



SECTION 31 00 00 – EMBANKMENT CONSTRUCTION

PART 1 – GENERAL

1.01 DESCRIPTION

- A. The work covered by this section consists of furnishing all labor, and materials, and performing all operations necessary for the construction of embankments and fills, including the foundation preparation, placement of embankment materials, construction of ramps, and other incidental earthwork as may be necessary to complete the embankments and fills, as specified herein, as shown on the plans, or as otherwise directed by the County.

1.02 REFERENCES

- A. American Society for Testing of Materials (ASTM) Standards:

D6913	Particle-Size Distribution of Soils Using Sieve Analysis
D698	Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort
D1556	Test Method for Density of Soil in Place by the Sand Cone Method
D2487	Standard Practice for Classification of Soils for Engineering Purposes
D4318	Test Method for the Liquid Limit and Plastic Limit of Soils
D6913	Standard Test Methods for Particle-Size Distribution (Gradation) of Soils Using Sieve Analysis
D6938	In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth)

- B. State of California, Department of Transportation (CALTRANS)

1. 2024 State Standard Specifications



1.03 GENERAL REQUIREMENTS

- A. With reference to the terms and conditions of the construction standards for excavations set forth in OSHA "Safety and Health Regulations for Construction", Chapter XVII of Title 29, CFR, Part 1926, Cal OSHA "Construction Safety Orders" Title 8, California State Labor Code 6705, and requirements listed in the General Conditions; Contractor shall employ a competent person and, when necessary based on the regulations, a licensed professional engineer, to act upon all pertinent matters of the work of this section.
 - 1. Refer to Section 31 23 16, "Dewatering" for dewatering, excavation, and shoring requirements.
- B. Refer to the project Stormwater Pollution Prevention Plan (SWPPP) for the recommended placement of Best Management Practices (BMPs) including inlet protection, concrete washout, and erosion control of disturbed soil areas. Install BMPs as indicated in the SWPPP prior to disturbing any site soils.

1.04 SUBMITTALS

- A. Submit for review in accordance with Section 01 33 00, "Submittal Procedures", the following:
 - 1. Surveys: Submit all point data within ten (10) days of performing field surveys.
 - 2. Product Data: Submit gradations and other required test data for all materials and earthwork components.
- B. Refer to Section 31 23 16, "Dewatering" for Dewatering Plan, and Excavation and Shoring Plan submittal requirements.

PART 2 – PRODUCTS

2.01 MATERIALS

- A. Engineered Fill. The engineered fill shall be constructed of earth obtained from the onsite excavations as prescribed in Section 31 23 16, "Structure Excavation and Backfill" or suitable material sourced and imported by the Contractor. Some earthen materials may be present within the onsite excavations which do not meet the requirements for Atterberg Limits or gradation. These excavated materials shall not be classified as unsuitable or wasted but shall be uniformly blended with other excavated materials until, in the opinion of the County, the blended material is suitable for engineered fill embankment construction. All blending of materials shall be performed prior to placement in the embankment section.



- B. If a disagreement between the Contractor and the County occurs over the suitability of blended materials, the Contractor shall perform laboratory testing to demonstrate compliance with the specifications. The testing by the Contractor shall comply with 3.08, Field Quality Control. The failure of the Contractor to perform the testing shall not relieve the Contractor from the obligation to provide suitable materials.
- C. Engineered Fill Material. Suitable engineered fill material shall consist of low to high plasticity soils classified in accordance with ASTM D 2487 as lean clay (CL), silty clay (CL-ML), silt (ML), or clayey sand (SC). Individual test results shall have a minimum of 20 percent passing the No. 200 standard sieve, 100 percent passing the 2-inch sieve, liquid limit of 50 or less, and plasticity index greater than or equal to 8 and less than or equal to 25.

2.02 EQUIPMENT

- A. Tamping Rollers. Tamping rollers shall consist of a heavy-duty double drum unit. The drums shall be water or sand-and-water ballasted. Each drum shall have staggered feet uniformly spaced over the cylindrical surface such as to provide approximately three tamping feet for each two square feet of drum surface. The tamping feet shall be six to nine inches in clear projection from the cylindrical surface of the roller and shall have a face area of not less than five or more than seven square inches. The roller shall be equipped with cleaning fingers, so designed and attached as to prevent the accumulation of material between the tamping feet, and these cleaning fingers shall be maintained at their full length throughout the periods of use of the roller. The weight of the roller shall not be less than 3,500 pounds per foot of linear drum length weighted and shall not be more than 2,000 pounds per foot of drum length empty. The two drums comprising one roller unit shall be yoked such that they will oscillate when traversing uneven surfaces. The design and operation of the tamping roller shall be subject to the approval of the County who shall have the right at any time during the prosecution of the work to direct such repairs to the tamping feet, minor alterations in the roller and variations in the weight as may be found necessary to secure optimum compaction of the earth fill materials. The Contractor may be required to add ballast to the roller to the maximum capacity specified by the manufacturer of the roller. The roller shall be drawn by a crawler-type or a rubber-tired tractor at a speed not to exceed 3.5 miles per hour. The use of the rubber-tired tractor shall be discontinued if the tires leave ruts that prevent uniform compaction by the tamping roller.



- B. Self-Propelled Rollers. At the option of the Contractor, self-propelled tamping rollers may be used in lieu of tractor-drawn tamping rollers. Self-propelled rollers exceeding the empty weight requirement may be used, provided that by the substitution of tamping feet having a face area not exceeding 30 square inches, the nominal foot pressure on the tamping feet of the self-propelled roller can be adjusted to approximate the nominal foot pressure of the towed roller for the particular working condition required for the towed rollers. For self-propelled rollers, in which steering is accomplished through the use of rubber-tired wheels, the tire pressure shall not exceed 40 pounds per square inch. Self-propelled rollers shall be operated at a speed not to exceed 3.5 miles per hour.
- C. Rubber-tired Rollers. Rubber-tired rollers shall have a minimum of four (4) wheels equipped with pneumatic tires. The tires shall be of such size and ply as to be capable of being operated at tire pressures between 80 and 100 pounds per square inch at a 25,000-pound wheel load. The roller wheels shall be located abreast and so designed that each wheel will carry approximately equal load in traversing uneven ground. The spacing of the wheels shall be such that the distance between the nearest edges of adjacent tires will not be greater than 50% of the rated tire width of a single tire at the operating pressure for a 25,000-pound wheel load. The roller shall be provided with a body suitable for ballast loading such that the load per wheel may be varied, as directed by the County, from 18,000 to 25,000 pounds. The roller shall be towed at a speed not to exceed five (5) miles per hour. The character and efficiency of this equipment shall be subject to the approval of the County.
- D. Smooth Drum Rollers. Smooth drum rollers shall not be used except for compaction of final finished grades.
- E. Sprinkling Equipment. Sprinkling equipment shall consist of tank trucks, pressure distributors, or other equipment designed to apply water uniformly and in controlled quantities to variable widths of surface.
- F. Crawler-type Tractors. Crawler-type tractors used for spreading or compaction shall weigh not less than 20,000 pounds, shall exert a unit tread pressure of not less than 6 pounds per square inch, and shall not be operated at a speed to exceed 3.5 miles per hour.
- G. Miscellaneous Equipment. Scarifiers, disks, spring tooth or spike tooth harrows, spreaders, and other equipment shall be of approved types, suitable for construction of embankment.

PART 3 – EXECUTION

3.01 EMBANKMENT FOUNDATION PREPARATION



- A. General. After stripping and any over-excavation is complete, and prior to the placement of fill materials, pits and other similar cavities or depressions shall be broken down, where so directed, to flatten out to slopes no steeper than 3 to 1 (horizontal to vertical). The embankment foundation sub-grade shall then be thoroughly scarified to a depth of six (6) inches, moisture conditioned to minus 2 to plus 3 percent of the optimum moisture and compacted to a minimum of 95% of the maximum dry density based upon laboratory test procedure ASTM D698. If, for any cause, this scarified surface, or other surface that is to receive fill, becomes compacted in such a manner that, in the opinion of the County, a plane of seepage or weakness might be induced, it shall again be thoroughly scarified before the placement of any additional fill. All scarifying and breaking of ground surface shall be done parallel to the centerline of the embankment.
- B. Drainage. The foundations receiving embankment, and all partially completed fill shall be kept thoroughly drained.
- C. Unstable Materials. Control the moisture content of all soils during compaction to prevent an unstable (pumping) condition. If the soils are trafficked by a minimum 16,000-pound axle load (65-psi tire pressure) and visible deflection or cracking occurs more than 6 inches from the wheel track, corrective measures shall be implemented. Such measures shall include disking to aerate, chemical treatment, replacement with drier materials, and/or other methods suitable to the County.

3.02 EMBANKMENT CONSTRUCTION

- A. General. Place compacted earthfill in embankments in the dry and compact as specified herein.
- B. Horizontal Layer Construction. The compacted embankment shall be constructed to a sufficient section to achieve the required compaction throughout the finished embankment. Materials to be compacted shall be placed or spread in layers not more than six (6) inches in thickness prior to compaction. Materials excavated to form keyways, inspection trenches, and over excavations, and suitable for use as embankment, shall be blended uniformly with other excavated soils or disposed of as directed by the County. Layers shall be started full out to the slope stakes and shall be carried substantially horizontal with sufficient crown or slope to provide satisfactory drainage during construction. All fill placed on slopes steeper than 5 horizontal to 1 vertical shall be keyed and benched as shown on the Drawings. When, in the opinion of the County, the surface of any compacted layer is too smooth to bond properly with the succeeding layer, it shall be scarified to a depth of 6 inches before the succeeding layer is placed thereon. The degree of compaction required is expressed as a percentage of the maximum dry density, based on laboratory test procedure, ASTM D698. The embankment shall be compacted to a minimum of ninety seven percent (97%) of the maximum dry density.
- C. Moisture Control.
 - 1. The moisture content required is expressed as a percentage, based on



laboratory test procedure ASTM D698. The moisture shall be uniformly distributed throughout the layer prior to compaction and shall be between minus one percent (-1%) and plus three percent (+3%) of the optimum moisture content. If the material is not within the required moisture content, the Contractor will be required to moisture condition the soil.

2. The moisture conditioning of fill materials shall be performed prior to placement in the embankment section. The final minor moisture conditioning may be made on the fill, as required. Harrowing or other approved methods will be required to work the moisture into the material until a uniform distribution of moisture is obtained. Water applied on a layer of fill shall be accurately controlled in amount and distribution so that free water will not appear on the surface during or subsequent to rolling.
 3. If the material is too wet for proper compaction or soft and yielding sub-grade is experienced (pumping), the Contractor will be required to aerate the material to moisture content within the desired limits prior to compaction.
- D. Rolling Operations. The compaction equipment shall conform to the requirements of 2.02, Equipment. If tamping rollers are used in tandem, not more than two rollers in tandem will be permitted. When tamping rollers are used in tandem, the tamper foot spacing shall be offset so that the circumferential rows on the rear drums are in line with the mid-point of the circumferential rows on the forward drums. Each pass of the tamping roller shall overlap the preceding or adjacent pass by not less than one foot. Portions of the embankment that the roller cannot reach for any reason shall be compacted by any approved method.
- E. Dressing. Dress embankment slopes by over-building and cutting back to the required grade. The Contractor may compact the shoulder of each lift during the placement of fill materials to assist in the subsequent dressing of the slopes.

3.03 CROSS SECTIONS

- A. Standard Embankment Sections. The dimensions and slopes of materials shall conform to the applicable embankment and access road sections shown on the Drawings and specified herein.

3.04 ROADS AND RAMPS

- A. Roads. At locations where access roads are destroyed because of the work required under this contract, provide temporary roads, if directed by the County, to give access during the construction period. Remove such facilities to the extent required by the County.



- B. Ramps. Construct road ramps at the locations shown on the Drawings by placement of a compacted fill as specified in 3.01, Embankment Foundation Preparation and 3.02, Embankment Construction. Temporary ramps to be constructed for the Contractor's convenience need not comply with these foundation preparation and embankment construction requirements. Unless otherwise directed by the County, temporary ramps shall be removed prior to completion of the work.

3.05 DITCHES AND DEPRESSIONS

- A. Fill all old pits, ditches, or depressions beyond the limits of the embankment foundation where shown on the Drawings or when required by the County, to the natural surface of the surrounding ground with approved material. Place the fill material in layers or lifts not to exceed six (6) inches in thickness and the only compaction required will be that obtained by the necessary spreading and placement operations, except that the equipment shall be so operated that the tracks are distributed evenly over the surface of each lift.

3.06 GRADE TOLERANCES

- A. General: Embankments shall be constructed to the net grade and cross section shown on the Drawings.
- B. Grade Tolerances: At all points, a tolerance of 0.2 feet above, and 0.0 feet below the prescribed grade will be permitted in the final dressing; provided that any excess material is so distributed that the crown of the embankment drains and there are no abrupt humps or depressions in surfaces or bulges in the width of the crown. The tolerance above grade may be modified at locations where, in the opinion of the County, such modifications will not impair the design or appearance of the structure.

3.07 SLIDES

- A. In the event of the sliding of any part of the embankment or roadway during its construction, or during the one-year period after acceptance, the Contractor shall, upon written order of the County, cut out and remove the slide and then rebuild that portion of the embankment.

3.08 FIELD QUALITY CONTROL

- A. Testing Methods and Frequency. The following tests will be performed by the County for in-place materials. The Contractor shall perform testing as required to control the work.
- B. Pre-Fill Placement. Minimum of five (5) moisture-density relationship tests (ASTM D698), with gradation (ASTM D6913), Atterberg Limits (ASTM D4318), and classification (ASTM D2487) testing for each type of fill material.



C. During Fill Placement:

1. Minimum of one (1) moisture-density relationship test (ASTM D698) with gradation (ASTM D6913), Atterberg Limits (ASTM D4318), and classification (ASTM D2487) testing for each 600 cubic yards of each type of fill material placed, with a minimum of one (1) per shift.
2. Minimum of one in-place density test (Nuclear Method, ASTM D6938, or Sand Cone Method, ASTM D1556) for every 300 cubic yards of fill placed, or a minimum of one test per lift of material, whichever is more frequent and regardless of volume placed. One-point compaction test (at or slightly below the optimum moisture content) for each in-place density test to confirm the validity of the Proctor value by comparison with the family of curves for the type of fill being placed.
3. If the nuclear method of density testing is used, a minimum of one sand cone test for every 10 nuclear tests per shift per fill type shall be performed.
4. In addition to the testing required for each moisture-density relationship, a minimum of one additional gradation and one Atterberg Limits test for every 1,200 cubic yards of fill placed, or a minimum of one test each per shift per type of fill placed.
5. The criteria given above are the minimum (type and frequency) testing requirements. Failing tests should not be applied toward satisfying these requirements; passing re-tests may be included. Additional testing may be requested for any reason by the County.

D. Retesting. Where tests indicate the embankment construction does not meet the specifications, remove and rework the material represented by the test as necessary to comply with the Specifications. Retest reworked areas until they meet the specified percentage of maximum dry density, gradation, plasticity, or organic content. The costs of all retests will be deducted from monies due or to become due to the Contractor.

E. Surveys.

1. The Contractor shall perform pre- and post-construction surveys, which will be spot-checked by the County.
2. Perform pre-construction surveys for embankment quantity measurement after demolition, clearing a grubbing, stripping, over excavation, and foundation preparation.
3. Perform post-construction top of embankment surveys for verification of grading tolerances after all embankment and surfacing is complete. Post-construction survey shall include spot elevations of the top of embankment at centerline and hinge points at the maximum spacing



interval specified herein. Except as otherwise approved by County, the top of embankment survey shall be performed after the entire reach of project and access road embankment has been completed, and no sooner than 30 days after completion of all embankment fill placement for the entire project.

4. Perform pre- and post-construction surveys at 50-foot maximum intervals and at grade breaks or other changes in geometry that may be required for quantity calculations or grading tolerance verification.
5. Pre-construction survey cross sections shall extend a minimum of 10 feet beyond the toe of embankment or to extent required to document work performed, whichever is greater.
6. Surveys shall be tied to baselines or other reference points.
7. Survey methods and proposed data plots shall be approved by the County in advance. Discrepancies in data provided shall be resolved to the satisfaction of the County prior to final payment.

END OF SECTION