

## CONSTRUCTION SPECIFICATION

### SWP-23. EARTHFILL

#### 1. SCOPE

The work shall consist of the construction of earth embankments, other earthfills, and earth backfills required by the drawings and specifications.

Earthfill is composed of natural earth materials that can be placed and compacted by construction equipment operated in a conventional manner.

Earth backfill is composed of natural earth materials placed and compacted in confined spaces or adjacent to structures (including pipes) by means of hand tamping, manually directed power tampers or vibrating plates, or equivalent.

#### 2. MATERIALS

All fill materials shall be obtained from required excavations and designated or approved borrow areas. The selection, blending, routing and disposition of materials in the various fills shall be subject to approval by the Inspector.

Fill materials shall contain no frozen soil, sod, brush, roots or other perishable materials. Maximum allowable size of rock particles incorporated in earthfill shall be 6" except adjacent to structures where manually directed power tampers or plate vibrators are used maximum size shall be 4".

The types of materials used in class C and W Earthfill shall consist of fine grained clayey soils having a unified soil classification of CL, GC, or SC excavated from the proposed areas or designated borrow area.

#### 3. FOUNDATION PREPARATION

Foundations for earthfill shall be stripped to remove vegetation and other unsuitable materials or shall be excavated as specified.

Except as otherwise specified, earth foundation surfaces shall be graded to remove surface irregularities and shall be scarified parallel to the axis of the fill or otherwise acceptably scored and loosened to a minimum depth of two (2) inches. The moisture content of the loosened material shall be controlled as specified for the earthfill, and the surface materials of the foundation shall be compacted and bonded with the first layer of earthfill as specified for subsequent layers of earthfill.

Earth abutment surfaces shall be free of loose, uncompacted earth in excess of two inches in depth normal to the slope and shall be at such a moisture content that the earthfill can be compacted against them to produce a good bond between the fill and the abutments.

Rock foundation and abutment surfaces shall be cleared of all loose materials by hand or other effective means and shall be free of standing water when fill is placed upon them. Occasional rock outcrops in earth foundations for earthfill, except in dams and other structures designed to restrain the movement of water, shall not require special treatment if they do not interfere with compaction of the foundation and initial layers of the fill or the bond between the foundation and the fill.

Foundation and abutment surfaces shall be not steeper than one (1) horizontal to one (1) vertical unless otherwise specified. Test pits or other cavities shall be filled with compacted earthfill conforming to the specifications for the earthfill to be placed upon the foundation.

#### 4. PLACEMENT

Earthfill shall not be placed until the required excavation and foundation preparation have been completed and the foundation has been inspected and approved by the Inspector. Earthfill shall not be placed upon a frozen surface, nor shall snow, ice, or frozen material be incorporated in the earthfill matrix.

Earthfill shall be placed in approximately horizontal layers. The thickness of each layer before compaction shall be as follows:

Class C Earthfill. The thickness of each layer of fill compacted by heavy equipment shall not exceed 6 inches before compaction.

Class W Earthfill. The thickness of each layer of fill compacted by heavy equipment shall not exceed 9 inches before compaction.

Materials placed by dumping in piles or windrows shall be spread uniformly to not more than the specified thickness before being compacted.

Hand compacted earth backfill shall be placed in layers whose thickness before compaction does not exceed 6 inches of earth backfill compacted by manually directed power tampers.

Earth backfill shall be placed in a manner which will prevent damage to the structures and will allow the structures to assume the loads from the earth backfill fill gradually and uniformly. The height of the earth backfill adjacent to a structure shall be increased at approximately the same rate on all sides of the structure.

Earthfill and earth backfill in dams, levees and other structures designed to restrain the movement of water shall be placed so as to meet the following additional requirements:

- a. The distribution of materials throughout each zone shall be essentially uniform, and the earthfill shall be free from lenses, pockets, streaks or layers of material differing substantially in texture, moisture content, or gradation from the surrounding material. Zone earthfills shall be constructed concurrently unless otherwise specified.
- b. If the surface of any layer becomes too hard and smooth for proper bond with the succeeding layer, it shall be scarified parallel to the axis of the fill to a depth of not less than two (2) inches before the next layer is placed.
- c. The top surfaces of embankments shall be maintained approximately level during construction, except that a crown or cross-slope of approximately two (2) percent shall be maintained to ensure effective drainage, and except as otherwise specified for drainfill or sectional zones.
- d. Dam embankments shall be constructed in continuous layers from abutment to abutment except where openings to facilitate construction or to allow the passage of stream flow during construction are specifically authorized in the contract.

- e. Embankments built at different levels as described under (c) or (d) above shall be constructed so that the slope of the bonding surfaces between embankment in place and embankment to be placed is not steeper than three (3) feet horizontal to one (1) foot vertical. The bonding surface of the embankment in place shall be stripped of all material not meeting the requirements of this specification, and shall be scarified, moistened and re-compacted when the new earthfill is placed against it. This is to insure a good bond with the new earthfill and to obtain the specified moisture content and density at the contact of the in place and new earthfills.

## 5. CONTROL OF MOISTURE CONTENT

During placement and compaction of earthfill and earth backfill, the moisture content of the materials being placed shall be maintained within the specified range.

Moisture content of fill material shall be such that when kneaded in the hand the soil will just form a ball which does not readily separate. Moisture content of fill material shall be maintained within the limits required to: (a) prevent bulking of fill material under the action of hauling or compacting equipment; (b) prevent adherence of fill material to treads and tracks of hauling or compacting equipment; and (c) insure blending of soil and rock into a reasonably homogeneous mass. Moisture content of earthfill shall be maintained within the range of 15-20%.

The application of water to the earthfill materials shall be accomplished at the borrow areas insofar as practicable. Water may be applied by sprinkling the materials after placement on the earthfill, if necessary. Uniform moisture distribution shall be obtained by disking.

Material that is too wet when deposited on the earthfill shall either be removed or be dried to the specified moisture content prior to compaction.

If the top surface of the preceding layer of compacted earthfill or a foundation or abutment surface in the zone of contact with the earthfill becomes too dry to permit suitable bond it shall either be removed or scarified and moistened by sprinkling to an acceptable moisture content prior to placement of the next layer of earthfill.

## 6. COMPACTION

Earthfill. Earthfill shall be compacted according to the following requirements for the class of compaction specified:

Class A compaction. Each layer of earthfill shall be compacted as necessary to provide the density of the earthfill matrix not less than the minimum density specified in section 9 of SWP 23 or identified on the drawings. The earthfill matrix is defined as the portion of the earthfill material finer than the maximum particle size used in the compaction test method specified.

Class B compaction. Each layer of earthfill shall be compacted to a mass density not less than the minimum density specified.

Class C compaction. Each layer of earthfill shall be compacted by a minimum of 3 passes of a 200 pounds per square inch tamping roller traveling in a direction

parallel to the main axis of the fill. The total number of passes needed will be specified by the Engineer and will be determined to be sufficient when “walk-out” of the roller occurs or by an approved equivalent method. Each pass shall consist of at least one passage of the roller wheel or drum over the entire surface of the layer.

Class W compaction Each layer of earthfill shall be compacted by either (1) routing of hauling and spreading equipment over the fill in such a manner that every point on the surface of each layer of fill will be traversed by not less than one tread track of the loaded equipment traveling in a direction parallel to the main axis of the fill; or (2) equivalent methods approved by the inspector.

Earth backfill. Earth backfill adjacent to structures shall be compacted to a density equivalent to that of the surrounding in-place earth materials or adjacent required earthfill or earth backfill. Compaction shall be accomplished by means of hand tamping or manually directed power tampers, plate vibrators, walk-behind, miniature, or self-propelled rollers. Unless otherwise specified, heavy equipment including backhoe mounted powertampers, or vibrating compactors and manually directed vibrating rollers, shall not be operated within two (2) feet of any structure. Towed or self-propelled vibrating rollers shall not be operated within five (5) feet of any structure. Compaction by means of drop weights operating from a crane or hoist will not be permitted.

The passage of heavy equipment will not be allowed: (1) over cast-in-place conduits prior to 14-days after placement of the concrete; (2) over cradled or bedded pre-cast conduits prior to seven (7) days after placement of the concrete cradle or bedding; or (3) over any type of conduit until the backfill has been placed above the top surface of the structure to a height equal to one-half the clear span width of the structure or pipe or two (2) feet, whichever is greater.

Compaction of earth backfill adjacent to structures shall not be started until the following time intervals have elapsed after placement of the concrete.

<u>Structure</u>	<u>Time Interval</u>
Vertical or near-vertical walls with earth loading on one side only	14 days
Walls backfilled on both sides simultaneously	7 days
Conduits and spillway risers, cast- in-place (with inside forms in place)	7 days
Conduits and spillway risers, cast-in- place (inside forms removed)	14 days
Conduits, pre-cast, cradled	2 days
Conduits, pre-cast, bedded	1 day
Cantilever outlet bents (backfilled both sides simultaneously)	3 days

7. REWORKING OR REMOVAL AND REPLACEMENT OF DEFECTIVE EARTHFILL

Earthfill placed at densities lower than the specified minimum density or at moisture contents outside the specified acceptable range of moisture content or otherwise not conforming to the requirements of the specifications shall be reworked to meet the

requirements or removed and replaced by acceptable earthfill. The replacement earthfill and the foundation, abutment and earthfill surfaces upon which it is placed shall conform to all requirements of this specification for foundation preparation, approval, placement, moisture control and compaction.

## 8. TESTING

During the course of the work, the Inspector will perform such quality assurance tests as are required to identify materials; determine compaction characteristics; determine moisture content; and determine density of earthfill in-place. Tests performed by the Inspector will be used to verify that the earthfills conform to contract requirements of the specifications and not as a replacement for the Contractor's quality control program.

Densities of earthfill requiring Class A compaction will be determined in accordance with ASTM D 1556, D 2167, D 2922 or D 2937 except that the volume and moist weight of included rock particles larger than those used in the compaction test method specified for the type of fill will be determined and deducted from the volume and moist weight of the total sample prior to computation of density or if using the nuclear gauge, added to the specified density to bring it to the measure of equivalent composition for comparison. The density so computed will be used to determine the percent compaction of the earthfill matrix. Unless otherwise specified, moisture content will be determined by one of the following methods: ASTM D 2216, D 3017, D 4643, D 4944, or D 4959.

During construction of the liner density tests and water content of soils shall be taken, a minimum of 5/acre/lift are required. Once the bottom and interior sideslopes of the basin or basins are completed permeability tests shall be performed on undisturbed core samples from the bottom of the basin and thin interior sideslopes. A minimum of two samples shall be taken for each basin at least one bottom sample and one interior sideslope sample per each acre of surface area. The undisturbed samples shall be tested for permeability in accordance with ASTM D-1587. The coefficient of permeability shall not exceed the MPCA criteria of 1/56 inch per day. If permeabilities fall below the MPCA criteria the basin or basins bottom or sideslopes shall be reworked to achieve proper compaction and successful retesting of permeabilities. Sample holes shall be filled with granular bentonite.

## 9. DETAILS

The thickness of each layer of fill compacted by heavy equipment shall be 9 inches before compaction. Each layer of fill shall be compacted by a 200 p.s.i. tamping roller traveling in a direction parallel to the main axis of the fill.

All earth fill adjacent to conduits and other structures shall be mechanically tamped. Within 2 feet of the conduit, compaction shall be by hand tamping or manually directed power tampers. Maximum thickness of layers compacted by hand tamping or manually directed power tampers or vibrators, shall be placed in layers not more than 6 inches thick before compaction.

Maximum allowable size of rock particles incorporated in earth fill shall be 6 inches except adjacent to structures where manually directed power tampers or plate vibrators are used, maximum size shall be 4 inches.

Earthfill for the embankment and pond liner shall consist of fine grained clayey soils having a unified soil classification of **CL**, and a PI (Plastic Index) greater than 10 and less than 30, excavated from designated borrow areas.

Compaction shall be Class A. If the earthfill material has a Plastic Index greater than 10 and less than 30, the fill matrix shall be compacted to a dry density equal to at least 90 percent of the maximum density obtained in compaction tests of the fill material performed by Method A, ASTM 698. If the earthfill material has a Plastic Index greater than 7 and less than 10, the fill matrix shall be compacted to a dry density equal to at least 95 percent of the maximum density obtained in compaction tests of the fill material performed by Method A, ASTM 698.

The allowable moisture content of the Class A fill material shall be at optimum to 3 percent above optimum.

Designated areas have been tested and approved for borrow. These sites require significant haul distances. Information on these sites is available from the Engineer. These borrow areas will be clearly marked by the Engineer prior to use.

The contractor has the option of providing borrow from his own sources, provided the material meets the requirements of this specification. The contractor shall provide certified test data showing the borrow material meets the requirements of this specification at least 14 days prior to its planned use. All expenses related to this testing are the responsibility of the contractor. All contractor provided borrow areas shall be approved in writing by the engineer prior to use.