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SECTION 200 - EARTHWORK

SECTION 200 – EXCAVATION

200.01 – DESCRIPTION

This section covers work consisting of excavation, disposal or compaction of all material not being removed under other items which are encountered within the limits of the work necessary for the construction of the project in accordance with these specifications and in conformity with the lines, grades and cross sections shown on the plans or established by the Engineer. All excavation will be classified as "unclassified excavation", "excess excavation" or "unsuitable material excavation" as hereafter described. Before beginning any excavation or embankment, the provisions of Section 200 shall be satisfied.

200.02 – MATERIALS

A) **UNCLASSIFIED EXCAVATION** shall consist of all the work as described herein which is necessary for the preparation and construction of the project, embankments, subgrade, shoulders, parking, curb trenches, drainage ditches, channels, cross street and alley approaches, sidewalks, driveways, private entrances, etc. Unclassified excavation shall include the removal and satisfactory disposal of all trees, brush, stumps, posts, fences, weeds, rock, concrete, existing pavement, gravel or macadam, sidewalks, curbs, pipes, culverts, sewer manholes and inlets where required, and all other structures, materials or debris; the stripping and removing of the top soil or sod to be piled separately from other materials and later restored to its original place when backfilling is completed; the completion of all necessary backfilling, tamping, compacting, and refilling; the restoring of all streets, alleys, right-of-ways or other lands, either public or private, damaged or occupied by the Contractor in the performance of the contract, to as good of condition as they were prior to the beginning of the work.

B) **EXCESS EXCAVATION** shall consist of all excavation not designated for embankment or stockpiling on the project and is to be removed from the limits of the project.

C) **UNSUITABLE MATERIAL EXCAVATION** consists of the removal and disposal of soft, spongy material below the finished grade, either saturated or unsaturated which will not be suitable for foundation material regardless of moisture content, extending downward to firm earth. The Contractor shall not begin backfill operations until cross section of the excavation has been determined and approved by the Engineer.

200.03 – EQUIPMENT

Excavating and grading equipment shall be approved types and designs, and shall be maintained in first class condition. Equipment used for disposing of excavated materials outside of the limits of the work shall be such as will avoid scattering or wasting material along the line of haul. The Contractor shall immediately clean up all material wasted or scattered.

200.04 – CONSTRUCTION METHODS

200.04.01 – GENERAL

All grass or weeds or other vegetation shall be cut and properly disposed of in a satisfactory manner before the ground is broken for grading and excavation. All existing structures, such as manholes and sewer inlets, which are to remain in place shall be adjusted or rebuilt and care shall be taken not to damage existing structures during grading or construction operations.

After the site of the work has been properly cleared and cleaned, excavation and grading of the

roadway shall proceed in conformity with the plans and the specifications.

Rock, boulders or existing structures which are abandoned, shall be removed to a depth of not less than twelve inches (12") below the subgrade elevation. Soft, spongy or other unsuitable material shall be removed to such a depth as may be necessary to permit the preparation of an acceptable subgrade. The determination of unsuitable material shall be made by the Engineer. All excavation below subgrade elevation shall be backfilled with approved select materials, placed in layers not exceeding nine inches (9") in thickness (loose measure). These layers shall be rolled or tamped, or both, to a density of ninety-five percent (95%) Standard Proctor at ±2% of optimum moisture content. (Per ASTM D698-00a)

This item will be used if unstable soil is encountered which cannot be stabilized by conventional dewatering operations. The trench shall be excavated to a depth not to exceed 2-1/2 feet below the pipe flowline until that depth or stable soil is reached. The area excavated will then be filled with crushed rock meeting either ASTM No. 57 gradation or the gradation of rock used for the underdrain cover aggregate.

Payment will be by the cubic yard, which shall include both excavation and fill material. The Contractor and City Engineer will agree each day on the depth and linear feet of unsuitable material. Quantities will be computed based on the specified trench width as shown on the typical section.

Care shall be taken not to disturb the ground below the required finish subgrade elevation except for necessary structures, and where provision is made for uniformly scarifying or loosening the ground below subgrade. Excavation outside the curb lines, or beyond the slab edges shall not be made wider than necessary for the setting of the forms or string lines. The finish grade, slopes and edges of the excavation on all parking, cross street or private driveway approaches, etc., shall be backfilled where necessary, using approved material thoroughly compacted in layers and dressed off uniformly in a neat and workmanlike manner. Slab edges shall be backfilled for a width of not less than two feet (2') measured at the level of the top of slab. Ample provision will be made at all times for completely and readily draining the subgrade and all excavations.

200.04.02 – STRUCTURES REMOVED AND SURPLUS EXCAVATED MATERIALS

All structures removed and surplus excavated materials are the property of the City. In general, all manhole frames and covers, sewer inlet frames and gratings, and all pipes, culverts, etc., salvaged from the work shall be hauled to and stored at the City facility designated in special provisions and approved by the Engineer. Gravel or Macadam surfacing material shall, as nearly as practicable, be removed separately from earth or other excavated materials, and when desired by the City for use on other streets, alleys, etc., shall be disposed of on sites designated or selected by the Engineer. In selecting locations for the disposal of surplus excavated materials the requirements for filling abutting or adjacent property shall be given priority in the order named. The disposal of all excavated materials other than as specifically mentioned above, shall be at the sites approved by the Engineer.

200.06 – METHOD OF MEASUREMENT

The quantities of unclassified excavation for which payment will be made shall be the quantities shown on the plans, provided the project is constructed essentially to the lines and grades shown on the plans.

When the plans have been altered, the quantities involved shall be measured from the original plan cross sections. Additional original cross sections may be interpolated or determined by other approved methods at points where necessary to more accurately determine the quantities. When quantity is not specified by the plans, all accepted excavation and borrow shall be measured in its original position by cross sectioning the area excavated. Volume will be computed from the cross section measurements by the average end area method, or other approved methods.

The Contractor and City Engineer will agree each day on the depth and linear feet of unsuitable material. Quantities will be computed based on the specified trench width as shown on the typical section. Unsuitable material Excavation will be measure the material removed. Replacement material will be measured and paid by the item used to replace the unsuitable material.

200.07 – BASIS OF PAYMENT

Excavation will be paid for at the contract/unit price for the items classified for payment for:

UNCLASSIFIED EXCAVATION	C.Y.
UNSUITABLE MATERIAL EXCAVATION	C.Y.
EXCESS EXCAVATION	C.Y.

which shall be full compensation for all items of work specified and, for which no separate unit prices are included in the contract, including all labor, materials, tools, equipment and incidentals necessary to complete the work in accordance with the plans and specifications.

SECTION 201 – EMBANKMENT

201.01 – DESCRIPTION

This section will cover construction of roadway embankments, including preparation of the areas upon which they are to be placed; the construction of dikes within or outside the right-of-way; the placing and compacting of approved material within roadway areas where unsuitable material has been removed; and the placing and compacting of embankment material in holes, pits and other depressions within the roadway area, in accordance with these specifications and in conformity with the lines, grades, thicknesses and typical cross sections shown on the plans or established by the Engineer. Only approved materials shall be used in the construction of embankments and backfills.

201.04 – CONSTRUCTION METHODS

All grass, weeds, trees, stumps and existing structures shall be removed in a satisfactory manner from the entire area to be occupied by the embankment. All embankments shall be formed of good sound earth, gravel or other acceptable materials, and shall be built to sufficient heights and width that after full shrinkage, will conform to the lines, grades and cross sections shown on the plans, or called for in these specifications. Rocks may be placed in embankment provided they are not placed in piles, and provided no rock larger than three inches (3”) is placed nearer the finish grade than twelve inches (12”). No sticks, weeds, trash or other vegetable matter, nor any other unsuitable materials shall be placed in embankments. Embankments shall not be constructed on or of frozen material.

All excess or unsuitable excavated material, including rock and boulders larger than eight inches (8”) in the largest dimension, that cannot be used in embankments shall become the property of the Contractor and disposed of by him to the satisfaction of the Engineer.

Embankments constructed of material of which a large portion is rock of such a nature that, in the opinion of the Engineer, construction in nine inch (9”) layers is not feasible shall be constructed in layers the depth of which shall not exceed the maximum size of the rock present in the material, and in no case shall the thickness of the layer exceed twenty-four inches (24”). End dumping will be required. The rock shall be dumped near the end of the existing lift and pushed over the end. Compactive effort on the rock and rocky material shall consist of making multiple coverings of each layer with a tamping type roller or with a vibratory roller as approved by the Engineer. Each layer shall be leveled and smoothed with suitable leveling equipment and by distribution of spalls and finer fragments of earth. The top twelve inches (12”) of embankment shall be constructed with approved materials, smoothed and placed in layers not exceeding nine inches (9”) in loose thickness and compacted as specified for embankments.

The surface layer of the roadbed shall not be wetted or compacted until final finish grade stakes have been set and all embankment material is in place. The surface layer of the entire embankment shall then be manipulated by scarifying and the moisture corrected as specified for embankments, after which the entire surface layer shall be compacted to not less than 95 percent of Standard Proctor Density. (Per ASTM D698-00a)

Material in embankments shall be placed in layers not exceeding nine inches (9") in depth measured when loose, and extending the entire width and length of the embankment. Each succeeding layer shall be uniformly spread over the surface, then thoroughly compacted. Areas inaccessible to the roller shall be thoroughly hand tamped until the degree of compaction is equivalent to that of the rolled area. Hand tampers shall have a tamping surface not exceeding twenty-five square inches (25 in^2) square inches, shall weigh not less than one pound per square inch (1 psi), and shall be of a design approved by the Engineer.

If the embankment can be deposited on only one side of abutments, wing walls, piers or culvert headwalls, care shall be taken that the area immediately adjacent to the structure is not compacted to the extent that it will cause overturning of or excessive pressure against the structure.

201.06 – METHOD OF MEASUREMENT

The quantities of embankment for which payment will be made shall be the quantities shown on the plans, provided the project is constructed to the lines and grades shown on the plans.

201.07 – BASIS OF PAYMENT

Embankment will be paid for at the contract/unit price for the item classified for payment for:

Embankment C.Y.

which shall be full compensation for all items of work specified and for which no separate unit prices are included in the contract, including all labor, materials, tools, equipment and incidentals necessary to complete the work in accordance with the plans and specifications.

SECTION 202 – BORROW

202.01 – DESCRIPTION

This section covers borrow which consists of required excavation, removal, and proper utilization of materials obtained from designated or approved sources. Compaction of embankments constructed from borrow, as provided herein, shall conform to the requirements of Section 201.

202.02 – MATERIALS

Where shown on the plans, selected materials will be utilized in the formation of embankment or to improve the roadbed. Borrow material shall be suitable for the embankment purpose desired, as determined by the Engineer.

202.04 – CONSTRUCTION METHODS

All suitable materials removed from the excavation shall be used, in so far as practicable, in the formation of embankments as required by the governing item for "Embankments", or shall otherwise be utilized as indicated on the plans or as directed, and the completed work shall conform to the established alignment, grades, and cross section. During construction, the borrow sources shall be kept drained, in so far as practicable, and the work shall be prosecuted in a neat and workmanlike manner.

Payment will not be allowed for excavation for any material which is used for purposes other than those

designated, except as provided in the governing specifications under Section 108.04.

Site of the borrow operations shall be left in a suitable and sightly condition, such as to provide proper drainage where practical. Where indicated on the plans, the sides and/or ends of borrow pits shall be sloped to the dimensions indicated on the plans.

202.06 – METHOD OF MEASUREMENT

Borrow will be measured in a compacted condition in its final position and the volume computed in cubic yards by the method of average end areas.

202.07 – BASIS OF PAYMENT

Borrow will be paid for at the contract/unit price for the items classified for payment for:

BORROW C.Y.

which shall be full compensation for all items of work specified and, for which no separate unit prices are included in the contract, including all labor, materials, tools, equipment and incidentals necessary to complete the work in accordance with the plans and specifications.

SECTION 210 – TRENCH CONSTRUCTION

SECTION 211 – DEWATERING

211.01 – DESCRIPTION

This section covers dewatering of trenches, pits, and all other excavation areas. The Contractor shall provide and maintain ample equipment with which to remove all water from every source that enters excavations for structures and pipelines. Dewatering operations shall ensure dry excavations and preservation of the elevations of excavation bottoms shown on the drawings. Surface drainage shall not be allowed to enter excavated areas.

Where areas to be excavated are located under water surfaces or near banks of flowing streams or other bodies of water, the Contractor may adopt and carry out any method of dewatering he may deem feasible for the performance of excavation work and for protection of the work thereafter, provided that method and equipment to be used results in completed work which complies with the specifications and is acceptable to the Engineer. In such cases, the excavation areas shall be effectively protected from water damage during the excavation period and until all contemplated construction work therein has been completed.

Prior to beginning excavation for pipes and structures, which are to be constructed at or below the ground water table, groundwater levels shall be lowered and maintained at a level at least two feet (2') below the bottom of trench or such structures until construction and backfilling operations have been completed.

The Contractor shall be responsible for damage to structures caused by hydrostatic displacement during construction operations.

211.04 – CONSTRUCTION METHODS

211.04.01 – SUBMITTALS

When requested by the Engineer, the Contractor shall submit the following, but not limited to, for review and approval:

A) Proposed dewatering method.

B) Well and pump layout, and depth of penetration.

C) Points of discharge.

211.04.02 – METHODS

A) **Bailing, Sump or Trench Pumping** - For trench or structural excavations, and for small quantities of water, a sump or trench pump may be used to pump excess water from the low end of the excavations. When, as determined by the Engineer, soil conditions are such that dewatering may readily be accomplished by ordinary bailing and use of trench pumps, well systems shall not be used.

B) **Well Systems** - When required, the Contractor may utilize the following methods of dewatering:

1) **Deep Pumped Wells Method** - In locations where the water table is deep, pumped filtered wells may be used for lowering the water level or for controlling artesian pressures in aquifers beneath excavations.

2) **Well Points Method** - Well points are small-diameter wells with one or more slotted or screened sections of pipe attached to riser pipes that are connected through swing joints to header pipes. Where a single row of well points is not enough to lower the water level adequately, then two (2) or more rows of well points shall be used as directed by the Engineer.

3) **Vacuum Method** - Soils that are too fine-grained for gravity drainage may be dewatered by application of a vacuum to filters surrounding well points.

4) **Electroosmosis Method** - Dewatering of soils by electro osmosis may be achieved by installing a line of metal well points serving as negative electrodes to attract water and allow it to be removed by suction and a line of rods serving as cathodes.

211.06 – METHOD OF MEASUREMENT

A) Dewatering trenches using a well system shall be measured as the length of trench dewatered plus twenty feet (20') from each end well, or forty feet (40') for one well.

B) Dewatering of excavations using a well system shall be measured as the length of the perimeter of the structure such as clarifiers or basins.

C) Dewatering for pits and/or shafts excavated for construction operations such as those needed for trenchless construction methods shall be measured per length of pit along the line.

D) All dewatering performed using bailing and trench or sump pumping shall be considered incidental work and NOT be paid for directly, but shall be included in the cost of other items.

211.07 – BASIS OF PAYMENT

The items measured as provided above will be paid for at the contract unit price bid:

DEWATERING L.F.

Such payment shall be compensation in full for furnishing all materials, labor, equipment, tools and incidentals, and for performing the work in accordance with these specifications.

SECTION 212 – TRENCH EXCAVATION AND BACKFILL

212.01 – DESCRIPTION

This section covers trench excavation for pipelines and consists of excavation necessary for construction of all underground work and all appurtenant facilities, including site preparation, placement of embedment material, backfilling, and compaction of pipe trenches and around structures and disposal of waste materials, all of which shall conform to the applicable provisions of these specifications.

Trench excavation shall be made in open-cut and true to the lines and grades shown on the plans or established by the Engineer.

212.04 – CONSTRUCTION METHODS

212.04.01 – EXCAVATION IN ADVANCE OF CONSTRUCTION

The length of trench excavated approximately to grade shall not exceed one hundred-fifty feet (150') and no trench excavation whatsoever shall be made farther than three hundred feet (300') in advance of completed backfill.

212.04.02 – TRENCH WIDTHS

A) **General -** Trenches shall be excavated to a width which will provide adequate working space and sidewall clearances for proper pipe installation, joining, and embedment. Stipulated minimum trench widths are not minimum average widths, but are minimum widths that shall be required. Stipulated maximum trench widths shall not be exceeded. Trench width shall be the width of the trench excavation measured from bank to bank at the top of the pipe. For rigid pipes, when the maximum trench width is exceeded, the Contractor shall be required to provide a higher strength pipe or higher bedding classification, singly or in combination as directed by the Engineer, at the Contractor's expense. Any additional foundation material and/or embedment material required due to over-excavation, beyond the maximum trench width shall be at the Contractor's expense. Minimum and maximum permissible trench widths shall be as shown in table below.

Pipe Nominal Size (Inches)	Minimum Trench Width (Feet)	Maximum Trench Width (Feet)
? 12	3.00	5.00
16	3.25	5.00
18	3.25	5.00
21	3.75	5.25
24	4.00	6.00
30	4.50	6.75
36	5.25	9.00
42	6.25	9.50
48	7.00	10.00
54	8.00	10.50
60	9.00	11.00
64	9.75	11.50
66	9.75	11.50
72	10.50	12.00
78	10.50	12.50
84	11.00	13.00
90	11.50	13.50

B) **Trenches Requiring Sheeting and Shoring -** Where trenches are excavated in soil of such nature as to require sheeting and shoring to assure proper installation, and safety of the workmen and any adjacent structures or other objects, the Contractor shall provide the necessary sheeting and shoring. Where possible, shields designed to be portable and moved along as work progresses may be used. The contract pay widths shown in the above shall apply to all trenches with or without sheeting or shoring.

C) **Trenches With Stepped Sides -** Where the work is located in open areas, if the right-of-way is of sufficient width and soil conditions are suitable, the Contractor may at his option, upon approval of the Engineer, excavate trenches with sloping or stepped sides provided that no additional compensation

for excavation and backfilling will be allowed for work performed outside the maximum trench widths designated in the above Table.

D) T**renches at Tunnels -** Where the water line is in a tunnel, the trench excavation shall be measured to the faces of the tunnel.

E) E**xcavation for Valve Boxes and Other Waterline Structures -** When structural excavation is listed as a separate pay item, excavation for valve boxes and other waterline structures shall be computed in cubic yards using dimensions of the net prescribed area outside trench width excavation where the length of trench is measured through or partially through structures. When structural excavation is not listed as a pay item, cost shall be included in the cost of other items.

F) **Exterior forms with or without sheeting and shoring** are used, the excavation shall be computed for a width five feet (5') greater than the exterior dimension of the structure.

G) **Excavation for Trenchless Construction Methods -** Excavation shall be considered a part of the trenchless work per linear foot, and shall not be paid for separately.

Any sheeting, shoring, bracing or sheet piling left in place, in conformity with the plans and specifications or as directed by the Engineer, shall be paid for separately.

212.04.03 – PERFORMANCE REQUIREMENTS

A) **General Excavation -** Excavation shall be made in open-cut from the surface of the ground and shall be made no larger than necessary to permit proper construction of the work in accordance with the plans and specifications. The entire foundation area in the bottom of all excavations shall be firm, stable and of uniform density as nearly as practical, and unless necessary, materials shall not be disturbed below grade. Where trenches are excavated in soft, unsuitable materials, or rock, trench bottom may be stabilized in accordance with Section 200.04.01, when directed by the Engineer. Where depth of trenching and other excavations are greater than twenty feet (20'), and when not provided for in the plans, an engineer shall be retained by the Contractor to design bank protection as per OSHA rules and regulations. The bank protection design, signed and sealed by a Professional Engineer registered in the State of Oklahoma, shall be submitted to the Engineer for approval.

B) **Sheeting, Shoring, Bracing and Sheet Piling -** The sides of all excavations shall be sufficiently sheeted, shored and braced so as to prevent slides, cave-ins, settlement or movement of the banks. In wet, saturated or flowing ground where it is necessary to install tight sheeting or cofferdams, wood or steel sheet piling of approved design and type shall be used. All sheeting, shoring and bracing shall have sufficient strength and rigidity to withstand the pressures exerted and maintain the walls of the excavation properly in place and protect all persons or property from injury or damage. When excavations are made adjacent to existing buildings or other structures, or in paved streets or alleys, particular care shall be taken to adequately sheet, shore, and brace the sides of the excavation to prevent any undermining of or settlement beneath the structures or the pavement. Underpinning of adjacent structures, when necessary, shall be done in an approved manner. The foundation material that is undermined shall be replaced and compacted in accordance with the requirements of this section. Sheeting, shoring, and bracing shall not be left in place unless otherwise shown on the plans or authorized by the Engineer. The removal of sheeting, shoring and bracing shall be done in such a manner as not to endanger or damage either the new structure or any existing structure or property, either private or public, and so as to avoid cave-ins or sliding of the banks. If for any reason the Contractor, with the approval of the Engineer, leaves in place any sheeting, shoring or bracing, no payment will be allowed for such material left in place unless it is classified as a contract pay item. All holes or voids left by the removal of sheeting, shoring or bracing shall be satisfactorily filled and compacted in accordance with the requirements of this section.

C) **Pumping, Dewatering and Draining -** The Contractor shall remove immediately any surface or seepage water or water from sewers, drains, creeks, or other sources which may accumulate during the excavation and construction work by doing the necessary pumping, dewatering or draining by ditch or other means. The Contractor shall have available at all times sufficient equipment in proper working order for doing the work herein required. All water removed from excavations shall be disposed of in an approved manner so as not to create unsanitary conditions nor to cause injury to persons or damage to the work in progress or to other property, either public or private, nor to interfere unduly with the use of streets, alleys, or of private drives and entrances.

D) **Disposal of Excavated Materials -** Excavated materials, so far as needed and of a suitable character, shall be piled adjacent to the work to be used for backfilling as required. Excavated materials unsuitable for backfilling or in excess of that required for backfilling shall be disposed of in an approved manner at locations designated or approved by the Engineer. Desirable topsoil, sod, etc., shall be carefully piled separately from other excavated materials so that it can be replaced to its original position when required. Excavated materials shall be handled at all times in such a manner as to cause a minimum of inconvenience to public travel and to permit safe and convenient access to private and public property adjacent to or along the line of the work.

212.04.04 – BACKFILLING

A) **Description -** Backfill is that portion of the total trench backfill down to but not including the pipe embedment material. The backfill shall be only material approved by the Engineer consisting of loose earth, free of clods, stones, organic matter, debris or other objectionable materials.

All backfilling shall be done in such a manner as not to disturb or injure the pipe or structures over or against which it is being placed. Any pipe or structure injured, damaged or moved from its proper line or grade during backfilling operations shall be opened up and repaired and then re-backfilled as herein specified.

The placing of backfill material shall not begin until approval for so doing has been given by the Engineer, but backfilling about structures or portions of structures shall be done immediately when so ordered by the Engineer. The top surface or slopes of all backfill shall be neatly graded off where select topsoil, sod or other material is removed and piled separately; such material shall be carefully replaced in a manner satisfactory to the Engineer. The top twelve inches (12”) of backfill material shall be of as good quality as the original topsoil that was removed.

B) **Compaction Requirements -** All backfill shall be placed and compacted in six inch (6”) lifts for hand-tamped equipment and eighteen inch (18”) lifts for self-propelled or power-driven equipment to the following minimum percent of Standard Proctor Density or Relative Density as determined by ASTM D-698, "Tests for Moisture-Density Relations of Soils and Soil-Aggregate Mixtures".

Cohesive backfill material shall reach the indicated compaction levels at plus or minus (±) three percent (3%) of optimum moisture content. The lift thickness shall be reduced, if necessary, to meet the compaction requirements specified herein.

General Location	Percent Compaction (%)
	Standard Proctor Test (ASTM D-698)
Under Traffic Area or Improved Existing Surfaces	95
Urban and Residential Areas	90
Undeveloped and Other Areas	85

C) **Compaction Methods -** Compaction methods may vary depending on the material or as approved by the Engineer.

1) **Cohesive Materials** - Compaction of cohesive materials may be obtained by use of impact type equipment. In confined areas, pneumatic tampers and engine driven rammers may also

be used. In relatively narrow trenches, self-propelled rammers may be used. In wide trenches, sheepsfoot rollers may be used.

2) **Cohesionless Materials** - Cohesionless materials are granular materials classified as non-plastic. In general, vibratory equipment may be used for proper compaction. In confined areas, vibratory plates may be used. For wider trenches, vibratory rollers may be used.

3) **Flooding (Jetting)** - When approved by the Engineer, backfill materials may also be compacted or settled by flooding where adequate quantities of water are available from the City's water system, privately owned ponds, creeks or other sources located within three hundred feet (300') of the trench. Water shall be used to produce a semi-fluid mass but an excessive amount shall not be used which may cause flowing of the mass along and out of the trench at stream crossings or other places of abrupt changes in ground profile. The Contractor shall make necessary arrangements with the City for purchase of water from the City mains, and with owners for water procured from privately owned sources.

   No additional compensation shall be allowed the Contractor for settling the backfill by flooding. The cost of such work shall be absorbed in the unit bid price for trench excavation and backfill or other pay units the Contractor may elect.

D) **Testing of Backfill -** All backfill shall be tested by an approved laboratory for compliance of the compaction requirements given in these specifications.

E) **Surface Restoration -** Upon completion of backfill, the Contractor shall replace all surface materials and shall restore paving, curbing, sidewalks, gutters, shrubbery, fences, sod, and other surfaces disturbed to a condition equal to that before the work began, furnishing all labor, tools, equipment, materials and incidentals thereto as provided elsewhere in these specifications.

212.06 – METHOD OF MEASUREMENT

General Bid prices for "Trench Excavation and Backfill" and "Structural Excavation" shall be full compensation for all labor, materials, tools, equipment and incidentals necessary to complete the work in accordance with the plans and these specifications.

Trench Excavation and Backfill The Contractor shall be paid for "Trench Excavation and Backfill" on a linear foot basis for depths from zero feet (0') to ten feet (10') , zero feet (0') to fifteen feet (15') , zero feet (0') to twenty feet feet (20'), zero feet (0') to twenty-five feet (25') , and zero feet (0') to thirty feet (30') . The price established shall be full compensation for trench excavation and backfill, and shall include all necessary sheeting, shoring, bracing and incidental dewatering, pumping, draining, and disposition of any surplus excavated material not needed unless otherwise provided.

Trench, Lineal Measurement For the purpose of determining pay quantities, trenches shall be measured through valve boxes and similar structures, based on the applicable width of trench for size of waterline under consideration unless otherwise designated. Should size of waterline change at a valve or other structure, the appropriate width of trench for each size shall apply, with the consideration for the purpose of ascertaining pay quantity, that the change of size takes place at the centerline of the valve or structure.

Structural Excavation When classified as a pay item, "Structural Excavation" shall be paid for on a cubic yard basis. The price established shall be full compensation for all necessary dewatering, sheeting, shoring, excavation and backfilling and disposal of surplus material. When not classified as a pay item, it shall be included in the cost of other items.

212.07 – BASIS OF PAYMENT

The items measured as provided above will be paid for at the contract unit price bid:

TRENCH EXCAVATION AND BACKFILL – ZERO (0') TO TEN FEET (10') L.F.

TRENCH EXCAVATION AND BACKFILL – ZERO (0') TO FIFTEEN FEET(15')	L.F.
TRENCH EXCAVATION AND BACKFILL – ZERO (0') TO TWENTY FEET (20')	L.F.
TRENCH EXCAVATION AND BACKFILL – ZERO (0') TO TWENTY-FIVE FEET (25')	L.F.
TRENCH EXCAVATION AND BACKFILL – ZERO (0') TO THIRTY FEET(30')	L.F.
TRENCH LINEAL MEASUREMENT	L.F.
STRUCTURAL EXCAVATION	C.Y.

Such payment shall be compensation in full for furnishing all materials, labor, equipment, tools and incidentals, and for performing the work in accordance with these specifications. In the absence of this Pay Item in a contract, the cost shall be considered incidental and no additional compensation shall be made for this work and the cost of same shall be included in the other pay items.

SECTION 213 – CRUSHED ROCK FOUNDATION

213.01 – DESCRIPTION

This section covers proper treatment of unsuitable and soft foundation materials. A crushed stone mat shall be provided for waterline support where directed by the Engineer. Stone shall be hand or mechanically tamped to obtain a firm support.

213.02 – MATERIALS

Gravel containing rounded aggregates shall not be acceptable for this work. The aggregates for crushed rock pipe foundation shall be a uniformly graded crusher run material meeting the following gradation requirements:

Nominal Sieve Sizes	Percentage Passing
2 inch	100%
½ inch	< 30%

213.04 – CONSTRUCTION METHODS

The crushed stone mat shall be six (6") to twelve inches (12”) thick and shall be hand or mechanically tamped to obtain a firm support.

213.06 – METHOD OF MEASUREMENT

Measurement for "Crushed Rock Foundation" shall be per cubic yard or ton. The price established shall be full compensation for furnishing and placing of all materials, labor, tools, equipment, and any incidentals necessary to complete this item of work.

213.07 – BASIS OF PAYMENT

The items measured as provided above will be paid for at the contract unit price bid:

CRUSHED ROCK FOUNDATION	C.Y.
CRUSHED ROCK FOUNDATION	TON

Such payment shall be compensation in full for furnishing all materials, labor, equipment, tools and incidentals, and for performing the work in accordance with these specifications.

SECTION 214 – LEAN MIX CONCRETE FOUNDATION

214.01 – DESCRIPTION

This section covers proper treatment of unsuitable foundation materials. A concrete mat shall be used for soil stabilization as a pipe support where directed by the Engineer.

214.02 – MATERIALS

The concrete mat shall be constructed using one (1) part Portland cement to twelve (12) parts of sand mix. A six inch (6") stabilizing mat shall be prepared by blending equal proportions of concrete mix and soil. The mat shall be placed at proper elevation to permit installation.

214.04 – CONSTRUCTION METHODS

A six inch (6") stabilizing mat shall be prepared by blending equal proportions of concrete mix and soil. The mat shall be placed at proper elevation to permit installation.

214.06 – METHOD OF MEASUREMENT

The unit price for "Lean Mix Concrete Foundation" shall be based on the volume of concrete used and not the volume of the finished concrete soil mat. The price established shall be full compensation for furnishing and placing of all materials, labor, tools, equipment, and incidentals necessary to complete this item of work.

214.07 – BASIS OF PAYMENT

The items measured as provided above will be paid for at the contract unit price bid:

LEAN MIX CONCRETE FOUNDATION C.Y.

Such payment shall be compensation in full for furnishing all materials, labor, equipment, tools and incidentals, and for performing the work in accordance with these specifications.

SECTION 215 – EMBEDMENT MATERIAL

215.01 – DESCRIPTION

This section covers furnishing and placement of material for embedment of both rigid and flexible pipes. The embedment is that material to be placed from a minimum of six inches (6") below bottom of the pipe to the springline (half pipe diameter) or to a minimum of six inches (6") above top of pipe for rigid and flexible pipes, respectively. The remaining material to be placed over the embedment is considered backfill. Refer to Section 505.04.01 of these Specifications for Pipe Embedment Material requirements used in waterline construction.

215.02 – MATERIALS

General - Embedment material shall meet the requirements ASTM C-33 No. 67 and gradations shown below:

Nominal Sieve Sizes	No. 67
1 inch	100%
¾ inch	90 to 100 %
½ inch	……
3/8 inch	20 to 55%
No. 4	0 to 10%
No. 8	0 to 5%
No. 200	……

215.04 – CONSTRUCTION METHODS

Compaction Requirements - All embedment material shall be placed and compacted in six inch (6") lifts to the following minimum percent of Standard Proctor Density or Relative Density as determined by ASTM

D-698, "Tests For Moisture-Density Relations of Soil-Aggregate Mixtures.

Compaction Test	Compaction Requirement
Minimum Standard Proctor Density	95%

Compaction Methods - All embedment materials shall be compacted in accordance with the methods described in Section 212.04.04.

215.05 – TESTING

All embedment material shall be tested by an approved laboratory for compliance of compaction requirements given in Section 212. Following acceptance of compaction, the Contractor may proceed with placing remaining backfill.

215.06 – METHOD OF MEASUREMENT

The unit price for "Embedment Material" shall be based on the volume or tonnage of material used. Contractor shall submit material delivery tickets and shall be verified by the Engineer. The price established shall be full compensation for furnishing and placing of all materials, labor, tools, equipment, and incidentals necessary to complete this item of work.

215.07 – BASIS OF PAYMENT

The items measured as provided above will be paid for at the contract unit price bid:

EMBEDMENT MATERIAL	C.Y.
EMBEDMENT MATERIAL	TON

Such payment shall be compensation in full for furnishing all materials, labor, equipment, tools and incidentals, and for performing the work in accordance with these specifications. In the absence of this Pay Item in a contract, the cost shall be considered incidental and no additional compensation shall be made for this work and the cost of same shall be included in the other pay items.

SECTION 216 – CONCRETE CRADLES

216.01 – DESCRIPTION

This section covers concrete cradle, Bedding Class "A", ASCE Manual No. 60, to be constructed as called for on the plans or as directed by the Engineer. Cradle shall be constructed beneath rigid pipes, to increase load bearing capacity of pipe-soil embedment system, either plain or reinforced, in accordance with the "Standard Details for Plain and Reinforced Concrete Cradle".

216.02 – MATERIALS

Before cradle is constructed, the subgrade shall be prepared and properly shaped at the required grade. All concrete shall be placed in a dry trench. Where concrete is placed in a wet trench, the work shall be done strictly as directed or approved by the Engineer.

216.04 – CONSTRUCTION METHODS

The pipes shall be firmly bedded in the concrete to proper grade. The concrete shall be so placed as not to damage the joints or disrupt any pipes. Backfilling shall be done in a careful manner and at such time after the concrete is placed as not to damage the concrete in any way.

216.06 – METHOD OF MEASUREMENT

Payment for "Concrete Cradle" shall be made at the unit price bid per cubic yard of concrete for each type. Quantity shall be computed based on the neat lines for concrete cradle (Plain, Type I Reinforcement, or Type II Reinforcement) as shown on the plans. The price established shall be full compensation for all materials, including concrete and steel reinforcement (if required), labor, tools, equipment and incidentals necessary to complete the work.

216.07 – BASIS OF PAYMENT

The items measured as provided above will be paid for at the contract unit price bid:

CONCRETE CRADLE PLAIN	C.Y.
CONCRETE CRADLE TYPE I REINFORCEMENT	C.Y.
CONCRETE CRADLE TYPE II REINFORCEMENT	C.Y.

Such payment shall be compensation in full for furnishing all materials, labor, equipment, tools and incidentals, and for performing the work in accordance with these specifications.

SECTION 217 – CONCRETE ARCHES

217.01 – DESCRIPTION

This section covers concrete arch, Bedding Class "A", ASCE Manual No. 60, to be constructed where shown on the plans or as directed by the Engineer. Concrete arch shall be constructed over top of rigid pipes, to increase load bearing capacity of pipe-soil system, either plain or reinforced, in accordance with the "Standard Detail for Concrete Arch".

217.04 – CONSTRUCTION METHODS

Before arch is constructed, the embedment material shall be placed and compacted to the pipe springline (one-half pipe diameter) as specified elsewhere in these specifications. The top of the embedment material shall be then prepared for placement of the concrete arch. All concrete shall be placed in a dry trench. Concrete shall be so placed as not to damage the joints or disrupt any pipes. Backfilling shall be done in a careful manner and at such time after the concrete is placed as not to damage the concrete in any way.

217.06 – METHOD OF MEASUREMENT

Payment for "Concrete Arch" shall be made at the unit price bid per cubic yard of concrete for each type. Quantity shall be computed based on the neat lines for concrete arch (Plain or Type I Reinforcement, or Type II Reinforcement). The price established shall be full compensation for all materials, including concrete and steel reinforcement, labor, tools, equipment, and incidentals necessary to complete the work.

217.07 – BASIS OF PAYMENT

The items measured as provided above will be paid for at the contract unit price bid:

CONCRETE ARCHES PLAIN,	C.Y.
CONCRETE ARCHES TYPE I REINFORCEMENT	C.Y.
CONCRETE ARCHES TYPE II REINFORCEMENT	C.Y.

Such payment shall be compensation in full for furnishing all materials, labor, equipment, tools and incidentals, and for performing the work in accordance with these specifications.

SECTION 218 – EMBEDMENT PLUGS

218.01 – DESCRIPTION

This section covers construction of embedment plugs, for control of groundwater flow, where called for on the plans or as directed by the Engineer. The minimum length of embedment plugs shall be ten feet (10'), and shall extend six inches (6") below the bottom and above top of pipe. Placement and materials shall be in accordance with the Standard Detail for Embedment Plugs.

218.02 – MATERIALS

Two types of embedment plugs may be used, at the Contractor's option, as follows:

Clay Plugs - The embedment and backfill material shall be select clay material separated from excavated materials and shall be approved by the Engineer prior to placement. This material shall be free of clods, clumps, debris, organic material, and stones. All clay plug material shall be compacted to a minimum of ninety percent (90%) of Standard Proctor Density (ASTM D-698) at plus or minus (±) three percent (3%) of optimum moisture content.

Flowable Fill Plugs - Flowable fill plugs shall consist of a Portland Cement grout having a minimum twenty-eight (28) day compressive strength of five hundred pounds per square inch (500 psi).

218.07 – BASIS OF PAYMENT

The items measured as provided above will be paid for at the contract unit price bid:

EMBEDMENT PLUGS (TYPE) EA.

Such payment shall be compensation in full for furnishing all materials, labor, equipment, tools and incidentals, and for performing the work in accordance with these specifications.

SECTION 220 – BASES

SECTION 220 – SUBGRADE

220.01 – DESCRIPTION

This section will cover the compaction of earthwork by rolling or tamping or any combination of these methods in the construction of embankments in accordance with Section 201 or compaction of subgrade.

220.04 – CONSTRUCTION METHODS

After the subgrade material has been accepted by the Engineer it shall be compacted to a minimum density of ninety-five percent (95%) of ASTM D698-00a Standard Proctor Density and shall be maintained at ±2 percent of optimum moisture content during the compaction process. The degree of compaction shall be determined by Field Density tests taken as provided under "Testing", Section 220.05.

The Contractor is responsible for the condition of the subgrade until the pavement is in place and any portion which becomes damaged or unstable due to having become wetted or from freezing, or for any other reason, shall be corrected prior to the placing of the pavement. The finished surface shall conform to the cross sections shown on the plans and shall be smooth and unyielding.

When the moisture content of the subgrade soil does not fall within the required Moisture Range, the subgrade shall be reworked to bring the moisture content into compliance with the specifications.

220.05 – TESTING

A standard proctor test as prescribed in this Section will be made of each type of soil on samples of the subgrade after the street is rough graded. Testing to be performed by a laboratory approved by the City.

The maximum number of satisfactory tests ordered by the Engineer for a private development and the applicable method of test will be that shown on the schedule below:

TEST SCHEDULE

DESCRIPTION	METHOD OF TEST	QUANTITY OF ITEM REPRESENTED BY ONE TEST
A) Soil Classification		4800 S.Y. of Subgrade or Select Soil
1) Preparation Of Soil Mechanical Analysis	ASTM D-421	
2) Mechanical Analysis Of Soils		
3) Liquid Limit Of Soils	ASTM D-4318	
4) Plastic Limit And Plastic Index	ASTM D-4318	
5) Soil Classification	ASTM D-2487	
B) Standard Proctor Density	ASTM D-698	
C) Field Density		4800 S.Y. of Subgrade
1) Subgrade	ASTM D-1556 or	
2) Trench under Paving	ASTM D-2922	2400 S.Y. of Subgrade or Select
D) CBR 1 per Class of Soil	and D-3017	Soil or 400 L.F. of Trench or at any
	ASTM D-1883	transverse crossing.

A) **Standard Density** as determined by the Standard Proctor test shall be the density to which the Field Density is referred for comparison or percentage for each type of soil used in the work.

B) **Optimum Moisture Content** shall be the moisture content corresponding to the Maximum Density of the Standard Compaction curve.

C) **Field Density** shall be the density of the compacted subgrade determined by the Field Density test.

D) **Moisture Content** shall be the actual moisture content of the soil in the compacted embankment at the time of testing or at the time the grade is to be covered.

220.06 – METHOD OF MEASUREMENT

The quantities of compaction for which payment will be made shall be in the quantities shown on the plans provided the project is constructed to the lines and grades shown on the plans. Any allowance for additional quantities shall first be approved by the Engineer.

220.07 – BASIS OF PAYMENT

The amount of completed and accepted work shall be paid for at the contract unit prices bid per square yard.

SUBGRADE S.Y.

Payment shall be full compensation for all materials, equipment, tools, labor and incidentals necessary to complete the work.

SECTION 221 – NATURAL SOIL BASE

221.01 – DESCRIPTION

This section will cover approved soil material of the thickness shown on the plans constructed as the

subgrade to provide a foundation for the pavement. It shall be constructed in accordance with these specifications to the lines and grades shown on the plans. Natural soil base will be used only for residential streets.

221.02 – MATERIALS

The subgrade material to be used for this work shall have a Liquid Limit of thirty-five (35) or less, a Plastic Index less than twelve (12) and fifteen (15) percent to forty-nine (49%) percent by weight passing the No. 200 sieve. These soils shall have a minimum California Bearing Rating (CBR) value of fifteen (15) at 0.1 inch penetration.

221.04 – CONSTRUCTION METHODS

The subgrade shall be scarified or otherwise processed to permit uniform dispersion of moisture to the specified depth. Areas of the subgrade through rock cuts that cannot be scarified or otherwise processed shall be undercut not less than six inches (6") and backfilled with soil meeting the requirements of Section 221.02 unless specified otherwise in accordance with Section 200.04.01.

221.06 – METHOD OF MEASUREMENT

Subgrade shall be plan quantity by the square yard in place as called for on the plans.

221.07 – BASIS OF PAYMENT

This item measured as provided for above will be paid for at the contract unit price bid per square yard for natural soil base in place and accepted:

NATURAL SOIL BASE	S.Y.

Payment shall be full compensation for all materials, equipment, tools, labor and incidentals necessary to complete the work.

SECTION 222 – SUBGRADE STABILIZATION

222.01 – DESCRIPTION.

This work shall consist of furnishing, placing and compacting one or more courses of a mixture of soil, a stabilization additive and water in accordance with these Specifications and in reasonably close conformity with the lines, grades, thickness, and typical cross sections shown on the Plans or established by the Engineer for the purpose of increasing the shear strength of subgrade soil. Stabilization additives for the purposes of this specification will be defined as cementitious additive (Portland Cement, fly ash or cement kiln dust) or lime.

222.02 – MATERIALS.

Materials shall meet the requirements specified in the following Subsections of Section 900 - Materials.

Hydrated Lime	921.02
Quick Lime	921.03
By-Product Lime	921.04
Fly Ash	922
Portland Cement	932.02
Water	932.04

Any cementitious additives shall be stored in a suitable, weather-tight building or compartment which will (1) protect it from dampness and (2) permit easy access for proper inspection and identification of each shipment. Do not mix cementitious additives from different sources in storage. Cementitious

additives shall not be used if for any reason it has become partially set or if it contains hard lumps or cakes.

The lime shall be stored in a suitable, weather-tight building or compartment, which will (1) protect it from dampness and (2) permit easy access for proper inspection and identification of each shipment. Lime shall not be used if for any reason it has become partially set or if it contains hard lumps or cakes. Do not mix limes from different sources in storage, even though they have been tested. By-product lime from residual or waste piles from approved sources may be used in lieu of hydrated or quick lime.

222.03 – EQUIPMENT.

All equipment necessary for subgrade stabilization shall meet the requirements of Subsection 301.03 and as further specified in this Section.

222.04 – CONSTRUCTION METHODS.

A) General. The primary requirement of these Specifications is to secure a completed course of stabilized material containing a uniform mixture of soil, stabilization additive, and water:

1) free from loose or segregated areas,

2) of uniform density and moisture content,

3) well bound for its full depth and

4) with a smooth surface suitable for placing subsequent courses.

5) It shall be the responsibility of the Contractor to regulate the sequence of this work, to use the prescribed amount of stabilization additive, to maintain the work, and to rework the courses as necessary to meet the above requirements.

B) Weather Limitations. Stabilization additives shall not be applied unless the air temperature is at least 40/F (4/C) and rising. The air temperature shall be taken 4 feet above the ground in the shade and away from artificial heat. Stabilization additives shall not be applied when any portion of the ground is frozen. The Contractor shall be responsible for the protection and quality of the stabilization additive and stabilized subgrade under any weather conditions.

C) Preparation of Existing Roadbed. Prior to beginning any subgrade stabilization, the roadbed shall be compacted and shaped to reasonably close conformity with the typical sections, lines, and grades as shown on the Plans or established by the Engineer. The subgrade shall be rolled in a manner approved by the Engineer, and any soft areas revealed by this rolling shall be corrected.

D) Scarifying and Loosening. Scarifying and loosening may be required prior to the application of stabilization additive to achieve the desired results as determined by the Engineer. The Contractor shall take precautions to avoid forming furrows of loosened material below the depth specified for the bottom of the stabilized subgrade. Except by special permission from the Engineer, the length of roadway scarified and loosened at any time shall not exceed the length in which the mixing with stabilization additive can be completed in two calendar days. In subgrade extents designated on the Plans or by the Engineer as having excessive rock—the dimensions or quantities of which 25 percent or more are greater than 2 ½ inches (63 mm) in size, making compliance with these Specifications impractical—the Engineer may waive certain portions of the work as described below. The Engineer may require exploratory scarifying by the Contractor before designation of extents for which full compliance of these Specifications is waived.

E) Application.

General. The type and proportion of stabilization additive indicated on the plans is approximate. The type and the final rate of application of stabilization additive ultimately used shall be based on tests

of the subgrade soil. The tests of the subgrade soils shall be performed by the Department. However, with the approval of the Engineer the Contractor has the option of having the tests performed by a laboratory approved by the Department in accordance with the Materials Division policy for soil stabilization at no additional cost to the Department. The stabilization additive shall be applied at the rate prescribed by the Engineer based on tests of the subgrade soil.

The Contractor may propose the use of a cementitious additive that was not specified on the Plans as a substitute, by submitting a proposal to the Engineer for review and approval. The proposal must include test results performed by a laboratory approved by the Department in accordance with the Materials Division policy for soil stabilization, the recommended application rates from those test results for the planned and proposed additives, and the cost comparison of the planned and proposed additives. Approval of the Engineer must be obtained prior to any substitution for the planned additive. Additives shall be used as specified in the following table.

	Soil Type – AASHTO M145						
Additive	A-1	A-2	A-3	A-4	A-5	A-6	A-7
Portland Cement	X	X	X	X	X	X	
Fly Ash		X	X	X	X	X	
Cement Kiln Dust	X	X	X	X	X		
Lime						X	X

The Contractor shall provide equipment necessary for proper control of the application rate of stabilization additive. Where tests indicate a significant change in the subgrade soil, the Department will establish a new application rate as deemed necessary for the section of road affected prior to the Contractor placing and spreading the stabilization additive.

1) Application of Cementitious Additive. Dry methods of application shall be used for placement of the cementitious additive onto the subgrade. Equipment for spreading shall be approved types which demonstrate the ability to distribute cementitious additive uniformly.

   Cementitious additive shall not be applied by the slurry method. Cementitious additive shall not be placed on wet subgrade or otherwise allowed to become wet during application prior to mixing. Cementitious additive shall not be applied when wind conditions are such that blowing cementitious additive becomes objectionable to traffic or adjacent property owners. Cementitious additive shall be placed only on that area of roadway where mixing, compaction, and finishing can be completed in the same day. During the interval of time between application and completion of the first mixing operations, cementitious additive that has been exposed to weather conditions resulting in wetting or excessive loss by blowing will not be accepted for payment, and cementitious additive unacceptable as the result of wetting shall be removed from the project.

   Specific extents of the subgrade may require modification with lime as a pretreatment to lower the plasticity index of the subgrade soils to below 20 prior to the application of a cementitious additive. The lime pretreatment shall be performed to the depth and at the rate prescribed by the Engineer based on tests of the subgrade soil. Application of lime for pretreatment shall be in accordance with the application of lime as described in Subsection 222.04.

2) Application of Lime. Lime shall not be applied when wind conditions are such that blowing lime becomes objectionable to traffic and adjacent property owners. Equipment for spreading shall be approved types which demonstrate the ability to distribute lime uniformly. When lime is applied to the soil ahead of the mixing equipment, the lime shall be placed only on that area where the first mixing operations can be completed during the same working day. During the interval of time between application and mixing, lime that has been exposed

to the open air for a period of six hours or more may not be accepted for payment; in addition, payment will not be made for lime loss due to excessive washing or blowing.

a) Dry Method.

(i) Quick Lime. When quick lime is used, the equipment for spreading lime shall be an approved type which shall demonstrate its ability to distribute the lime uniformly in controlled amounts.

(ii) Hydrated Lime. Bagged hydrated lime may be used for dry-method application only under unusual circumstances, i.e., when it would be impossible or impracticable to use other methods and only upon written approval of the Engineer and provided that all applicable Federal, State, and local laws are met. The bagged lime shall bear the manufacturer's certified weight.

b) Slurry Method. Lime shall be mixed with water into a slurry by either of the following methods.

(i) Central Plant. Mixing shall be accomplished through integral paddles, recirculating pumps, or other devices that will meet mixing requirements. The slurry distributor truck, hauling from the central plant, shall be equipped with a recirculating pump or agitator of sufficient size which will keep the lime and water in a uniform mixture until spread.

(ii) Transit Mix. The lime from the storage bin shall be metered or weighed by an approved method into the tank transit mix equipment. The tank truck shall be equipped with a recirculating pump or agitator to maintain a uniform mixing of the lime and water while in transit. The distributor truck shall be equipped with a pump, regardless of the type of mixing method used. The slurry will be applied through the spray bars under pressure to assure a uniform flow and distribution. The slurry produced by either method shall consist of a minimum mixture of approximately 1 ton of lime to each 500 gallons of water and shall not contain more than 40 percent lime. Use of compressed air for mixing will not be permitted.

c) By-product Lime. When by-product lime is used, the equipment for spreading lime shall be an approved type, which will demonstrate its ability to uniformly distribute the lime at controlled amounts.

F) Mixing.

General. Mixing of the stabilization additive with the subgrade soil shall follow application and spreading as a continuous construction operation. Work areas for mixing shall not exceed 5,000 square yards (4000 m2) unless otherwise authorized by the Engineer.

1) Single Mixing for Cementitious Additive Stabilization: The Single Mixing procedure shall be as hereinafter described for soils classified as Groups A-1 and A-3 in AASHTO M145 soil classification. The Double Mixing procedure described in Subsection 222.04(f)(2) may be allowed at the Contractor's option for these soil classifications.

a) Mixing. Unless authorized by the Engineer, the pulvermixer shall be equipped with a spray bar in the mixing chamber that is capable of injecting a sufficient quantity of water to produce a soil-cementitious additive mixture with a moisture content within the specified range in a single pass of the mixer. The quantity of water necessary for the mixing will vary with the nature of materials, normally enough water will be added to obtain a water content 2 to 5 percentage points above the optimum moisture

content for maximum density of the compacted soil-cementitious additive mixture. All clods shall be reduced in size by mixing until the soil cementitious additive mixture meets the following size requirements when tested dry by laboratory sieves:

Sieve Size	Percentage Passing
1 ½ inch	100%
¾ inch	50 minimum

Cementitious additive shall be added and the section shall be repulverized at the correct moisture content to any portion of the work area that the cementitious additive has hydrated prior to compaction at the contractor's expense, unless waived by the Engineer.

b) Additional Mixing. The specified degree of pulverization and the specified range of the moisture content of the mixture shall be achieved in the initial mixing of the cementitious additive or a second pass with a pulvermixer will be required. The pulvermixer shall be equipped to add additional water, if required. Cementitious additive shall be added and the section shall be repulverized at the correct moisture content to any portion of the work area that the cementitious additive has hydrated prior to compaction at the contractors expense, unless waived by the Engineer.

2) Double Mixing for Cementitious Additive Stabilization: The double mixing procedure shall be as hereinafter described for soils classified as Groups A-2, A-4, A-5, and A-6 in AASHTO M145 soil classification. The Single Mixing procedure described in Subsection 222.04(e)(2) may be allowed only after approval by the Engineer for these soil classifications, if the mixing can be properly performed by using special equipment or construction methods proposed by the Contractor.

a) First Mixing. The moisture content of the subgrade soil shall not exceed 80 percent of the optimum moisture as determined by AASHTO T-99 at the time of first mixing. The soil and cementitious additive shall be mixed until a uniform mixture is obtained in which all clods and non-aggregate lumps are reduced to a maximum of 2 ½ inches (63 mm) diameter size. The addition of water will not be permitted during the first mixing. First mixing operations shall begin no later than 4 hours after the application of cementitious additive. When deemed necessary by the Engineer, any portion of the area shall be rescarified and additional cementitious additive added to ensure adequate soil stabilization. The cementitious additive and soil shall be thoroughly mixed prior to the beginning of final mixing operations.

b) Final Mixing. After the soil and cementitious additive have been satisfactorily mixed, water shall be added during the final mixing operations to initiate the soilcementitious additive reaction. Water shall be sprinkled or sprayed as a mist onto the subgrade in a manner that produces a uniform coverage. The method of mixing shall be an approved procedure utilizing traveling mixing equipment that demonstrates uniform dispersion of cementitious additive and water throughout the soil. Sufficient water shall be added in the final mixing process to ensure chemical reaction between cementitious additive and soil. The quantity of water necessary for the final mixing operations will vary with the nature of the materials, normally enough water will be added to obtain a water content 2 to 5 percentage points above the optimum moisture content of the compacted soil-cementitious additive mixture. All clods shall be reduced until the soil-cementitious additive mixture meets the following size requirements when tested dry by laboratory sieves:

Sieve Size	Percentage Passing

1 ½ inch	100%
¾ inch	50 minimum

c) Double Mixing for Lime Stabilization: The mixing procedure shall be as hereinafter described.

(i) FIrst Mixing. The Contractor shall mix the soil, lime, and water until a uniform mixture is obtained in which all clods and non-aggregate lumps are reduced to a maximum of 2 ½ inches (63 mm) diameter size. The quantity of water necessary for the first mixing operation will vary with the nature of the material, normally enough water will be added to obtain a water content 2 to 5 percentage points above the optimum moisture content of the compacted stabilized soil. Sufficient water shall be added in the first mixing process to insure proper chemical reaction between the lime and soil. When proper mixing has been accomplished, the mixture shall be allowed to cure. Curing time when hydrated lime is used shall be 72 hours at ambient temperatures above 40/F (4/C). Curing time when quick lime is used shall be 48 hours at ambient temperatures above 40/F (4/C). Curing time when byproduct lime is used shall be 60 hours at ambient temperatures above 40/F (4/C).

During the curing period, the material shall be maintained in a moist condition. The surface of the stabilized area shall be sealed by light rolling to the extent that the surface will repel water and contain the moisture. When deemed necessary by the Engineer, the Contractor shall rescarify any portion of the area under stabilization for additional sprinkling to insure proper moisture for the curing.

(ii) Final Mixing. After the required curing time, the material shall be mixed uniformly by approved methods. All clods shall be reduced until the soil-lime mixture meets the following requirements when tested dry by laboratory sieves:

Nominal Sieve Sizes	**Percentage Passing**
1 ½ inch	100%
No. 4	60 minimum

(iii) Quick Lime Mixing. Within two hours after spreading quick lime and before water is added, approved means shall be used to turn under a significant portion of the quick lime to reduce harmful exposure to the heat of hydration. Sufficient water shall be added within 6 hours after spreading to permit hydration of the quick lime. CAUTION: Uncovered quick lime may be hazardous when in the presence of moisture.

d) Mixing for Lime Pretreatment: Mixing of lime for pretreatment shall be in accordance with the first mixing for lime described in Subsection 222.04(f).

e) Mixing for Depths of 8 inches or greater compacted thickness. No course stabilized shall exceed 8 inches in depth. If the depth of material to be stabilized in cut sections is more than 8 inches (200mm), that portion above the lower 8 inches shall be removed so that the bottom course can be stabilized in place. The upper portions of the cut section also shall be stabilized in courses not more than 8 inches in depth. During normal fill construction, stabilization shall be accomplished by adding and mixing the amount of stabilization additive as required on the plans to each 8 inch lift, completing the depth of fill to the typical section shown on the plans. The initial mixing shall be considered the only mixing necessary for all except the top course.

Variations to the mixing depths that may be properly performed by special equipment or methods may be used only after approved by the Engineer.

f) Mixing for Excessive Rock Areas. In areas designated by the Engineer as excessive rock areas, it is the intent that the completed course of stabilized material shall comply with the Standard Specifications as to uniformity of stabilization additive, density, moisture content, and depth insofar as practicable. Mixing and pulverization shall be accomplished in two stages and shall be sufficient to accomplish the intent of the Specifications. The particle size requirement may be waived by the Engineer.

G) Compaction. The soil-cementitious additive mixture shall be compacted immediately after mixing, so that the compaction operation is a continuation of the mixing operation. The soil-lime mixture shall be compacted during the same day as the final mixing unless approval is obtained from the Engineer to continue compaction on the following day. The target density shall be determined in the field by moisture- density tests on representative samples of the soil-stabilization additive mixture obtained from the roadway when compaction is started. The test method for the target density will be as specified in Subsection 201.04, modified to provide one compacted specimen of the soil-stabilization additive mixture as obtained from the roadway; and separate portions of the sample will be used for additional specimens with the moisture reduced or increased.

The soil-stabilization additive mixture shall be compacted immediately after mixing and before any appreciable loss of mixing moisture occurs. Mixing and compaction operations shall be performed so that the mixture will be compacted within plus or minus 2 percentage points of optimum moisture content. However, during the course of construction, changes or adjustments in the specified moisture requirements to meet field conditions may be authorized by the Engineer.

Compaction shall be continued until the entire depth of the mixture is uniformly compacted to not less than 95 percent of target density. Field density will be determined in accordance with Subsection of 201.04. The rate of operation and the number of rollers shall be sufficient to uniformly compact the section of roadway being processed as specified above for the cementitious additive and within two hours of the final mixing for the lime additive.

Depths of two or more lifts or courses shall be compacted as specified in the mixing procedure. The material shall be sprinkled or dried as necessary to provide the moisture for proper compaction. Compaction shall be continued until the entire depth of mixture is compacted to not less than 95 percent of the target density established in accordance with the paragraph above.

The material shall be sprinkled and rolled. All irregularities, depressions, or weak spots which develop shall be immediately corrected by scarifying the areas affected, adding or removing material as required, and reshaping and recompacting by sprinkling and rolling.

In addition to complying with the requirements specified for density, the full depth of the material shown on the Plans shall be uniformly compacted to the extent necessary for it to remain firm and stable under construction equipment. After each section is completed, density tests as necessary, will be made by the Engineer for acceptance. Throughout this entire operation the shape of the course shall be maintained and the surface upon completion shall be smooth and in conformity with the typical section shown on the Plans and to the established lines and grades. Should the material, due to any reason or cause, lose the required stability, density, or finish before the next course is placed or the work is accepted, it shall be replaced and refinished at the sole expense of the Contractor.

In areas designated by the Engineer as excessive rock areas, it is the intent that compaction be in substantial compliance with these Specifications. However, it is recognized that the soil-stabilization additive mixture may not be uniform and some variation is to be expected in both the target density and optimum moisture, depending on the stabilization additive content of a given

sample. In the event the in-place density tests are not practical because of rock in the soil-stabilization additive mixture, the Engineer may waive the density and moisture content requirements and approve compacting by visual observation in lieu of such tests.

H) Finishing and Curing. After the final layer of the stabilized subgrade has been compacted, it shall be brought within reasonable compliance to the lines, grades, and typical sections. The completed section shall then be finished with a suitable roller sufficiently light to prevent hair cracking. The stabilized subgrade shall be maintained at a moisture content satisfactory for proper curing by sprinkling until a prime, seal, or succeeding course is placed, whichever occurs first.

I) Tolerance. The finished surface tolerance shall be in conformity with the Plans.

222.06 – METHOD OF MEASUREMENT.

Fly ash will be measured by the ton. Cement kiln dust will be measured by the ton. Portland Cement will be measured by the ton. Cementitious stabilized subgrade will be measured by the square yards of subgrade stabilization completed in place. Lime will be measured by the ton. Lime stabilized subgrade will be measured by the square yard of subgrade stabilization completed in place. Lime Pretreatment will be measured by the square yard of subgrade pretreatment completed in place. Water and rolling will not be measured for payment.

222.07 – BASIS OF PAYMENT.

Accepted quantities for stabilized subgrade, measured as provided above, will be paid for at the contract unit price as follows:

FLY ASH	TON
LIME	TON
CEMENT KILN DUST	TON
PORTLAND CEMENT	TON
CEMENTITIOUS STABILIZED SUBGRADE	SY
LIME STABILIZED SUBGRADE	SY
LIME PRETREATMENT	SY

Such payment shall be full compensation for furnishing all materials, equipment, labor, and incidentals to complete the work as specified.

Payment for quick lime shall be based upon a 90 percent available lime index by rapid sugar method, calculated as percent CaO by weight.

Payment for hydrated lime shall be based upon a 90 percent available lime index by rapid sugar method, calculated as percent Ca(OH)2 by weight.

Payment for by-product lime shall be based on a substitution ratio calculated on a 90 percent available lime index by rapid sugar method. When the available lime index percentage falls below 90 percent, payment will be made at an adjusted price—which shall be reduced at the rate of one percent of the Contract unit bid price for lime for each percent, or fraction thereof, from 90.0 percent down to—and including—an available lime index of 80.0 percent. When the available lime index falls below 80.0 percent for the type of lime used, add a sufficient quantity of additional lime of the same type to bring the total amount to the required 90.0 percent of available lime index at no additional cost to the City.

SECTION 225 – AGGREGATE BASE

225.01 – DESCRIPTION

This work shall consist of furnishing and placing one or more courses of aggregates and additives, if specified, on a prepared subgrade or subbase in accordance with these specifications and in

reasonably close conformity with the lines, grades, thicknesses and typical cross sections shown on the Plans or established by the Engineer.

Aggregate base may be mixed off the roadbed and may be blended by plant mixing or other approved methods.

Aggregate base may be mixed on the roadbed with approved methods that will produce a uniformly blended material. Aggregate base shall not be mixed on any completed base or surface course.

225.02 – MATERIALS

Materials shall conform to the requirements specified in the following Section of Section 923 - Materials, for the type gradation specified.

Aggregate Base

The gradation may be either Type A or Type B unless otherwise specified on the Plans or in the Special Provisions. After work starts the same gradation type and source as specified or selected shall be used throughout the project unless otherwise permitted in writing by the Engineer, except as follows:

The gradation shall be type A in the top 3 inches on any base course except when the specified thickness is 6 inches or less where it shall be for the total thickness.

225.04 – CONSTRUCTION METHODS

A) Preparation of Subgrade - Prior to placing any new base material or subbase and base course material on the roadbed, the subgrade shall be completed according to the requirements of Section 220, Subgrade, of these Specifications or the method specified on the Plans or in the Special Provisions.

B) If there is an existing aggregate course in place, it shall be prepared in accordance with the requirements of the method of Section 226, Processing Existing Base and Surface, of these Specifications as indicated on the Plans and in the Special Provisions.

C) Mixing Aggregate Base

1) Offsite Mixing. When mixing or blending of materials for aggregate base is done at an approved location off the roadbed one of the following procedures shall be used.

a) Stationary Plant - Mixing Method. The aggregate and water shall be mixed in an approved central mixing plant of the pugmill type, rotary drum type or in a continuous type of mixer.

b) Water shall be added during the mixing operation in the amount necessary to provide the proper moisture content for satisfactory compaction.

c) If a pugmill type or rotary drum type of mixer is used, the materials shall be proportioned by batch weights, and if a continuous type of mixer is used, the materials may be proportioned by volume or by weight.

d) Should the Contractor elect to proportion the materials by volumetric methods and perform the mixing in a continuous type mixer, the completed mixture shall be uniform in character and of the same consistency with respect to aggregates and water as that obtained by weight proportioning and batch mixing.

e) If a continuous type mixer is used, the correct proportions of each aggregate size introduced into the mixer shall be drawn from storage by an approved type of continuous feeder through adjustable calibrated gates, which shall supply the correct amount of coarse aggregate and fine aggregate required to meet the specified

gradation, and so arrange that the proportion of each aggregate size can be separately adjusted. The storage of materials shall be sufficient to supply the mixer when it is in operation at full capacity.

f) The weight of charge in a batch mixer or the rate of feet to a continuous type mixer shall not exceed that which will permit complete mixing of the material.

g) Mixing of materials shall be continued until a uniform mixture is obtained.

2) Onsite Mixing. When the materials required to produce the specified mixture are to be combined and blended on the roadbed, the weighed material shall be delivered and placed in measured windrows, each in the proper proportions before blending. Fine aggregate to be added to the mixture shall be pulverized to 100 percent passing the one inch sieve and not less than 80 percent passing the No. 4 sieve.

a) The total quantities for blending at one operation shall not be in excess of the amount that can be readily handled and thoroughly and uniformly mixed and blended to these requirements.

b) During the latter stages of the mixing and before the final mixing is completed, the mixture shall be moistened as deemed necessary to provide a suitable working condition during the final stages of mixing. Such application of water shall be accurate and uniform throughout the length of the section being treated so that no excess wet or dry spots will be evidenced in the finished blend. Application of excess water should be avoided, either during mixing or during compaction, in order that undue softening of the subgrade will not develop.

D) Spreading - Aggregate base materials mixed at locations off the roadbed shall be transported to the roadbed by means of suitable vehicles and deposited by means of approved spreading equipment. The layers shall be placed so that when compacted they will be true to the grades or levels required with the least possible surface disturbance. The Contractor shall make such adjustments in placing procedures or equipment as may be required to obtain true grades, to minimize segregation and degradation, to reduce or accelerate loss or accretion of water, and to assure an acceptable base.

1) The aggregate base material shall be spread and compacted to the required density in one or more layers, as specified below, and of such width and thickness that after compacting, the finished base will conform to the required grade and cross section. The aggregate base material for each separate course shall be spread for the full width of the roadbed before the placing of the succeeding courses.

2) Longitudinal and transverse joints shall be staggered a minimum of 12 inches in each succeeding course.

3) Aggregate base material shall be laid in courses of a minimum of 3 inches compacted thickness and shall not exceed a maximum of 6 inches compacted thickness, except when shoulders are shown on a typical section to be constructed as a separate operation, then they may be constructed in one course providing they do not exceed 8 inches in thickness, and in two approximately equal courses where they exceed 8 inches. In either case, the compacted shoulders shall meet specified density requirements.

4) After the blended and flattened windrow of aggregate base material mixed on the roadbed has been tested and approved by the Engineer, it shall be spread uniformly as specified above over the full length and width of the section to be compacted. This spreading shall be done in such a manner as to prevent segregation of the mixture.

E) Shaping and Compaction - Compaction of each layer shall continue until a density of not less than

100 percent of modified proctor density, as determined by AASHTO T-180, method D, has been achieved. Provided, that aggregate base outside the pavement edge for new construction, or outside the old pavement edge for widening, shall have a minimum density of 95 percent of standard density, AASHTO T-180, method D. The surface of each layer shall be maintained during the compaction operations in such a manner that a uniform texture is produced and aggregates firmly keyed. Water shall be uniformly applied over the base materials during compaction in the amount necessary for proper consolidation.

F) Tolerances - Tolerances for surface, width and thickness shall be in conformity with Plans and Specifications.

225.06 – METHOD OF MEASUREMENT

Aggregate base will be measured by the cubic yard, compacted in place to the specified density. Measurement will be based on the actual length multiplied by the theoretical cross section shown on the Plans. Rolling and water as required to obtain a specified density will not be a separate pay item, but the cost of same shall be included in the price of other bid items.

225.07 – BASIS OF PAYMENT

Accepted aggregate base, measured as provided above, will be paid for at the contract unit price for:

AGGREGATE BASE C.Y.

which shall be full compensation for furnishing all materials, equipment, labor and incidentals to complete the work as specified.

SECTION 226 – PROCESSING EXISTING BASE AND SURFACE

226.01 – DESCRIPTION

This work shall consist of the removal, processing, reuse or disposal of existing aggregate surface course or base course and asphalt surface.

This work shall be done in accordance with one of the following methods as specified herein and shown on the Plans or as indicated by a pay item on the Plans and in the Proposal.

226.04 – CONSTRUCTION METHODS

General. The aggregate or other materials in place shall be loosened by scarifying or the use of other suitable methods to its full depth and width. All loosened aggregate or asphalt shall be processed and broken into pieces which will pass a 3 inch sieve. The materials shall be windrowed on the subgrade or shoulder as the case may require. Care shall be exercised in loosening, removing, processing and storage of aggregate to avoid the addition of excess amounts of soil or other foreign material which would render it unsuitable for the use hereafter specified. Damaged material resulting from improper workmanship of the Contractor will not be measured for payment.

Method A - For Salvage and Stockpiling. The processed materials shall not contain detrimental amounts of subgrade or soil or other foreign material. The processed material shall be loaded and hauled to storage locations indicated. All materials shall be stored in a neat and workmanlike manner. All grass, weeds and other rubbish shall be removed from the storage area prior to stockpiling material.

Method B - For Use in Subgrade. The processed materials shall be windrowed on the shoulders during the shaping and conditioning of the subgrade. The materials shall then be spread uniformly over the full width of the section and compacted and completed with the subgrade in accordance with the method specified.

Method C - For Use as Subbase. The processed materials shall be spread evenly on the previously

completed and compacted subgrade and then compacted to the requirements specified for the method of subgrade preparation.

Method D - For Use in New Base Courses, Shoulders, or Ramps. The processed materials may be placed on the completed subgrade as a base course, shoulders or ramps, or it may be blended uniformly with new material for any course. The suitability of the removed materials shall be determined by the Engineer and materials used as authorized.

These materials shall be compacted to not less than 95 percent of standard density for shoulders, ramps and base courses.

226.06 – METHOD OF MEASUREMENT

Processing existing base and surface will be measured by the station of 100 feet or fraction thereof measured along the center line of the roadbed.

226.07 – BASIS OF PAYMENT

Accepted quantities for processing existing base and surface, measured as provided above, will be paid for at the contract unit price for:

PROCESSING EXISTING BASE AND SURFACE, METHOD A	STA.
PROCESSING EXISTING BASE AND SURFACE, METHOD B	STA.
PROCESSING EXISTING BASE AND SURFACE, METHOD C	STA.
PROCESSING EXISTING BASE AND SURFACE, METHOD D	STA.

which shall be full compensation for furnishing all equipment, tools, labor and incidentals necessary to complete the work as specified.

SECTION 250 – TRENCHLESS CONSTRUCTION

SECTION 251 - JACKING

251.01 - DESCRIPTION

This section covers furnishing and installation of pipe by trenchless method of Jacking as shown on the plans and in conformity with these specifications. In general, a boring head begins the tunnel excavation from an access pit and is pushed along by a hydraulic pump unit that remains in the pit. The link to the boring head is maintained by adding jacking pipe between the pushing unit and the head. By this procedure, the pipe is laid as the tunnel is bored.

251.02 – MATERIALS

251.02.01 - SUBMITTALS

Submittals shall be provided in accordance with the requirements specified in Section 615.02.

251.02.02 – PIPE MATERIALS

Acceptable pipe materials and fittings shall meet the requirements of the appropriate sections listed below:

Pipe Type	Pipe Material	Section
Rigid	Reinforced Concrete Pipe (RCP)	647
	Vitrified Clay Pipe (VCP)	649
Flexible	Polyvinyl Chloride (PVC)	652
	Reinforced Fiberglass Pipe (RFP)	653

251.03 - CONSTRUCTION METHODS

All construction requirements specified in Section 615.04 shall apply. The excavation and backfill for pits and installation of shoring shall be as outlined in Section 212.04(b).

Heavy-duty jacks suitable for forcing the pipe through the embankment or earth shall be provided. In operating jacks, even pressure shall be applied to all jacks used. A suitable jacking head, usually of timber, and suitable bracing between jacks and jacking head shall be provided so that pressure will be applied to the pipe uniformly around the ring of the pipe. A suitable jacking frame or backstop shall be provided. The pipe to be jacked shall be set on guides properly braced together to support the section of the pipe and to direct it in the proper line and grade. The whole jacking assembly shall be placed so as to line up with the direction and grade of the pipe. In general, soil shall be excavated or augured just ahead of the pipe and material removed through the pipe, and the pipe forced through the embankment with jacks into the space thus provided. The excavation for the underside of the pipe for at least one-third (1/3) of the circumference of the pipe shall conform to the contour and grade of the pipe. The excavation for the top half of the pipe shall conform closely to the outside diameter of the pipe, and a clearance greater than two inches (2”) will not be permitted.

The pipe preferably shall be jacked from the low or downstream end. Lateral or vertical variation in the final position of the pipe from the line and grade established by the Engineer will be permitted only to the extent of one inch (1”) in ten (10) , provided that such variation shall be regular and only in one direction and that the final grade of flow line shall be in the direction indicated on the plans.

Nothing contained herein shall be construed as relieving the Contractor from his responsibility for the safety of the work and for all damages to persons or property.

251.03.01 – SEWER SERVICE CONNECTIONS

All sewer service connections shall be accomplished and paid for in accordance with Section 611.

251.06 – BASIS OF PAYMENT

"Jacking" shall be measured by the lineal foot of pipe completed. Payment for "Jacking" shall be made at the unit price bid per lineal foot for each size. The price established shall be full compensation for furnishing and placing all materials, including pipe, excavation and backfill, sheeting, shoring, bracing and drainage, disposal of all surplus materials, labor, tools, equipment, and incidentals necessary to complete this item of work.

251.07 – BASIS OF PAYMENT

The items measured as provided above will be paid for at the contract unit price bid:

KING (SIZE)	L.F.
KING – (PIPE SIZE)	L.F.
KING – CASING (SIZE)	L.F.

Such payment shall be compensation in full for furnishing all materials, labor, equipment, tools and

incidentals, and for performing the work in accordance with these specifications.

SECTION 252 – BORING

252.01 – DESCRIPTION

This section covers furnishing and installation of pipe by trenchless method of boring as shown on the plans or specified.

Boring consists of the initial installation of a steel casing pipe, installed mechanically, and with a suitable assembly designed to produce a smooth, straight shaft at the established line and grade. The pipe is then installed inside the casing pipe pursuant to the Standard Detail for Boring.

252.02 – MATERIALS

Acceptable pipe materials and fittings shall meet the requirements of the appropriate sections listed below:

Pipe Type	Pipe Material	Section
Rigid	Reinforced Concrete Pipe (RCP)	647
	Vitrified Clay Pipe (VCP)	649
Flexible	Ductile Iron Pipe (DIP)	650
	High Density Polyethylene Pipe (HDPE)	651
	Polyvinyl Chloride (PVC)	652
	Reinforced Fiberglass Pipe (RFP)	653

252.02.01 – SUBMITTALS

The Contractor shall furnish for the Engineer's approval, a plan showing his proposed method of handling, including the design for the equipment, equipment support of backstop, arrangement and position of jacks, pipe guides, etc., complete in assembled position. The approval of this plan by the Engineer will not relieve the Contractor from his responsibility to obtain the specified results.

252.02.02 – CASING PIPE MATERIALS

Acceptable casing pipe materials shall meet the requirements of the appropriate sections listed below:

Casing Pipe Material	Section
Steel Casing Pipe (Water)	528
Steel Casing Pipe (Sanitary Sewer)	654

252.04 - CONSTRUCTION METHODS

A) General – Where pipe is required to be installed under railroad embankments or under highways, streets, or other facilities by trenchless methods, construction shall be made in such a manner that will not interfere with the operation of the railroad, street, highway, or other facility, and shall not weaken or damage any embankment or structure. During construction operations, barricades and lights to safeguard traffic and pedestrians shall be furnished and maintained, as directed by the Engineer, until such time as the backfill has been completed and then shall be removed from the site.

The Contractor shall take proper precautions to avoid excavating earth or rock or shattering rock beyond the limits of excavation shown on the plans. All damages caused by excavating or blasting, either to surface or subsurface structures, shall be repaired or replaced by the Contractor

at his own cost and expense.

Suitable pit shafts, or trenches shall be excavated for the purpose of conducting the trenchless operations and for placing end joints of the pipe. Wherever end trenches are cut in the sides of the embankment or beyond it, such work shall be sheeted securely and braced in a manner satisfactory to the Engineer to prevent earth caving.

The removal of any obstruction that may be found to conflict with the placing of the pipe shall not be measured for payment nor paid for as a separate contract pay item. The removal of any such obstruction shall be included in the cost of other items.

Once the pipe installation has commenced it shall be continued uninterrupted around the clock until the pipe has been installed between the specified limits.

Any pipe damaged during operations shall be removed and replaced by the contractor at his expense.

The pits or trenches excavated to facilitate the operations shall be backfilled immediately after the pipe has been installed.

B) Boring Requirements - Work shall comply with the Standard Detail for Boring. The excavation and backfill for pits and installation of shoring shall be as outlined in Section 212.

Boring without the concurrent installation of a casing pipe shall not be permitted, unless shown on plans or directed by the Engineer. All joints in casing pipe shall be welded. Casing pipe shall extend through the entire fill and be installed in a manner that shall not disrupt traffic nor damage roadway grade and surface. The introduction of water into the excavation shall be prohibited.

The size of the bored hole shall not exceed the outside diameter of the pipe bell or casing pipe more than one inch (1”). The use of water or other fluids in connection with the boring operation shall only be permitted when approved by the Engineer.

Nothing contained herein shall be construed as relieving the Contractor from his responsibility for the safety of the work and for all damage to persons and property.

C) Skid Supports

a. Wood Skid Supports – Wood skid supports, from bell to spigot, shall be used and fastened securely to pipe with steel strapping, cables or clamps. Use of petroleum products shall not be allowed as a lubricant to ease installation. When wood skids are used, they shall be pressure treated with creosote pentachlorophenol, or salt type preservative in accordance with APWA C-2. Cut surfaces shall be given two (2) heavy brush coats of the same preservative. Skid support spacing and position shall be in accordance with the Standard Detail for Boring.

b. Casing Spacers – Casing spacers shall be PVC with stainless steel bands as manufactured by Advance Products & Systems, Inc. of Lafayette, Louisiana or approved equal. Use and positioning of spacers shall be in accordance with the manufacturer's recommendations.

D) Plugging Pipe Ends - Both ends of the casing pipe shall be plugged with a grout or concrete having a minimum compressive strength of twenty-five hundred pounds per square inch (2,500 psi) or grouted masonry and shall conform to the applicable requirements of Section 900. Each plug shall be a minimum length of eighteen inch (18”) The grouting pressure shall be in accordance with the pipe manufacturer's recommendations.

E) Filling Annular Space - The annular space between the waterline pipe and the steel casing pipe shall not be filled.

252.06 – METHOD OF MEASUREMENT

"Boring" shall be measured by the lineal foot of pipe bored. Payment for "Boring" shall be made at the unit price bid per lineal foot for each size. The price established shall be full compensation for furnishing and placing all materials including steel casing pipe, carrier pipe, grout or concrete, excavation and backfill, sheeting, shoring, bracing and drainage, disposal of all surplus materials, labor, tools, equipment, and incidentals necessary to complete this item of work. For water construction, "Boring – Pipe or Boring – Casing" shall be measured by the lineal foot bored. Payment for " Boring – Pipe or Boring – Casing " shall be made at the unit price bid per lineal foot for each size. The price established shall be full compensation for furnishing and placing all materials including pipe or casing, excavation and backfill, sheeting, shoring, bracing and drainage, disposal of all surplus materials, labor, tools, equipment, and incidentals necessary to complete this item of work.

252.07 – BASIS OF PAYMENT

The items measured as provided above will be paid for at the contract unit price bid:

BORING (SIZE)	L.F.
BORING – (PIPE SIZE)	L.F.
BORING – CASING (SIZE)	L.F.

Such payment shall be compensation in full for furnishing all materials, labor, equipment, tools and incidentals, and for performing the work in accordance with these specifications.

SECTION 253 – TUNNELING

253.01 – DESCRIPTION

This section covers furnishing and installation of pipe by trenchless method of tunneling using steel plate liners. Tunneling may be accomplished by open-face mining with or without shields. Compressed air may also be required to control the entry of water into the tunnel.

253.02 – MATERIALS

253.02.01 – SUBMITTALS

Submittals shall be provided in accordance with the requirements specified in Section 252.

253.02.02 – PIPE MATERIALS

Acceptable pipe materials and fittings shall meet the requirements of Section 252.02.

253.02.03 – TUNNEL LINER STEEL PLATES

Tunnel liner steel plates shall conform to the requirements of Section 528 and 654. The minimum wall thickness shall be United States Gauge 12 (0.2046 inches).

253.05 – CONSTRUCTION METHODS

All construction requirements specified in Section 528 and 654 shall apply. The excavation and backfill for pits and installation of shoring shall be as outlined in Section 212.

The tunnel shall be excavated in such a manner and to such dimensions that will permit placing of the proper supports necessary to protect the excavation. The Contractor shall take the proper precautions to avoid excavating earth or rack or shattering rock beyond the limits of excavation shown on the plans. All damages by excavation and blasting, either to surface or subsurface structures, shall be repaired or replaced by the Contractor at his own cost and expense.

Adequate provisions shall be provided for safety and health of the workmen. All equipment operated in the tunnel shall be powered by either air or electricity. No equipment shall be permitted in the tunnel that uses a petroleum product for fuel. Electric lights shall be used for illumination of the tunnel construction, for illumination of completed portions of the tunnel used for passage, and wherever lighting is needed for inspection of the work. Sufficient number of lamps shall be used to properly illuminate the work and all wiring for electric power and lights shall be installed and maintained in a safe and secure manner. The Contractor shall maintain the tunnel air in a condition suitable for the health of the workmen and sufficiently clear for surveying operations. A sufficient supply of fresh air shall be provided and maintained at all times in all underground places and provisions shall be made for the quick and complete removal of gases and dust resulting from blasting or other tunnel operations. Except when unnecessary due to natural ventilation, artificial ventilation shall be maintained in the tunnel by ventilating plants of ample capacity operated when needed to meet the preceding requirements.

Suitable steel or timber sheeting, shoring, and bracing shall be used to support the sides and roof of the excavation. Supports may be left in place provided that they clear the minimum thickness of the concrete backfill around the pipe. No separate payment will be made for supports left in place. The space between the liner plate and the limits of excavation shall be pressure grouted or mud jacked. Tolerance in line and grade shall be as specified in "Jacking".

Nothing contained herein shall be construed as relieving the Contractor from his full responsibility for the safety of the work and for all damages to persons and property.

253.06 – METHOD OF MEASUREMENT

"Tunneling" shall be measured by the lineal foot of pipe tunneled. Payment for "Tunneling" shall be made at the unit price bid per lineal foot for each size. The price established shall be full compensation for furnishing and placing all materials, including steel liner plate, waterline pipe, grout or cement, backfill, sheeting, shoring, bracing and drainage, disposal of all surplus materials, labor, tools, equipment, and incidentals necessary to complete this item of work.

253.07 – BASIS OF PAYMENT

The items measured as provided above will be paid for at the contract unit price bid:

TUNNELING (SIZE) L.F.

Such payment shall be compensation in full for furnishing all materials, labor, equipment, tools and incidentals, and for performing the work in accordance with these specifications.

SECTION 254 – MICRO AND SMALL DIAMETER TUNNELING

254.01 – DESCRIPTION

This section covers furnishing and installation of pipe by trenchless method of micro and small diameter tunneling. Micro and small diameter tunneling is the installation of pipe by Jacking the pipe behind a remotely controlled steerable, laser guided, articulated tunnel shield.

The size range of microtunneling shall be as follows:

Microtunneling - Tunneling in diameters that are too small for man entry, i.e., thirty-six inches (36”) or smaller in internal diameter.

Small Diameter Tunneling - Tunnels with an internal diameter greater than thirty-six inches (36”) and smaller than sixteen feet (16') in internal diameter.

254.02 – PIPE MATERIALS

Acceptable pipe materials and fittings shall meet the requirements of the appropriate sections listed

below:

Pipe Type	Pipe Material	Section
Rigid	Reinforced Concrete Pipe (RCP)	647
	Vitrified Clay Pipe (VCP)	649
Flexible	Polyvinyl Chloride (PVC)	652
	Reinforced Fiberglass Pipe (RFP)	653

Acceptable casing pipe materials shall meet the requirements of the appropriate sections listed below:

Casing Pipe Material	Section
Steel Casing Pipe (Water)	528
Steel Casing Pipe (Sanitary Sewer)	654

254.03 – EQUIPMENT

The Microtunnel boring machine shall be operated remotely. The Small Diameter tunnel-boring machine shall be given to a system capable of being remotely operated from outside the tunnel unless otherwise specified or approved by the Engineer.

The Tunnel Shield shall have a full face with an enclosed plenum chamber containing slurry under pressure. The shield must be equipped with a valve system that enables the plenum chamber to be isolated from the tunnel. The machine may, if required, be capable of conversion to mechanical earth pressure balanced, screw auger shield type.

The Tunnel Shield shall be capable of fully supporting the face both during excavation and during shutdown, and shall have the capability of presetting a calculated earth balancing pressure and positively measuring the earth pressure at the face.

In soil conditions of very low strength and high water table, the tunnel shield may, if required by the Engineer, be equipped with a sliding cutter head. The pressure exerted by the cutter head over the excavated face shall remain constant, regardless of variations in the excavation rate. The rate of excavation must be able to be varied independent of the jacking speed and be set to zero, if necessary.

The system shall be laser-guided and monitored continuously with a closed circuit television or other approved control system. All functions of the system shall be monitored and transmitted to the operation console. The microtunneling system shall be capable of being remotely controlled from the surface. The minimum information to be available to the operator on the control console includes rate of advance, length of conduit installed, thrust force, deviation from line and grade, role, inclination, and valve positions.

The soil transportation method shall be capable of handling and removing material of high water content from the face. The system shall be capable of any adjustment required to balance the ground water pressure to a level of plus three (3') and an accuracy of plus or minus (±) one foot (1').

The jacking system, including any intermediate jacks used, shall be capable of continuously monitoring the jacking pressure, the rate of advancement, and the distance jacked.

When soil conditions dictate, the tunnel shield must be capable of crushing cobbles and boulders. The excavation system shall be fully capable of excavating all materials that it will encounter.

The tunnel shield must be articulated and maneuvered by trunion mounted steering jacks or other approved method to enable accurate control of line and level.

The jacking system shall develop a uniform distribution of jacking forces on the end of the pipe.

Intermediate jacking stations shall be provided when the calculation of the total jacking pressure, needed to complete the installation, exceeds the maximum designed working compressive loads allowed for the pipe provided by the Contractor and approved by the Engineer.

A lubrication system shall be provided that injects an approved lubricant at the rear of the tunneling shield (if necessary, through the pipe wall in man entry sized tunnels) to lower the friction developed on the sides of the pipe during jacking.

A separation plant shall be provided when using the slurry balance system. The plant shall clean the excavated soil from the water for disposal and return the water back to the cutting face for reuse.

The over cut on the tunneling shield shall not exceed one inch (1") without the approval of the Engineer. The annular space created by the over cut must be filled with bentonite or approved lubricant suitable for the particular soil condition to be tunneled.

The tunneling system shall be capable of maintaining grade to within plus or minus (±) one and one half inches (1 ½ ") over the total distance between the jacking and reception shaft.

All groundwater encountered during the excavation of the tunnel shall be balanced by the tunneling machine. No loss of ground water shall be permitted.

Slurry tunneling systems shall use a minimum volume of water in the slurry system.

The tunneling shield must be capable of bi-directional drive on the cutter head wheel to minimize drift and rotation or roll of the conduit during installation.

254.04 – CONSTRUCTION METHODS

254.04.01 – DESCRIPTION

The Contractor shall have discretion to select the method of microtunneled pipe installation, subject to approval by the Engineer.

The tunneling shield connected to and followed by the pipe being installed, shall ensure that the soils being excavated through are fully supported at all times. This shall be accomplished without the use of any ground stabilization, de-watering, or other support techniques.

The minimum depth of cover for the micro-small diameter tunnel is normally six feet (6') or one and one half (1 ½) times the outer diameter of the conduit being installed, whichever is the greater.

254.04.02 – TUNNELING SHIELD

The tunnel shields shall be powered by electric or hydraulic motors. The shield shall be articulated to enable steering of the system. Steering rams and valves shall be controlled by a low-pressure power pack located in the shield or other approved means.

Line and grade shall be controlled by a laser beam transmitted from the drive shaft along the centerline of the pipe to a target mounted in the shield. The position of the laser on the target shall be transmitted back to the operator by closed circuit television, together with other information such as face pressure, roll, pitch, steering attitude, and valves open or closed.

254.04.03 – SOIL TRANSPORT SYSTEMS

A) Slurry System - Slurry system may be used to match soil excavation speed to the excavation rate and achieve a minimum velocity to prevent settlement of solids in the slurry lines, and to balance the groundwater pressure.

This shall be achieved by the use of variable speed pumps, pressure control valves, and a flow meter. A slurry by-pass unit shall be included in the system to allow the direction of flow to be changed and isolated as necessary. The slurry system shall have separation equipment that will remove the soil from the water. This may be accomplished by simple lagoons or tanks as approved by the Engineer. With larger shields, hydro-cyclones and vibrating screens may also be used.

B) Auger System - May be used to remove the excavated soil by auger to the jacking shaft, where it may be removed by conventional means.

C) Jacking System - The main jacks shall successively push the machine together with a string of connected pipes. The capacity of the jacks and the extension rate shall be synchronized with the excavation rate of the shield. Intermediate jacking stations shall be used when the calculation of the total jacking force needed to complete the installation exceeds the maximum design working compressive loads allowed for the pipe.

D) Controls - A control equipment shall be required to integrate the system of excavation and removal of soil and simultaneous replacement by pipe.

254.04.04 – SUBMITTALS

Submit for review complete working drawings showing details of the proposed method of construction and the sequence of operations to be performed during construction. Show the method of microtunneling, including the microtunneling system to be used, location of working shafts, including method of excavation, shoring and bracing, and de-watering techniques that are proposed to be used. The following is not intended to limit, but to provide the minimum of, details which must be included.

A) Manufacturer's literature describing in detail the microtunneling system to be used. Detailed description of projects on which the system has been successfully used, including the names, addresses, and telephone numbers of owner's representatives and engineers for these projects.

B) Method of muck disposal.

C) Method(s) of controlling groundwater.

D) Shaft dimensions, locations, surface construction, profile, depth, method of excavation, and shoring and bracing.

E) Design calculations for the proposed pipe to be used. The design calculations shall take into account maximum ground and hydrostatic loads, jacking thrusts, slurry and grout pressures, external loads such as railroads and highway traffic, and any other loads that may be reasonably anticipated. All loads shall be shown and described.

F) When used, structural details of reinforced concrete pipe, including reinforcing at the joints.

All Contractor submittals requiring structural design shall be signed and sealed by a Professional Engineer, registered to practice engineering in the state of Oklahoma.

The Engineer shall base the review of submitted details and data with consideration of requirements for the completed work, utilities, and the possibility of unnecessary delays in the execution of the work to be constructed. Review and acceptance of the Contractor submittals by the Engineer shall not be construed in any way as relieving the Contractor of his responsibilities.

254.04.06 – DRIVE AND RECEPTION SHAFTS

Shafts shall be of the minimum size possible commensurate with safe working practices and located as shown on the plans. Where no such locations are given, the Contractor shall determine such locations. Shaft locations shall, where possible, be kept clear of intersections and within a single traffic lane in order

to minimize disruption to the flow of traffic. The contractor shall furnish, install, and operate pumps, pipes, appliances, and equipment to keep the jacking shaft free from water. The design of the shafts shall ensure safe exit from the driving shaft and entry into the receiving shaft of the tunneling shield and provide sufficient backstop capacity to resist the forces developed by the thrust jacks.

254.04.07 – EXECUTION

Methods of construction for the shafts, jacking pits, or other components of the construction shall be such as to ensure the safety of the work, Contractor's employees, the public, and adjacent property, whether public or private.

All shafts and jacking pits shall conform with applicable Trench Safety Standards and OSHA excavation, trenching, and shoring standards which are contained in the Code of Federal Regulations 25 (CFE) 1925.650 - 1925.653.

Shafts and jacking pits shall be adequately ventilated. Air monitoring of the shafts or pits shall be conducted on a continuous basis. Threshold limits of the gas concentrations monitored shall be:

Gas Type	Concentration Threshold Limit
Carbon Monoxide	? 0.005%
Methane	? 0.25%
Hydrogen Sulfide	? 0.001%
Oxygen	? 20.0%

All work of excavating, shoring, and bracing and tunneling shall be so executed that settlement is minimized.

Before beginning construction at any location, the contractor must adequately protect existing structures, utilities, trees, shrubs, and other permanent objects. The repair of or compensation for damage to permanent facilities due to negligence or lack of adequate protection on the part of the Contractor shall be at no cost to the City.

Excavation face pressure on the tunnel shield shall be maintained at all times between the measured active earth pressure and fifty percent (50%) of the computed passive earth pressure. Fluid pressure applied at the face to balance the ground water shall be maintained at a level slightly in excess of normal hydrostatic pressure and shall be monitored continuously.

The machine shall be operated so as to prevent either surface heave or loss of ground during tunneling, and shall be steerable to maintain line and grade within the tolerances specified. This shall be achieved by continuously monitoring line, level inclination, and steering attitude during the operation. When the earth pressure slurry balance system is used, the composition of the slurry must be carefully monitored for specific gravity and viscosity, particularly with sizes in excess of twenty-four inches (24”) in internal diameter.

The thrust reaction backstop shall be properly designed and constructed. The backstop shall be normal to the proposed pipe alignment. The thrust wall shall be designed to support the maximum obtainable jacking pressure developed by the main jacking system. Special care shall be taken when setting the pipe guide rails in the starter shaft to ensure correctness of the alignment, grade, and stability. The shield is not to be jacked until the concrete thrust block (if selected) and the treated soil zone (if required) in the driving shaft have attained their required strength.

The pipe shall be jacked in place without damaging the pipe joints or completed pipe section. Any pipe that has been damaged during installation shall be replaced by the Contractor. The cost of replacement or installation of a new pipe shall be at no additional cost to the City.

All excavated material from tunnel and shaft construction shall be disposed of. No stockpiling shall be permitted on the construction site. Material shall be removed at regular intervals not exceeding forty-eight (48) hours.

All excavation and backfilling shall be accomplished in accordance with the requirements established in Section 212.

The Contractor shall monitor ground movements associated with the work and maintain these within permissible tolerances. Surface settlement and heave monitoring points shall be located along the line of the tunnel. The contractor shall install instrumentation, take readings, and provide the Engineer with copies, all in accordance with these specifications. These actions are meant to supplement the Contractor's monitoring system and do not relieve the Contractor of his responsibility, nor place on the Engineer, responsibility for control of ground movement and protection of the work and adjacent structures.

254.06 – METHOD OF MEASUREMENT

"Microtunneling" or "Small-Diameter Tunneling" shall be measured by the lineal foot of pipe completed. Payment for "Microtunneling" or "Small-Diameter Tunneling" shall be made at the unit price bid per lineal foot for each size, complete in place, as provided in the Proposals. The price established shall be full compensation for dewatering shafts, sheeting shoring and bracing, drainage, providing access shafts or portals, disposal of surplus excavated materials, including excavation and backfill and replacement of surface, or other improvements, furnishing all labor, tools, equipment, and incidentals, furnishing and installing the waterline pipe, steel casing pipe and performing all that is required to construct the tunnel as shown on the plans and called for in these specifications.

254.07 – BASIS OF PAYMENT

The items measured as provided above will be paid for at the contract unit price bid:

MICRO-TUNNELING (SIZE)	L.F.
SMALL DIAMETER TUNNELING (SIZE)	L.F.

Such payment shall be compensation in full for furnishing all materials, labor, equipment, tools and incidentals, and for performing the work in accordance with these specifications.

SECTION 290 – EARTHWORK CONSTRUCTION STANDARD BID ITEMS

290.01 – DESCRIPTION

This section covers Standard Bid Items used in the contract documents for the construction of earthwork. Additional bid items may be called out in the Special Provisions, other sections of the Standard Specifications, or as directed by the Engineer for additional work covered and change orders.

SECTION	CODE	DESCRIPTION	UNIT
200	200-00	UNCLASSIFIED EXCAVATION	C.Y.
200	200-01	UNSUITABLE MATERIAL EXCAVATION	C.Y.
200	200-02	EXCESS EXCAVATION	C.Y.
201	201-00	EMBANKMENT	C.Y.
202	202-00	BORROW	C.Y.
211	211-00	DEWATERING	L.F.
212	212-01	TRENCH EXCAVATION AND BACKFILL - ZERO (0') FT TO TEN (10') FT	L.F.
212	212-02	TRENCH EXCAVATION AND BACKFILL - ZERO (0') FT TO FIFTEEN (15') FT	L.F.
212	212-03	TRENCH EXCAVATION AND BACKFILL - ZERO (0') FT TO TWENTY (20') FT	L.F.
212	212-04	TRENCH EXCAVATION AND BACKFILL - ZERO (0') FT TO TWENTY-FIVE (25') FT	L.F.
212	212-05	TRENCH EXCAVATION AND BACKFILL - ZERO (0') FT TO THIRTY (30') FT	L.F.
212	212-06	TRENCH LINEAL MEASUREMENT	L.F.
212	212-07	STRUCTURAL EXCAVATION	C.Y.
213	213-01	CRUSHED ROCK FOUNDATION	C.Y.
213	213-02	CRUSHED ROCK FOUNDATION	TON
214	214-00	LEAN MIX CONCRETE FOUNDATION	C.Y.
215	215-01	EMBEDMENT MATERIAL	C.Y.
215	215-02	EMBEDMENT MATERIAL	TON
216	216-01	CONCRETE CRADLE PLAIN	C.Y.
216	216-02	CONCRETE CRADLE TYPE I REINFORCEMENT	C.Y.
216	216-03	CONCRETE CRADLE TYPE II REINFORCEMENT	C.Y.
217	217-01	CONCRETE ARCHES PLAIN,	C.Y.
217	217-02	CONCRETE ARCHES TYPE I REINFORCEMENT	C.Y.
217	217-02	CONCRETE ARCHES TYPE II REINFORCEMENT	C.Y.
218	218-00	EMBEDMENT PLUGS (TYPE)	EA.
220	220-00	SUBGRADE	S.Y.
221	221-00	NATURAL SOIL BASE	S.Y.
222	222-01	FLY ASH	TON
222	222-02	LIME	TON
222	222-03	CEMENT KILN DUST	TON
222	222-04	PORTLAND CEMENT	TON
222	222-05	CEMENTITIOUS STABILIZED SUBGRADE	S.Y.
222	222-06	LIME STABILIZED SUBGRADE	S.Y.

SECTION	CODE	DESCRIPTION	UNIT
222	222-07	LIME PRETREATMENT	S.Y.
225	225-00	AGGREGATE BASE	C.Y.
226	226-01	PROCESSING EXISTING BASE AND SURFACE, METHOD A	STA.
226	226-02	PROCESSING EXISTING BASE AND SURFACE, METHOD B	STA.
226	226-03	PROCESSING EXISTING BASE AND SURFACE, METHOD C	STA.
226	226-04	PROCESSING EXISTING BASE AND SURFACE, METHOD D	STA.
251	251-01	JACKING (SIZE)	L.F.
251	251-02	JACKING - (PIPE SIZE)	L.F.
251	251-03	JACKING - CASING (SIZE)	L.F.
252	252-01	BORING (SIZE)	L.F.
252	252-02	BORING (PIPE SIZE)	L.F.
252	252-03	BORING - CASING (SIZE)	L.F.
253	253-00	TUNNELING (SIZE)	L.F.
254	254-01	MICRO-TUNNELING (SIZE)	L.F.
254	254-02	SMALL DIAMETER TUNNELING (SIZE)	L.F.