~~stainless steel bands~~ according to 00490.13.

Where tees or wyes for connection are absent or unusable, connect ~~service lines~~ as noted below:

<u>Existing Sewer</u>	<u>Lateral is equal to 1/2 the Diameter or Smaller than Sewer Main</u>	<u>Lateral is Larger than 1/2 Diameter of Sewer Main</u>
<u>Rigid Pipe</u>	<u>Manufactured wye or tee, Tapping Tee</u>	<u>Manufactured wye or tee</u>
<u>Flexible Pipe or CIPP</u>	<u>Manufactured wye or tee, Tapping Tee</u>	<u>Manufactured wye or tee, Saddle Tee</u>

- Manufactured wye or tee – Remove a section of the existing sewer. Connect the manufactured wye or tee using approved commercial adapters according to 00490.13.
- Tapping Tee – Install tapping tees by coring without damage to the existing sewer. Support the sewer and replace bedding material, as necessary, to prevent settlement of the sewer grade.

CIPP- Remove a portion of the Host Pipe to expose the CIPP liner. Install tapping tees on CIPP into the hole cut for internal reinstatement. If no hole was cut for internal reinstatement, install the new tapping tee 12 inches upstream or downstream of the existing lateral connection. Bed the tapping tee with a single 60 pound bag of dry ready mix concrete.

- Saddle Tee - Glue epoxy saddle connection type connections to the existing sewer using IPS 810 Weld-On two part epoxy or approved equal. Secure the saddle to the sewer pipe with two stainless steel straps. Allow the epoxy to set before backfilling the connections.

CIPP - Remove a portion of the Host Pipe to expose the CIPP liner. Glue epoxy saddle connection type connections to the CIPP liner using IPS 810 Weld-On two part epoxy or approved equal. Secure the saddle to the sewer pipe with two stainless steel straps. Allow the epoxy to set before backfilling the connections.

~~with approved commercial taps.~~ Do not backfill any tap until it is inspected and approved by the Engineer.

Install taps by coring without protrusion into, or damage to, the existing sewer. Support the sewer and replace bedding material, as necessary, to prevent settlement of the sewer grade.

00490.43 Abandoning Pipe in Place - ~~Drain abandoned pipes and plug watertight.~~ Plug all open ends of abandoned pipes with gasketed mechanical plugs or grout seals, as directed. Where abandoned pipes connect to sewer manholes, install the plugs or seals from the inside of the manhole and reshape the channel to conform to the Standard Drawings.

~~Fill abandoned pipes greater than 12 inches diameter with sand, controlled low-strength material meeting the requirements of 00442, or other approved material.~~

Plug abandoned lateral connections within 2 feet of the sewer main. Do not backfill any abandoned lateral connection until it is inspected and approved by the Engineer.

00490.44 Filling Abandoned Pipes, Manholes and Catch Basins - Cap or plug all connecting pipes to manholes and catch basins that are scheduled to be abandoned. Remove the manhole cone or flat top and manhole sections, or the catch basin frame, to a minimum depth of 3 feet below finish grade and fill the remaining manhole barrel or catch basin with Granular Material meeting the requirements of Section 02630. Compact the Granular Material to 90 percent of maximum density according to AASHTO T 99. When in landscaped or unimproved roadway sections, backfill with approved materials meeting the requirements of 00330.13. Place Topsoil meeting the requirements of 00330.11 for the last 1 foot of backfill.

Fill abandoned pipes greater than 12 inches diameter with sand or, controlled low-strength material meeting the requirements of 00442, or other approved material.

00490.45 Salvaging Manhole Frames, Covers and Grates - Remove manhole frames, covers and grates scheduled for salvage and store in an approved location. Frames, grates and covers meeting Specifications may be salvaged from Structures to be adjusted and may be reused in the Work if of suitable size and condition. Replace, at no additional cost to the Agency, all items damaged or lost by the Contractor with similar items that are comparable in all respects with those they are to replace, and which are adequate for the intended purpose.

Clean salvaged components to be reused of foreign material by methods that will not harm the components.

00490.46 Adjusting Manholes: Adjust manholes to final surface grade

~~(a) **Metal Steps** — Metal steps are not allowed. If existing manholes or similar Structures have metal steps, provide new steps in the adjusted Structure, in kind. Construct according to the Standard Drawings.~~

(b) Concrete and Masonry Manholes - Manholes may be raised or lowered as specified below or as shown.

- (1) Minor adjustments of manholes are those that require adding or removing precast grade rings or metal rings as approved.
- (2) Major adjustments of manholes are those that infringe into the cone or flat top section. Remove the cone or flat top, add or remove sections, and replace the cone or flat top. Use risers to attain desired grade.

Precast sections removed in the adjusting Work may be reused in other adjusting Work or in new construction provided they are in good condition and otherwise conform to the Specifications. Dispose of precast items, not reused on the Project, according to 00290.20.

(c) Raising Tops of Manholes - For manhole adjustments in new asphalt concrete paving, raise the manholes to finished grade following final paving. The top of the manhole may be raised by the use of riser rings or by reconstructing the neck. Fabricated metal rings and plates may be furnished and used in the adjustment Work, if approved by the Engineer, and provided that:

- The metal and its fabrication provide at least the strength and support required for covers or grates.
- Uniform bearing of bearing surfaces is assured.
- Positive safeguards are made against displacement when in service.

Do not exceed 24 inches total distance from the top of the metal frame at its new adjusted grade to the top of the cone. Riser rings and repairs shall conform with the requirements of Section 00470. Extend manhole barrels of brick, block or concrete in kind.

(1) Concrete Manholes - Reconstruct the neck of the manhole as follows:

- Remove existing frames, covers and grates.
- Chip away the exposed top surface on which new mortar or concrete is to be placed, to a depth of 1 1/2 inches or until firm concrete is exposed.
- Clean the new surface by brushing, and moisten with water at the time of placing new concrete.
- Place new concrete to the required grade and cure at least 3 days when using Commercial Grade Concrete, and as directed when using high early strength concrete.
- Seat the frame in fresh mortar and bring to the proper grade.

(2) Masonry Manholes - Reconstruct masonry manholes of bricks or concrete blocks as follows:

- Raise with new bricks, blocks, precast components, mortar or combinations thereof, or with concrete, as conditions warrant.
- Do not place mortar for building up existing masonry to a depth of more than 3 inches.
- Do not place concrete to a depth of less than 3 inches.
- To conform to these requirements, cut down as necessary the existing shells or walls of Structures to be adjusted to provide space for the new construction.

(d) Lowering Tops of Manholes (Minor Adjustment) - When the adjustment does not require removal of the cone or flat top, proceed as follows:

- Expose the top of the Structure to the required depth.
- Cut off or remove elements of the Structure to an elevation below that established for the bottom of the metal frame or cover.
- Build up with mortar, concrete, brick or concrete blocks to the required elevation.
- Join new material to old as specified in above under (a) through (c).

(e) Metal Manholes - Adjust metal manholes to grade by resetting the entire Structure on a firm foundation, by adding extensions of like design and material, or by severing the barrel in an acceptable manner. Dispose of salvaged Structures, not reused on the Project, according to 00290.20.

00490.47 Adjusting Catch Basins and Inlets:**(a) Cast-in-Place Concrete Catch Basins and Inlets:**

- After existing frames and grates or covers have been removed, chip away the exposed top surface to expose firm concrete. Provide at least 1 inch clearance below the frame to be placed.
- Clean the new surface by brushing and moistening with water at the time of placing new concrete.
- Provide the necessary forms to maintain existing Structure dimensions in the new Work.
- Place new concrete according to Section 00440 to the required grades. The frame may either be preset in the form or placed in the fresh concrete to the required grades.
- Finish the concrete top surfaces as required to match the grades required.
- Grout existing and new inside surfaces as required to attain a uniform surface transition.

(b) Precast Concrete Catch Basins and Inlets - The entire precast Structure may be reset to a new grade when the nature of the Structure and conditions permit.

Precast concrete sections may be added or removed as required to obtain proper grade.

Precast Structures may be raised by using precast sections provided that:

- The material conforms to the general requirements of the existing Structure.
- Sections are set and joined to each other and to existing sections.
- Uniform bearing of bearing surfaces is assured.
- Positive safeguards are made against displacement when in service.

(c) Catch Basin and Inlet Connections - Adjust as follows:

- Place connecting pipe at the required line and grade.
- Set the connecting pipe through the full thickness of the wall flush with the inner face of the wall.
- Connect to the Structure with a watertight joint.

(d) Capping Concrete Structures - Permanently close openings in concrete inlets, boxes, and Structures as shown and by:

- Removing existing frame and grate.
- Chipping away existing concrete to an elevation below finished grade.
- Reconstructing Structure to accept reinforced concrete cap.
- Installing cap on existing inlet, box, or Structure.

00490.48 Adjusting Boxes, Cleanout Lids and Similar Structures - Raise or lower boxes, lids and similar Structures by one of the following methods:

- Resetting the entire Structure on a firm foundation.
- Adding extensions of like material below the original Structure if raising the Structure to a point where it would not enclose or protect its contents.
- Placing precast box extensions, or cast-in-place concrete.
- Complete replacement of the Structure with a new Structure of adequate design approved by the Engineer.

00490.49 Finish Grade - Center a 12-foot straightedge, as nearly as practicable, over the center of the cover of manholes and boxes. The final grade of the Pavement surface and adjusted manholes and boxes shall not vary more than 1/4 inch from the finish grade and Cross Section at any point along the straightedge.

00490.50 Cleanouts on Existing Service Laterals - Using electronic locating equipment, mark the existing Service Lateral within the public Right-of-Way. Excavate, remove and replace a portion of the Service Lateral within and near the public Right of Way boundary with approved cleanout. Construct the riser to finished grade and install mechanical plug. Install frame and cover and construct a concrete apron. Connect Service Laterals and Service Lines to the cleanout.

If the existing Service Line is smaller than 6 inches, use a rigid reducer fitting to transition between the pipe and the cleanout. Use rigid couplers for connecting to all existing Service Lines, or adjustable repair couplers according to 00490.13 for clay or concrete pipe.

Measurement

00490.80 Measurement - The quantities of adjusted and reconstructed manholes inlets, boxes, and other similar Structures will be measured on the unit basis.

The quantities of manholes over existing sewers, connections to existing Structures, filling abandoned Structures, and capping existing concrete Structures will be measured on the unit basis.

The quantities of Pipe Repairs will be measured on a unit basis and includes excavation, regardless of method or depth. Quantities of pipe, fittings and couplers used in Pipe Repairs are incidental.

The quantities of Cleanouts on Existing Sewer Laterals, and Lateral Connections to Existing Sewers will be measured on the unit basis.

The quantities of Filling Abandoned Pipes will be measured according to 00445.80(a).

Payment

00490.90 Payment - The accepted quantities of Work performed under this Section will be paid for at the Contract unit price, per unit of measurement, for the following items:

Pay Item	Unit of Measurement
(a) Minor Adjustment Of Manholes.....	Each
(b) Major Adjustment Of Manholes.....	Each
(c) Adjusting Inlets.....	Each
(d) Adjusting Boxes	Each
(e) Adjusting Catch Basins	Each
(f) Extra for Manholes Over Existing Sewers.....	Each
(g) Connection To Existing Structures.....	Each
(h) Filling Abandoned Structures	Each
(i) _____ inch _____ Pipe Repairs.....	Each
(ij) Capping Existing Concrete Structures	Each
(k) Cleanouts on Existing Sewer Laterals.....	Each
(l) Abandon Pipes in Place.....	Each
(m) Lateral Connections to Existing Sewers	Each
(n) Connection to Existing Pipe	Each
(o) Filling Abandoned Pipes.....	FT

Item (a) applies to manholes adjusted by adding or removing precast or metal grade rings.

Item (b) applies to manholes adjusted by:

- removing and reconstructing part or all of the cone or flat top
- removing and replacing the entire cone or flat top
- adding precast risers below the cone of precast manholes

Item (f) includes all extra or additional costs associated with installing the manholes over existing sewers. These costs are in addition to those which are included in payment for the manholes.

Manholes will be paid for according to 00470.90.

Item (h) applies to filling ~~abandoned pipes~~, manholes, inlets, boxes and other similar Structures.

In item (i) the nominal pipe diameter, pipe material and type of sewer will be inserted in the blanks.

Item (i) includes all work required to access and repair the pipe as shown, including, but not limited to, earthwork, connecting pipe to existing structures, connecting pipe to existing pipes, flow diversion, by-pass pumping, bedding, backfill and compaction.

Item (k) includes excavation, bedding, backfill, compaction, fittings, couplers, plugs, PVC pipe and concrete apron as required.

Unless a specific Pay Item in the form of item (n) appears in the Contract Schedule of Items, no separate or additional payment will be made for pipe connections.

Payment will be payment in full for furnishing and placing all Materials, and for furnishing all Equipment, labor, and Incidentals necessary to complete the Work as specified.

00490

No separate or additional payment will be made for:

- earthwork
- backfill
- protective coatings
- replacement of manhole or similar structure backfill
- base drains
- Aggregate bases
- Pavements
- connections
- Structure abandonment
- removing and disposing of existing Structures and pipe
- bypass pumping

Section 00495 - Trench Resurfacing

Description

00495.00 Scope - This Work consists of resurfacing pipe trenches, including replacement of Pavement, curbs, sidewalks, Rock Surfacing, Topsoil, landscaping and other features removed or damaged during pipe trenching operations for pipes, conduit, vaults, junction boxes, manholes, catch basins, curb inlets and other subsurface installations.

Materials

00495.10 Materials - Furnish trench resurfacing Materials that either match existing material removed from ~~pipe~~ trenches, or new Materials meeting the following requirements:

Aggregate.....	00641
<u>Commercial Asphalt Concrete Pavement (CACP).</u>	<u>00740</u>
Asphalt Concrete Pavement (ACP)	00744 and 00745
Concrete Paving.....	00756
Concrete Sidewalks, Curbs, and Driveway	00759
Emulsified Asphalt Concrete (EAC).....	00735
Emulsified Asphalt Prime Coat	00705
Emulsified Asphalt Surfacing.....	00710
Emulsified Asphalt Tack Coat	00730
Rock Surfacing	00641
Topsoil, Planting, and Seeding.....	<u>01030 and 01040</u>

Furnish sand used for edge sealing that is clean sand with no visible sign of silts or organic materials.

Construction

00495.40 General - The following construction requirements are for resurfacing trenches in various locations. Refer to Section 00405 for trench surface removal requirements.

(a) Asphalt Concrete Paving - Place ACP according to Sections 00744, ~~and 00745,~~ as applicable.

(b) Temporary Emulsified Asphalt Concrete Paving - When temporary Surfacing is required prior to placing permanent Surfacing, place CACPEAC paving a minimum of 24 inches thick. The temporary paving shall be smooth with surface variations not greater than 1/2 inch from the Existing Surfacing. Where the temporary patch adjoins existing surfaces the joint shall not be greater than 1/4 inch high. Maintain the temporary Surfacing until the permanent Surfacing is placed. ACP mix may be used if approved.

(c) Emulsified Asphalt Prime Coat - Construct Emulsified Asphalt prime coat according to Section 00705.

(d) Emulsified Asphalt Surfacing - Construct Emulsified Asphalt Surfacing treatment according to Section 00710.

(e) Edge Sealing Tack Coat Application - Tack the vertical face of the asphalt pavement joints and adjoining structures to be paved against prior to placing pavement according to 00744.42. Seal and sand asphalt pavement joints according to 00744.15 and 00744.50(a). Seal all adjoining asphalt concrete Pavement surfaces with an edge sealing tack coat. Place sufficient tack coat to seal the adjoining surfaces. After the tack coat has been placed, place clean sand over the tack

~~coat. Reapply additional tack coat and sand cover to any edges that are not completely sealed in the first application.~~

(f) Aggregate Base - Place Aggregate Base according to Section 00641.

(g) Concrete Sidewalk, Curb and Driveway - Construct concrete sidewalk, curbs and driveways according to Section 00759. Sidewalks and driveways shall be removed and replaced in complete panels to the joint lines. Areas damaged by the Contractor's operations shall be removed and replaced as directed by the Engineer.

(h) Concrete Paving - Construct concrete paving according to Section ~~00756~~00758.

(i) Rock Surfacing - Construct Rock Surfacing according to Section 00641.

(j) Topsoil - Place Topsoil according to Sections 00405 and 01040.

(k) Landscaping - Place landscaping according to the requirements of Section 01040.

(l) Seeding and Mulch - Place seeding and mulch according to Sections 01030.

Measurement

00495.80 Measurement - The quantities of trench resurfacing will be measured on the area basis. The length will be measured horizontally along the centerline of the installed pipe from edge to edge of the surface replaced. The width will be the nominal inside diameter of the pipe plus:

- ~~4820~~ inches for pipes less than 1542 inches in diameter
- ~~5624~~ inches for pipes ~~1842~~ inches and 2145 inches in diameter
- ~~6032~~ inches for pipes 2448 inches and 3624 inches in diameter
- ~~36~~ inches for pipes ~~24~~ inches and ~~30~~ inches in diameter
- 7248 inches for pipes between 36 inches and 72 inches, inclusive

When the pipe is installed under Pavement by tunneling, boring, or jacking methods, the Work will be measured according to 00406.80.

Payment

00495.90 Payment - The accepted quantities of trench resurfacing will be paid at the Contract unit price, per square yard, for the item "Trench Resurfacing".

Payment will be payment in full for furnishing and placing all Materials, and for furnishing all Equipment, labor, and Incidentals necessary to complete the Work as specified.

No separate or additional payment will be made for replacement of disturbed landscape items.

When the pipe is installed under Pavement by tunneling, jacking, or boring methods, the Work will be paid for according to 00406.90.

When the Contract Schedule of Items does not indicate payment for trench resurfacing or other Work under this Section, no separate or additional payment will be made. Payment will be included in payment made for the appropriate items under which this Work is required.