SECTION 02301

EARTHWORK

PART 1 – GENERAL

1.01 SUMMARY

A. Section Includes: Perform all excavation, shoring, dewatering, backfilling, compaction and grading necessary or required for the construction of the work as covered by these Specifications and indicated on the Drawings. The excavation shall include the removal and disposal of all materials of whatever nature encountered, including water, rock, and all other obstructions that would interfere with the proper construction and completion of the required work.

1.02 REFERENCES

A. American Society for Testing and Materials (ASTM).

B. State of California, Department of Transportation, Standard Specifications (Standard Specifications).

C. State of California, Department of Transportation, Manual of Test (California Test).

1.03 SUBMITTALS

A. Submit in accordance with Section 01300.

B. Submit the following under the Product Information category.

1. Sheeting and Shoring Plan: Refer to paragraph 1.08, below and Section 01040, paragraph 1.14.
2. Samples and Test Results: Furnish, without additional cost to the Owner, such quantities of import materials as may be required by the Engineer for test purposes. Cooperate with the Engineer and furnish necessary facilities for sampling and testing of all materials and workmanship. Submit test results for import materials. Tests shall be performed within sixty (60) days of the submission. All material furnished and all work performed shall be subject to rigid inspection, and no material shall be delivered to the site until it has been favorably reviewed by the Engineer, or used in the construction work until it has been inspected in the field by the Engineer.

1.04 QUALITY ASSURANCE

A. Source Quality Control: Test import materials proposed for use to demonstrate that the materials conform to the specified requirements. Tests shall be performed by an independent certified testing laboratory.

B. Field Quality Control:
   1. The Owner will provide earthwork testing services, including compaction tests. The Contractor shall excavate holes for in-place soil sampling.
   2. The Owner will pay for initial tests. The Contractor will be charged $150 per test for retests resulting from non-compliance.

C. Testing Methods:
   1. Durability Index: Manual of Test, State of California, Department of Transportation.
   2. Specific Gravity: ASTM D854
   3. Laboratory Compaction: ASTM D1557, Method A or C.
   4. In-place Density: ASTM D1556 or ASTM D2922, at the Engineer's option.
   5. Particle Size Analysis of Soils: ASTM D422.
   6. Plastic Limit and Plasticity Index: ASTM D4318.
   7. Soil Classification: ASTM D2487.
   8. In-place Moisture Content: ASTM D3017.

D. Definition:
   1. Relative Compaction: In-place density divided by the maximum dry density laboratory compaction expressed as percentage.

1.05 EXPLOSIVES

A. Do not use explosives unless specifically authorized, in writing, by the Engineer.

B. Any construction procedure elected by the Contractor which involves the use of explosives shall be performed in accordance with all applicable Federal, State, and local laws and regulations. The Contractor shall obtain all permits required for such use of explosives and shall have complete responsibility for their transportation, storage, and use.

1.06 SUBSURFACE INVESTIGATIONS

A. See Supplementary Conditions SC-20.

B. The bidders may make additional subsurface investigations at the site prior to the bidding of the project. Prior to making any drillings or excavations, the bidder shall secure permission from the Owner, and property owners if on private property.

1.07 REFERENCE SPECIFICATIONS

A. Whenever the words "Standard Specifications" are referred to, the reference is to the State of California, Department of Transportation, Standard Specifications dated January 1992 (or latest edition).

1.08 ADDITIONAL SAFETY RESPONSIBILITIES

A. The Contractor shall select, install and maintain shoring, sheeting, bracing, and sloping as necessary to maintain safe excavations. The Contractor shall be responsible for ensuring such measures: (1) comply fully with 29 CFR Part 1926 OSHA Subpart P Excavations and Trenches requirements, (2) provide necessary support to the sides of excavations, (3) provide safe access to the Engineer's sampling and testing within the excavation, (4) provide safe access for backfill, compaction, and compaction testings, and (5) otherwise maintain excavations in a safe manner that shall not endanger property, life, health, or the project schedule. All earthwork shall be performed in strict accordance with applicable law, including local ordinances, applicable OSHA, CalOSHA, California Civil Code, and California Department of Industrial Safety requirements.

PART 2 – PRODUCTS

2.01 MATERIALS

A. Granular Bedding Material:

1. Type A material shall consist of natural sand obtained from acceptable pits. The sand shall be in accordance with Standard Specifications paragraph
19-3.025B, and shall have a minimum sand equivalent of 50, as determined by CALTEST 217-G.
No Type A material shall be used unless it has been accepted by the Engineer. Reports on the material from an independent testing laboratory shall be submitted for the Engineer's review.
2. Type B material shall be Class 2 aggregate base, 3/4-inch maximum, in accordance with Standard Specifications paragraph 26-1.02A. Submit test reports as specified for Type A material, or a past test report for material from the same pit to be used on this project.
3. Type C material shall be crushed rock free from organic matter and of such size and graduation that the desired compaction can be readily attained. When tested in accordance with ASTM D422, it shall conform to the following requirements:

U.S. Standard Sieve Size	Percent by Weight Passing
3/4-inch	100
1/2-inch	85 – 100
3/8-inch	20 – 60
No. 4	0 – 10

No Type C material shall be used unless it has been accepted by the Engineer. Submit test reports as specified for Type A material.

4. Type D material shall be a blend of granular materials having a sand equivalent not less than 20, meeting the following requirements:

U.S. Standard Sieve Size	Percent by Weight Passing
3/4-inch	100
No. 4	80 – 100

No Type D material shall be used unless it has been accepted by the Engineer. Submit test reports as specified for Type A material.

B. Select Native Material: Select native material shall consist of 3-inch-minus material from excavations, or from other sources obtained by the Contractor. The material shall be inorganic and reasonably well graded from coarse to fine with at least 70 percent by weight passing the 2-inch sieve.

In the event that adequate quantities of select native material cannot be obtained from excavation, then the Contractor shall acquire material conforming to the Specifications from other sources, or use the hereinbefore specified Granular Pipe Bedding Material. Imported material, if any, shall be obtained by the Contractor at no additional cost to the Owner.

C. Slurry Cement Backfill: Slurry cement backfill shall conform to Standard Specifications, Section 19-3.062 (1992). Slurry cement backfill shall consist of a fluid, workable mixture of aggregate, cement, and water. The aggregate, cement, and water shall be proportioned either by weight or by volume. Not less than 188 pounds of cement shall be used for each cubic yard of material produced. The water content shall be sufficient to produce a fluid, workable mix that will flow and can be pumped without segregation of the aggregate while being placed. Grading of the aggregate shall be as follows:

U.S. Standard Sieve Size	Percent by Weight Passing
1-1/2 -inch	100
1 inch	80 – 100
3/4-inch	60 – 100
3/8-inch	50 – 100
No. 4	40 – 80
No. 100	10 – 40

D. Drain Rock: Standard Specifications, paragraph 68-1.025 Class I, maximum size as shown on the Drawings.

E. Pea Gravel: River-run, rounded pea gravel with a maximum dimension no larger than 1/2-inch, and with no more than 10% passing the No. 200 sieve. The material shall have a durability index of 40 or higher.

F. Structural Backfill: Imported material, or processed select native material, meeting the following requirements:

1. Gradation criteria:

U.S. Standard Sieve Size	Percent by Weight Passing
4-inch	100
3/4-inch	70 min.
No. 4	60 min.

2. Sand equivalent not less than 20.
3. Liquid limit not greater than 35.
4. Plastic limit not greater than 12.
5. Sufficient binder to allow minor excavations.

G. Impervious Material: Clay with a minimum percentage of material passing the No. 200 sieve of 50%. The material shall be free of organics, rocks, or clods greater than 4 inches in diameter.

H. Water: The water used shall be reasonably free of objectionable quantities of silt, oil, organic matter, alkali, salts and other impurities. Water quality must be acceptable to the Engineer.

PART 3 – EXECUTION

3.01 CONTROL OF WATER

A. All excavations shall be kept free from water and all construction shall be in the dry.

1. It should be presumed that the presence of groundwater will require dewatering operations. Furnish, install, maintain, and operate all necessary pumping and other equipment for dewatering all excavations. At all times have on the project sufficient pumping equipment for immediate use, including standby pumps for use in case other pumps become inoperable.
2. Provide a sufficient number of pumps so as to hold the groundwater level at an elevation of not less than 1 foot below the lowest elevation of the pipe, duct or other material to be placed.
3. Dispose of water in such a manner as to cause no injury or nuisance to public or private property, or be a menace to the public health.
4. The dewatering operation shall be continuous, so that the excavated areas shall be kept free from water during construction, while concrete is setting and achieves full strength, and until backfill has been placed to a sufficient height to anchor the work against possible flotation.
5. Continue dewatering during backfilling operations such that the groundwater is at least 1 foot below the level of the compaction effort at all times. No compaction of saturated materials will be allowed.
6. Dewatering devices must be adequately filtered to prevent the removal of fines from the soil.
7. The Contractor shall be responsible for any damage to the foundations or any other parts of existing structures or of the new work caused by failure

of any part of the Contractor's protective works. After temporary protective works are no longer needed for dewatering purposes, they shall be removed by the Contractor.

8 If pumping is required on a 24-hour basis, requiring engine drives, then engines shall be equipped in a manner to keep noise to a minimum. Refer to Section 01140 for noise control requirements.

9. Prevent disposal of sediments from the soils to adjacent lands or waterways by employing whatever methods are necessary, including settling basins.

B. The Contractor shall be responsible for furnishing temporary drainage facilities to convey and dispose of surface water falling on or passing over the site.

3.02 EXISTING UTILITIES

A. General: The known existing utilities and pipelines are shown on the Drawings in their approximate location. The Contractor shall exercise care in avoiding damage to all utilities, as he will be held responsible for their repair if damaged. There is no guarantee that all utilities or obstructions are shown, or that locations indicated are accurate. Utilities are piping, conduits, wire, cable, ducts, manholes, pull boxes and the like.

B. Check on Locations (Potholing):

1. Contact all affected utility owners and request them to locate their respective utilities prior to the start of "potholing" procedures. The utility owner shall be given seven (7) days written notice prior to commencing potholing. If a utility owner is not equipped to locate its utility, the Contractor shall locate it.
2. Clearly paint the location of all affected utility underground pipes, conduits and other utilities on the pavement or identify the location with suitable markers if not on pavement. In addition to the location of metallic pipes and conduits, non-metallic pipe, ducts and conduits shall also be similarly located using surface indicators and detection tape, if present, and shall then be similarly marked.
3. After the utility survey is completed, commence "potholing" to determine the actual location and elevation of all utilities where crossings, interferences, or connections to new pipelines or other facilities are shown on the Drawings, marked by the utility companies, or indicated by surface signs. Prior to excavating for any new pipelines or structures, the Contractor shall locate and uncover these existing utilities, including services and laterals, to a point 1 foot below the utility. Any variation in the actual elevations and the indicated elevations shall be brought to the Engineer's attention.
4. Excavations around underground electrical ducts and conduits shall be performed using extreme caution to prevent injury to workmen or damage to electrical ducts or conduits. Similar precautions shall be exercised around gas lines, telephone and television cables.
5. Backfill after completing potholing. In existing streets pave with 1-inch of cold mix asphalt concrete.

C. Interferences: If interferences occur at locations other than shown on the Drawings, the Contractor shall notify the Engineer, and a method for correcting said interferences shall be supplied by the Engineer. Payment for interferences that are not shown on the plans, nor which may be inferred from surface indications, shall be in accordance with the provisions of the General Conditions, Article 11.

D. Any necessary relocations of utilities, whether shown on the Drawings or not, shall be coordinated with the affected utility. The Contractor shall perform the relocation only if instructed to do so in writing from the utility and the Engineer.

3.03 GENERAL CONSTRUCTION REQUIREMENTS

A. Site Access: Access to the site will be over public and private roads. Exercise care in the use of such roads and repair at own expense any damage thereto caused by Contractor's operations. Such repair shall be to the satisfaction of the Owner or agency having jurisdiction over the road. Take whatever means are necessary to prevent tracking of mud onto existing roads and shall keep roads free of debris.

B. Barriers: Barriers shall be placed at each end of all excavations and at such places along excavations as may be necessary to warn all pedestrian and vehicular traffic of such excavations.

C. Demolition of Pavement: Where trenching or excavation occurs in paved areas, the pavement shall be scored and broken ahead of the trenching or excavation operation. The extent of paving removed shall be limited to the minimum necessary for the excavation.

D. Environmental Protection Procedures: Refer to Section 01140.

E. Storage of Materials: Neatly place excavated materials far enough from the excavation to prevent stability problems. Keep the materials shaped so as to cause the least possible interference with plant operations and drainage.

3.04 SITE GRADING

A. Clear, grub and strip in accordance with Section 02200. Grubbing is not required in areas to be excavated; however, excavated material to be used as fill shall not contain organic material. Refer to paragraph 2.01 of this Section.

B. Rough Grading: After completion of stripping, rough grade cut areas to the lines, grades and contours shown on the Drawings.

C. Fills:

1. Scarify to a minimum 6-inch depth all areas where fills are required. Moisture condition the scarified surface to within 2% of optimum water content, and compact to minimum 90% relative compaction. Do not place any fill until the Engineer has inspected, tested to his satisfaction, and favorably reviewed the prepared subgrade.

2. Construct fills as shown on the Drawings, true to line, grade and cross section. Construct fills of select native material unless otherwise specified. Place material in approximately 8-inch-thick horizontal layers measured before compaction, and carried across the entire width to the required slopes. Compact all fills to a relative compaction of at least 90% unless otherwise specified. Properly moisture condition before compaction.
3. Where fills are to be made and compacted on sloping ground surfaces, steeper than 5:1, such slopes shall be benched a minimum of 6 feet horizontally as the work is brought up. This requirment shall apply unless a more restrictive recommendation is made in the geotechnical report. Recompact material thus removed by benching along with the new embankment material.
4. It may be necessary to overbuild slopes and trim back to the compacted core to achieve adequate compaction of slope faces.

D. Ditches: Cut ditches accurately to the cross sections and grades shown. Take care not to overexcavate ditches, and backfill excessive excavation to grade. Trim all roots, stumps, rock and other foreign matter from the sides and bottom of the ditches. Compact the surfaces of ditch slopes and bottom.

3.05 TRENCH EXCAVATION

A. Excavation for pipe and other utilities such as duct banks shall be in open cut. The trench shall be as wide as necessary for sheeting and bracing and the proper performance of the work up to the maximum width permitted by the typical cross sections shown on the Drawings. The sides of the trenches shall be vertical in paved areas. The bottom of the trench shall be constructed to the grades and shapes indicated on the Drawings. Should the Contractor desire to use other equivalent methods, he shall submit his method of construction to the Engineer for favorable review prior to its use.

B. Take care not to overexcavate. Accurately grade the bottom of the trenches to provide uniform bearing and support for each section of the pipe or conduit at every point along its entire length, except for the portions of the pipe sections where it is necessary to excavate for bell holes and for the proper sealing of pipe joints, and as hereinafter specified. Dig bell holes and depressions for joints after the trench bottom has been graded. In order that the pipe rest on the bedding for as nearly its full length as practicable, bell holes and depressions shall be only of such length, depth and width as required for properly making the joint. Remove stones as necessary to avoid point bearing.

C. Backfill and compact overexcavations to 95% relative compaction with Type A or Type B material. There shall be no additional payment to the Contractor for overexcavations not directed by the Engineer. Remove unsatisfactory material encountered below the grades shown as directed by the Engineer and replace with Type A or Type B material. Removal and replacement of such unsatisfactory material directed by the Engineer shall be paid for as extra work by a Change Order.

D. Grade trenches so that they are uniformly sloped between the pipe elevations shown on the Drawings. If no elevations are shown on the Drawings, provide 3 feet of minimum cover. Comply with the minimum and maximum trench widths shown on the Drawings. Notify the Engineer if the trench width exceeds the maximum allowable width for any reason.

E. For all piping or conduits to be placed in any excavated and backfilled area, such as at connections to structures, the structural backfill shall be first compacted to a level at least 3 feet from the top of the piping or conduit elevation and then retrenched to pipe grade.

F. Provide ladders for access to the trench by construction and inspection personnel.

3.06 EXCAVATION FOR STRUCTURES

A. All excavation for structures shall be done to the dimensions and levels indicated on the Drawings or specified herein. Excavate to such width outside the lines of the structure to be constructed as may be required for proper working methods, the erection of forms and the protection of the work.

B. Take care to preserve the foundation surfaces in an undisturbed condition. If the Contractor overexcavates or disturbs the foundation surfaces, without written authorization of the Engineer, he shall replace such foundations with concrete fill or other material approved by the Engineer in a manner which will show by test an equal bearing value with the undisturbed foundation material. No additional payment will be made for the added quantity of concrete fill or other material used because of overexcavation.

C. Inspection of Excavation: Notify the Engineer when excavation for the structure is complete. No forms, reinforcing steel, concrete, or precast structure shall be placed until the excavation has been inspected by the Engineer.

D. Where unsatisfactory material is encountered below the grades shown for structural excavations, it shall be removed and replaced with selected material as directed by the Engineer and compacted. Removal and replacement of such unsatisfactory material directed by the Engineer shall be paid for as extra work by a Change Order.

3.07 SUPPORT OF EXCAVATIONS

A. Adequately support excavation for trenches and structures to meet all applicable requirements in the current rules, orders and regulations. Excavation shall be adequately shored, braced and sheeted so that the earth will not slide or settle and so that all existing structures and all new pipe and structures will be fully protected from damage. Keep vehicles, equipment, and materials far enough from the excavation to prevent instability.

B. Take all necessary measures to protect excavations and adjacent improvements from running, caving, boiling, settling, or sliding soil resulting from the high

groundwater table and the nature of the soil excavated. Attention is directed to Section 832 of the Civil Code of the State of California relating to lateral subadjacent supports, and wherever structures or improvements adjacent to the excavation may be damaged by such excavation, the Contractor shall comply with this law.

C. The support for excavation shall remain in place until the pipeline or structure has been completed. During the backfilling of the pipeline or structure, the shoring, sheeting and bracing shall be carefully removed so that there shall be no voids created and no caving, lateral movement or flowing of the subsoils.

3.08 TRENCH BACKFILL

A. Place bedding and backfill materials true to the lines, grades, and cross sections indicated on the Drawings and compacted to the degree specified on the Drawings. Place bedding and backfill materials in horizontal lifts not to exceed 8 inches in thickness measured before compaction. The difference in level on either side of a pipe shall not to exceed 4 inches.

B. Backfill material shall not be placed over the pipe or conduit until after the joints have been completed and inspected by the Engineer.

C. The Contractor shall protect the pipe or conduit from damage during the construction period and shall repair broken or damaged pipe at no extra cost to the Owner. Carefully place backfill around and over the pipe and do not allow it to fall directly upon the pipe. Tamping of backfill over the pipe shall be done with tampers, vibratory rollers and other machines that will not injure or disturb the pipe.

D. Do not allow construction traffic nor highway traffic over the pipe trench until the trench backfill has been brought back even with existing adjacent grade.

3.09 STRUCTURAL BACKFILL

A. Crushed Rock Subgrade: Place a layer of Type C material, compacted to at least 95% relative compaction under structures to the lines, grades and minimum thicknesses shown on the Drawings. Unless shown specifically otherwise in the Drawings, do not use rock as backfill above the elevation of the highest base slab of the structure.

B. Backfill Adjacent to Structures:
   1. Backfill shall be Structural Backfill compacted to at least 90% relative compaction.
   2. Do not place backfill against structures until the concrete has been patched and cured.
   3. Do not place backfill against structures until at least twenty-eight (28) days after the concrete was placed, or until the concrete has achieved a strength of at least 2,500 psi, whichever is earlier. Concrete strength shall be demonstrated by field cured cylinders tested at the

Contractor's cost, prepared and tested in accordance with ASTM C31 and ASTM C39.

4. Do not place backfill against hydraulic structures until the structure has passed the specified leakage tests.
5. Place backfill in uniform, level layers, not exceeding 8 inches thick measured before compaction. Bring backfill up uniformly on all sides of the structure, and on both sides of buried walls.

3.10 RETAINING WALL/TANK FOUNDATION

A. Retaining Wall:
   1. Construct the retaining wall such that the vertical face of the toe and the entire bottom of footing is placed against undisturbed native material, as shown on the Drawings.
   2. Do not backfill behind the retaining wall until:
      a. The tank ringwall has cured a minimum of seven (7) days.
      b. Pipe trenches and other excavations within 10 feet of the retaining wall have been excavated and backfilled.

B. Excavate the area within the outside perimeter of the tank ringwall to the elevation shown on the Drawings. Backfill in accordance with paragraph 3.04 of this Section, using structural backfill material, except that scarifying is not required. Moisture condition to approximately 2% above optimum before compaction.

C. Construct the tank ringwall in an excavated trench such that:
   1. Contractor shall follow the guidelines and recommendations contained in the Geotechnical Report prepared for this project, if any.
   2. The bottom of the ringwall bears against undisturbed, competent native material.
   3. The outside vertical surface of the ringwall bears against undisturbed, competent native material, except for westerly portion of the tank area as specified below. Outside of the ringwall perimeter, do not excavate below the subgrade required for paving, except for the following:
      a. Retaining wall footing.
      b. Pipe trenches.
      c. The westerly portion of the tank area that requires fill. Within 5 feet of the outside of the ringwall, remove surface soils to competent material. Construct fill in accordance with paragraph 3.04 of this Section or per the Geotechnical Report prepared for this project, whichever is more restrictive, using structural backfill material, to no lower than the subgrade required for paving. Excavate the ringwall trench into this material.

3.11 NOT USED

3.12 COMPACTION

A. Add water to the backfill material or dry the material as necessary to obtain a moisture content within 2% of optimum. Employ such means as may be

necessary to secure a uniform moisture content throughout the material of each layer being compacted.

B. After the material has been moisture conditioned, compact it with compaction equipment appropriate for the use to achieve specified compaction.

C. If the backfill material becomes saturated from rains or any other source because it was not compacted to the specified density or was not backfilled and compacted to surface grade, through negligence or otherwise, remove the faulty material and replace it with suitable material compacted to the specified density. No additional payment will be made for doing such work or removal and replacement.

D. Compaction of embankment and backfill materials by flooding, ponding or jetting will not be permitted.

E. When densities of compacted materials do not meet the requirements, remove and/or recompact the material until the requirements are met. The Contractor will be backcharged the cost of retesting all failing tests, including the initial retest. Such backcharges will be deducted from the Contractor's Progress Payments.

3.13 FINISH GRADING

A. Finish grade the site to the elevations shown on the Drawings. Finish grading shall be uniform and pleasing and shall provide drainage from all areas to collection points. The finished surfaces shall be smooth and compacted.

3.14 DISPOSAL OF EXCAVATED MATERIAL

A. Dispose of unsuitable material or excavated material in excess of that needed for backfill or fill offsite in accordance with the requirements of Section 01140.

END OF SECTION