

Kiewit Infrastructure West Co.
Klamath River Renewal Project
Technical Specifications

31 05 00 - MATERIALS FOR EARTHWORK

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PART 1 - GENERAL

1.1 SUMMARY

- A. This specification describes the aggregate material and geotextile requirements, including but not limited to:
1. E2 – Pipe Zone Material.
 2. E3 – Structural Fill.
 3. E4 – Select Fill.
 4. E5 – Road Embankment Fill.
 5. E6/E8 – Bedding Material.
 6. E7a/E7b/E7c – Erosion Protection.
 7. E9/E9a/E9b – General Fill Material.
 8. E10 – Random Fill.
 9. E11 – Class II Aggregate Base.
 10. E12 – Engineered Streambed Material.
 11. E13 – Drain Rock.
 12. CR1/CR2 – Concrete Rubble.

1.2 RELATED SECTIONS

- A. Section 31 10 00 – Clearing, Grubbing and Stripping.
- B. Section 31 23 00 – Excavation and Fill Placement.
- C. Section 31 25 00 – Erosion and Sedimentation Controls.
- D. Section 31 60 00 – Foundation Preparation.
- E. Section 31 71 00 – Tunnel Construction.
- F. Section 32 50 00 – Roads, Bridges and Culverts.

1.3 REFERENCE STANDARDS

- A. Highway and Transportation Officials:
1. AASHTO M 43 - Standard Specification for Sizes of Aggregate for Road and Bridge Construction.

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2. AASHTO M 147 - Standard Specification for Materials for Aggregate and Soil-Aggregate Subbase, Base, and Surface Courses.
3. AASHTO T 180 - Standard Method of Test for Moisture-Density Relations of Soils Using a 10-lb Rammer and an 18-in. Drop.

B. ASTM International:

1. ASTM C136/C136M - Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates.
2. ASTM D123 - Standard Terminology Relating to Textiles.
3. ASTM D276 - Test Method Identification of Fibres in Textiles.
4. ASTM D1557 - Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort 56,000 ft-lbf/ft³.
5. ASTM D2419 - Standard Test Method for Sand Equivalent Value of Soils and Fine Aggregate.
6. ASTM D2487 - Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System).
7. ASTM D3744 - Standard Test Method for Aggregate Durability Index.
8. ASTM D3776 - Standard Test Methods for Mass Per Unit Area (Weight) of Fabric.
9. ASTM D3786 - Standard Test Method for Bursting Strength of Textile Fabrics - Diaphragm Bursting Strength Tester Method.
10. ASTM D4253 - Standard test method for maximum index density and unit weight of soils using a vibratory table.
11. ASTM D4254 - Standard test method for minimum index density and unit weight of soils and calculation of relative density.
12. ASTM D4318 - Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils.
13. ASTM D4354 - Practice for Sampling of Geosynthetics for Testing.
14. ASTM D4355 - Test Method for Deterioration of Geotextiles from Exposure to Ultraviolet Light and Water (Xenon-Arc Type Apparatus).
15. ASTM D4439 - Terminology for Geotextiles.
16. ASTM D4491 - Standard Test Methods for Water Permeability of Geotextiles by Permittivity.
17. ASTM D4533 - Standard Test Methods for Trapezoid Tearing Strength of Geotextiles.
18. ASTM D4632 - Standard Test Method for Grab Breaking Load and Elongation of Geotextiles.
19. ASTM D4751 - Standard Test Methods for Determining Apparent Opening Size of Geotextile.
20. ASTM D4759 - Practice for Determining the Specification Performance of Geosynthetics.
21. ASTM D4873 - Standard Guide for Identification, Storage, and Handling of Geosynthetic Rolls and Samples.

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22. ASTM D6241 - Standard Test Method for the Static Puncture Strength of Geotextiles and Geotextile-Related Products Using a 50-mm Probe.
23. ASTM D6913 – Standard Test Methods for Particle-Size Distribution (Gradation) of Soils Using Sieve Analysis.
24. ASTM D6938 - Standard Test Methods for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth).

C. California State Parks Accessibility Guidelines, 2015 Edition.

D. California Department of Transportation (CalTrans) - Standard Specifications:

1. Section 96 – Geosynthetics.
2. Section 26 – Aggregate Bases.

E. Oregon Department of Transportation (ODOT) - Standard Specifications:

1. Section 02320 – Geosynthetics.

1.4 DEFINITIONS

- A. **Bedding** – Material obtained from existing borrows or by blasting and/or crushing rock, cobbles, and boulders, to be used underneath erosion protection.
- B. **D₅₀** – The diameter of the median rock size in the erosion protection gradation.
- C. **Filter** – Natural or processed sand, gravel and cobbles, crushed rock, crushed gravel, or a mixture of these materials.
- D. **Optimum Moisture Content** – The moisture content corresponding to the maximum dry density as determined by the standard Proctor compaction test using ASTM D1557.
- E. **Erosion Protection** - Rock material with specified gradations used for the prevention of soil erosion caused by exposure to river flows.
- F. **Riprap** – Previously installed rock material which may require sorting to meet Erosion Protection gradation specifications.
- G. **Aggregate Base** – Road surface material (per Caltrans Standard Specifications, Section 26, 4-26) for all newly constructed non-asphalt surface roads.

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1.5 SUBMITTALS

- A. Items listed in this section are to be submitted to the Engineer for information prior to the start of any Works, unless noted otherwise.
- B. Quality Control Plan.
- C. Aggregate/Geosynthetic Supplier Accreditation.
- D. Material Certificates: submit test results from manufacturers for review and approval by the engineer.
- E. Quality Control Test Results: submit test results from QC control tests from materials sourced onsite for review and approval by the Engineer.
- F. Material source plan: a detailed plan for each source of material including the proposed methods of exploitation and processing (if applicable).

1.6 QUALITY ASSURANCE

- A. Perform Work in accordance with relevant state standards (i.e. State of Oregon for JC Boyle and State of California Department of Transportation Standards for all other sites).
- B. Work shall be in conformance with Drawings, submittals, and other project documents.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. General.
 - 1. Materials should be obtained as specified in Section 31 23 00 – Excavation and Fill Placement.
 - 2. Materials shall be composed of durable particles free of organic matter, ice, snow, and other frozen materials. Organics are allowed in Type 10 random fill.
 - 3. All materials shall be well-graded within their gradation limits.
 - 4. Materials shall be in conformance with gradation bands shown on the Drawings.
- B. Aggregate Materials Description and Requirements.
 - 1. See Clause 2.1, C. for gradation plots.

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2. Type E2 – Pipe Zone.
 - a. Material description: Gravel and Sand.
 - b. Placement and Compaction: Placed and spread evenly in maximum 6-inch lifts compacted to 95% maximum dry density as determined by ASTM D1557. If a well-defined density vs moisture curve cannot be determined from ASTM D1557, material shall be compacted to 75% relative density as per ASTM D4253 and ASTM D4254.
3. Type E3 – Structural Fill.
 - a. Material description: Gravel and Sand.
 - b. Placement and Compaction: Placed and spread evenly in maximum 8-12 inch lifts compacted to 95% maximum dry density as determined by ASTM D698 (Section 5.3.1 - coarse granular fill), to be observed continuously (i.e. probe testing each lift, at 20 ft intervals pending results of test fill). Method specification for achieving required compaction shall be determined by the Engineer following test fill, per ASTM D698.
 - c. Plasticity: Plasticity Index < 12, Liquid Limit <35 as determined by ASTM D4318.
4. Type E4 – Select Fill.
 - a. Material description: Cobbles, Gravel and Sand.
 - b. Placement and Compaction: Placed and spread evenly in maximum 18-inch lifts compacted to 95% maximum dry density as determined by ASTM D1557. If a well-defined density vs moisture curve cannot be determined from ASTM D1557, material shall be compacted to 75% relative density as per ASTM D4253 and ASTM D4254.
5. Type E5 – Road Embankment Fill.
 - a. Material description: Cobbles, Gravel, Sand and Fines.
 - b. Placement and Compaction: Placed and spread evenly in maximum 12-inch lifts compacted to 95% maximum dry density as determined by ASTM D698.
 - c. Plasticity: Plasticity Index < 12, Liquid Limit <35 as determined by ASTM D4318.
6. Type E6/E8: Bedding.
 - a. Material description: Cobbles and Gravel.
 - b. Placement and Compaction: Placed and spread evenly in maximum 12-inch lifts in a non-segregating manner. Provide nominal compaction using construction equipment (e.g. track walk, static rolling, bucket tamping, etc.).
7. Type E7 – Erosion Protection.
 - a. Material description: Boulders and Cobbles.

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- b. Erosion protection is categorized by type a/b/c as shown in the following table. All E7 erosion protection shall meet or exceed the gradations for each type as shown in Table 1.

Table 1 – Type E7 – Erosion Protection Details

E7 Type	Nominal Diameter (in)	D ₁₅ Min (in)	D ₅₀ Min (in)	D ₈₅ Min (in)	D ₁₀₀ Min (in)
E7a	9	5.5	8.5	11.5	13.0
E7b	21	13.0	20.0	27.5	31.5
E7c	36	22.0	34.0	47.0	54.0

- c. Placement: See Section 3.4. Thicknesses as shown on Drawings.
- d. Erosion protection to be hard, durable, able to withstand long exposure to weathering, and have a minimum bulk saturated surface dry (SSD) specific gravity of 2.64 for the Oregon Site and 2.74 for the California Sites.
- e. Erosion Protection should have a durability index of 40 or greater and a sand equivalent of 75 or greater.
- f. Size to meet or exceed the size dimensions specified on the rock intermediate dimension (secondary axis).
- g. Rock particles with a minimum dimension less than 1/3.5 the maximum dimension shall not be used.
8. Type E9 – General Fill.
- a. Material description: Boulders, Cobbles, Gravel, Sand and Fines.
- b. Placement and Compaction: Type E9 material placed and spread evenly in maximum 24-inch lifts. Provide nominal compaction using construction equipment (e.g. track walk, static rolling, bucket tamping, etc.).
9. Type E9a – General Fill.
- a. Material description: Boulders, Cobbles, Gravel, Sand and Fines.
- b. Placement and Compaction: Type E9a material is end dumped and spread or placed in maximum 24-inch lifts with nominal compaction provided by construction equipment during hauling and spreading.
10. Type E9b – General Fill for Final Stabilization.
- a. Material description: Boulders, Cobbles, Gravel and Sand.
- b. Placement and Compaction: Type E9b material placed and spread evenly in maximum 24-inch lift. Provide nominal compaction using construction equipment (e.g. track walk, static rolling, bucket tamping, etc.).
11. Type E10 – Random Fill.

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- a. Material description: Overburden, rock and/or organics.
- b. No gradation requirements.
- c. Placement: Material shall only be placed in designated disposal sites, as per the Drawings.
- d. Compaction: Material shall be track walked to achieve nominal compaction.
- 12. Type E11 – Class II Aggregate Base.
 - a. Material description: Gravel and Sand.
 - b. Aggregate must be clean and consist of any combination of the following: Broken stone, Crushed gravel, Natural rough-surfaced gravel, Sand, Processed reclaimed asphalt concrete, PCC, LCB, or CTB. Use either 1-1/2-inch or 3/4-inch maximum aggregate gradation unless otherwise specified. Do not change selected aggregate gradation without authorization.
 - c. Caltrans 26-1.02B Class 2 Aggregate Base Aggregate quality characteristics must comply with the requirements shown in Table 2.
 - d. Placement and Compaction: Material shall be placed in 4-inch to 6-inch loose lifts and compacted to at least 95% relative compaction and 2% optimum moisture or until firm and unyielding under a vibratory roller.

Table 2 – Type E11 – Aggregate Quality Characteristics

Quality Characteristic	Requirement	
	Operating Range	Contract Compliance
Resistance (R-value, min)	--	78
Sand equivalent (min)	25	22
Durability index (min)	--	35

- 13. Type E12 – Engineered Streambed Material.
 - a. Material description: Boulders, Cobbles, Gravel, Sand and Fines.
 - b. Placement and Compaction: See technical specifications Section 32 50 00 Roads, Bridges and Culverts for installation and compaction specifications. Thicknesses as shown on Drawings.
- 14. Type E13 – Drain Rock.
 - a. Material description: Gravel.
 - b. Placement and Compaction: Placed and spread evenly in maximum 6-8 inch lifts, compacted using bucket tamping or hand tools.
 - c. Drain Rock should have a durability index of 40 or greater and a sand equivalent of 75 or greater.

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15. Type CR1/CR2 – Concrete Rubble.
 - a. Material description: Broken Concrete/Reinforced Concrete, Boulders, Cobbles, Gravel, and Sand. Broken concrete destined for the disposal sites shall limit the protruding reinforcing bars to 9 inches in length. Where reinforcing bars are bent over the broken concrete pieces, the bent reinforcing bars shall be limited to 24 inches in length with a maximum of 4 inches from the surface of the broken concrete. Where reinforcing railroad rails are present in the concrete pieces, the protruding railroad rail shall not exceed 3 feet in length.
 - b. Placement and Compaction of Type CR1: End – Dumped Placement. Concrete rubble shall be end-dumped and spread or placed in maximum 48-inch lifts with nominal compaction provided by construction equipment during hauling and spreading. During placement of concrete rubble, care shall be taken to fill voids with soil and rock materials. Concrete rubble shall not be used for final stabilization cover material of the disposal sites. Rubble shall be well chinked to mitigate potential sinkhole development. Placement of concrete rubble in the scour hole at the J.C. Boyle facility differs from the specifications outlined in this section. See Technical Specification 31 23 00 Excavation and Fill Placement for the scour hole backfilling requirements.
 - c. Placement and Compaction of Type CR2: Placed and spread evenly in maximum 36-inch lifts to provide a reasonably level surface for safe passage of equipment and then track walked. During placement of concrete rubble Type CR2, care shall be taken to fill voids with soil and rock materials as per Section 3.5.

C. Aggregate Material Gradation Limits.

1. Table 3 shows the gradation limits for the aggregate materials described in B excluding Types E7 – Erosion Protection (shown in B.) and E10 – Random Fill (no gradation requirements). The table below shall be used for plotting gradation minimum and maximum limits. Sieve sizes as required to test the materials shall be selected by the Contractor to provide the necessary information for acceptance of the material tested.

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Table 3 – Aggregate Material Gradation Limits

Material Type	Coarse Limit		Fine Limit	
	US Standard Sieve Sizes	Percent Passing by Weight (%)	US Standard Sieve Sizes	Percent Passing by Weight (%)
E2	1.5"	100	1/4"	100
	#16	5	#200	12
E3	3"	100	3/4"	100
	#4	60	#200	30
	#200	5		
E4	4"	100	3/8"	100
	#10	10	#16	60
			#200	10
E5	4"	100	3/8"	100
	#10	10	#16	60
			#200	30
E6	3"	100	1"	100
	1"	10	3/8"	10
E8	12"	100	3"	100
	3"	10	1"	10
E9	20"	100	3/8"	100
	3/4"	10	#16	60
			#200	30
E9a	20"	100	#16	100
	3/4"	10	#200	40
E9b	20"	100	3/8"	100
	3/4"	10	#16	60
			#200	10
E11	1"	100	3/4"	100

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Material Type	Coarse Limit		Fine Limit	
	US Standard Sieve Sizes	Percent Passing by Weight (%)	US Standard Sieve Sizes	Percent Passing by Weight (%)
	3/4"	90	#4	60
	#4	35	#30	30
	#30	10	#200	9
	#200	2		
E12	60"	100	40"	100
	40"	85	20"	85
	12"	50	1"	50
	3/8"	0	#200	0
E13	4"	100	1.5"	100
	3"	30	1"	5
	2"	25		
	1"	5		
a. CR1	36"	100	3/8"	100
	12"	10	#16	60
			#200	30
CR2	24"	100	3/8"	100
	6"	10	#16	60
			#200	30

D. Geotextiles.

1. Geotextile installed for erosion and sediment control features shall provide bare soil retention, nurture vegetation, and provide high performance turf reinforcement. An acceptable product is Mirafi TM-Series or equivalent.
2. Geotextiles to be installed as per the Manufacturers recommendations and specifications and the following California and Oregon guidelines:
 - a. California Stormwater BMP Handbook – Construction.
 - b. Construction Stormwater Best Management Practiced Manual, 1200-C NPDES General Permit, State of Oregon, Department of Environmental Quality.

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3. Geotextile installed for separation between subgrade and earthfill materials shall be a nonwoven, needle-punched fabric that meets the relevant state's minimum physical property requirements, either Table 1 from Caltrans Section 96 "Geosynthetics" (shown in Table 4), or Table 2 from ODOT Section 02320 "Geosynthetics and Slope Protection" (shown in Table 5). All numeric values in Table 4 except AOS represent MARV in the weakest principal direction. Values for AOS represent maximum average roll values. Geotextile shall not be installed until conformance test results are reviewed and the geotextile is accepted by the Engineer.

Table 4 – Nonwoven Separation Geotextile Caltrans Requirements

Property	Value	Test Method
Grab Tensile Strength	250 lbs	ASTM D4632
Grab Tensile Elongation	< 50%	ASTM D4632
Tear Strength	90 lbs	ASTM D4533
CBR Puncture Strength	500 lbs	ASTM D6241
Permittivity	0.05 sec ⁻¹	ASTM D4491
Apparent Opening Size (AOS)	0.012 in	ASTM D4751
UV Resistance (at 500 hours)	70% strength retained	ASTM D4355

Table 5 – Nonwoven Separation Geotextile ODOT Requirements

Property	Value	Test Method
Grab Tensile Strength	113 lbs	ASTM D4632
Grab Tensile Elongation	50%	ASTM D4632
Tear Strength	41 lbs	ASTM D4533
CBR Puncture Strength	223 lbs	ASTM D6241
Permittivity	0.05 sec ⁻¹	ASTM D4491
Apparent Opening Size (AOS)	No. 30 US Sieve	ASTM D4751
UV Resistance (at 500 hours)	50% strength retained	ASTM D4355

PART 3 - EXECUTION

3.1 DELIVERY, STORAGE AND HANDLING OF GEOSYNTHETICS

- A. Geosynthetic labeling, shipment, and storage shall follow ASTM D4873. Product labels shall clearly show the manufacturer or supplier name, style name, and roll number. During all periods of shipment and storage, the geotextile shall be protected from direct sunlight, ultraviolet rays, temperature greater than 140 degrees Fahrenheit, and mud,

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dirt, dust, and debris. At no time shall the geotextile be exposed to sunlight for a period exceeding 14 days.

- B. Each geosynthetic roll shall be wrapped with a material that will protect the geosynthetic from damage due to shipment, water, sunlight, and contaminants.
- C. During storage, geosynthetic rolls shall be elevated off the ground and adequately covered to protect them from the following: site construction damage, precipitation, extended ultraviolet radiation including sunlight, chemicals that are strong acids or strong bases, flames including welding sparks, excess temperatures, and any other environmental conditions that may damage the physical property values of the geosynthetic.

3.2 INSTALLATION OF GEOTEXTILES

- A. The Contractor shall handle all geotextiles in such a manner as to ensure the geotextile is not damaged.
- B. The surface on which the geotextile is to be placed shall be prepared to a smooth condition free of debris or obstructions which may damage the geotextile. The subgrade shall be approved by the Engineer prior to geotextile placement. Care shall be taken not to entrap stone, excessive dust, or moisture in the geotextile. The Contractor and Installer shall not operate equipment over the geotextile without meeting minimum cover requirements of capping operations. The Contractor shall follow the Manufacturer's recommendations and these Specifications during installation of the geotextile.
- C. Geotextiles shall be deployed free of wrinkles and folds. On slopes, the geotextiles shall be anchored at the top and unrolled down the slope. In the presence of wind, all geotextiles shall be weighted with sandbags or other material which will not damage the geotextile.
- D. Adjacent geotextile panels shall have minimum two-foot overlaps. All seams shall be oriented parallel to (in the direction of) the slope. Seams constructed perpendicular or transverse to the direction of the slope will not be accepted. The geotextile shall be examined over the entire surface after installation to ensure that no potentially harmful objects are present.
- E. Damaged geotextiles and geotextiles contaminated with dirt shall be repaired immediately. Repairs shall be made with the same geotextile product style as the original material. All repairs shall meet the approval of the Engineer, prior to cover placement.

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- F. Geotextile panels which require repair to be replaced with new material. Replacement material shall have a minimum overlap of two feet at the entire perimeter. All seams shall be oriented parallel to (in the direction of) the slope. Seams constructed perpendicular or transverse to the slope will not be accepted.
- G. Placement of cover on the geotextile shall be accomplished in a manner as to ensure that the geotextile is not damaged. Cover material shall be placed within 15 days of deployment.
- H. Cover material shall be placed such that excess tensile stress is not mobilized in the geotextile. Cover placement operations shall comply with the requirements and limitations of the contract documents and project design documents.

3.3 INSTALLATION OF AGGREGATE MATERIALS

- A. Excavation:
 - 1. Excavate aggregate materials from Site locations as indicated in the Drawings and as specified in Section 31 23 00 – Excavation and Fill Placement.
 - 2. Materials shall be obtained from approved locations or from on-site excavation borrow sites operated by the Contractor.
 - 3. Contractor operated borrow sites shall be developed in accordance with all applicable State Acts.
- B. Stockpiling:
 - 1. Separate different aggregate materials with dividers or stockpile apart to prevent intermixing of aggregate types or contamination.
 - 2. Direct surface water away from stockpile site to prevent erosion or deterioration of materials as per Section 31 25 00 – Erosion and Sedimentation Controls.
 - 3. Stockpile hazardous materials on impervious material and cover to prevent erosion and leaching until they are disposed.
- C. Placement: Place aggregate materials at Site locations as indicated on the Drawings and as specified in Section 31 23 00 – Excavation and Fill Placement.
- D. Additional specific installation details for Type E7 – Erosion Protection included in section 3.4.

3.4 INSTALLATION OF EROSION PROTECTION - TYPE E7a/E7b/E7c

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- A. Erosion Protection – Type E7a/E7b/E7c shall be placed mechanically in a well interlocked fashion in locations shown in the Drawings to provide scour protection.
- B. Erosion Protection - Type E7a/E7b/E7c shall not be placed until foundation preparation is completed, geotextile installed (if applicable) and the subgrade surfaces have been observed by the Engineer.
- C. The maximum drop high for Erosion Protection - Type E7a/E7b/E7c placement is 2 feet.
- D. Erosion Protection - Type E7a/E7b/E7c shall be mechanically tamped after placement.
- E. Erosion Protection - Type E7a/E7b/E7c layer shall be constructed to the full course thickness in one operation and in such a manner as to avoid displacement of the underlying materials.
- F. The rock shall be delivered and placed in a manner that results in a reasonably homogenous appearance, with the larger rocks uniformly distributed and firmly in contact with one another and with smaller rocks and spalls filling the voids between the larger rocks. The final revetment surface shall be reasonably uniform with no individual particles substantially protruding from the slope face.
- G. In locations where the erosion protection is placed below water, the material shall be placed and tamped using a GPS enabled conventional or telescopic (Gradall) excavator to ensure the design thicknesses are achieved. The contractor is also permitted to increase the thickness below the water line more than the thicknesses shown on the drawing. End dumping is not permitted.

3.5 INSTALLATION OF CONCRETE RUBBLE

- A. The installation of concrete rubble section does not apply to areas where Type E9 – General Fill is specified separately of concrete rubble. The Drawings denote separate concrete rubble placement from Type E9 – General Fill at locations such as the powerhouse backfill, and the installation of concrete rubble section only applies to the CR2 denoted locations.
- B. Concrete rubble shall be covered by a minimum of 2 ft of cover material.
- C. During the placement of Type CR2 - concrete rubble, care shall be taken by the contractor to infill voids between concrete pieces with soil and rock using the procedure below:

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1. After a lift of concrete rubble has been placed, a layer of Type E9 general fill material shall be placed over the concrete rubble layer. The lift shall then be track walked to push the general fill into the voids and compact the concrete rubble.
 2. If voids are still visible after the area has been track-walked another layer of E9 general fill shall be placed and the process repeated until the voids are no longer visible.
 3. The thickness of the Type E9 fill that blankets the concrete rubble lift prior to nominal compaction will be dependant on the void ratio of the concrete and will be adjusted on an as-needed basis by the contractor. The Type E9 general fill layer shall be thin enough to avoid material bridging that would prevent the infilling of the voids.
 4. The contractor shall avoid overfilling the concrete rubble and creating continuous layers of Type E9 material.
- D. The placement of Type CR1 will not require the more stringent placement method outlined in Clause 3.5, C. Type CR1 is only specified on the drawings where slope stability is not a requirement, except for the scour hole which is governed by its own placement requirements as per Section 31 23 00 – Excavation and Fill Placement.
- E. Where a capping layer is specified above segregated materials, or large particle material with cavities and/or voids, filter material may be specified by the Engineer.

3.6 INSTALLATION OF ENGINEERED STREAMBED MATERIAL

- A. See Section 32 50 00 Roads, Bridges and Culverts for installation and compaction requirements for Engineered Streambed Material.

3.7 QUALITY

- A. For materials procured off-site or from commercial suppliers, the Contractor shall provide quality control certificates in accordance with the testing frequencies detailed in Table 6.
- B. The Contractor will be responsible for field quality testing (control tests) for all fill materials excavated from on-site borrow areas that are incorporated in the permanent work at the frequencies detailed in Table 6. Minimum testing requirements: frequency is “1 per” the number of cubic yards of material as required for the Work.

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Table 6 – Control Testing Schedule

Material Type	Moisture Content (ASTM D2216)	Particle Size Distribution (ASTM D6913)	Laboratory Compaction (ASTM D1557 or D4523 & D4524 as applicable)	Specific Gravity and Absorption (ASTM D854 and ASTM D6473)	Atterberg Limits (ASTM D4318)	Durability Index (ASTM D3744)	Sand Equivalent (ASTM D2419)
	1 per	1 per	1 per	1 per	1 per	1 per	1 per
E2 – Pipe Zone	650	650	650	3,250	-	-	-
E3 – Structural Fill	650	650	650	3,250	3,250	-	-
E4 – Select Fill	1,300	1,300	1,300	3,250	-	-	-
E5 – Road Embankment Fill	1,300	1,300	1,300	3,250	-	-	-
E6 / E8 – Bedding	-	650	-	-	-	-	-
E7a/E7b/E7c – Erosion Protection	-	Visual	-	2000	-	2000	Source
E9/E9a/E9b – General Fill	-	20,000	-	-	-	-	-
E10 – Random Fill	-	-	-	-	-	-	-
E11 – Class II Aggregate Base	500	500	2,000	-	-	-	-
E12 – Engineered Streambed Material	-	Visual	-	2,000	-	2,000	-
E13 – Drain Rock	-	Source	-	Source	-	-	Source
CR1/CR2 – Concrete Rubble	-	Visual	-	-	-	-	-

NOTES:

- CONTROL TESTING TO BE PERFORMED PRIOR TO USE OF MATERIALS IN THE WORKS TO CONFIRM MATERIAL COMPLIANCE. CONTROL TESTING MAY BE UNDERTAKEN ON STOCKPILED MATERIALS OR PRIOR TO DELIVERY OF COMMERCIAL PRODUCTS TO SITE. RECORD TESTING (SECTION 31 23 00 EXCAVATION AND FILL PLACEMENT) TO BE UNDERTAKEN ONCE MATERIALS ARE PLACED TO CONFIRM COMPLIANCE OF IN-SITU MATERIALS.
- SOME E7A/E7B/E7C AND E13 CONTROL TESTS ARE USED TO CHARACTERIZE A SOURCE. ONE OF EACH TEST IS REQUIRED AT LOCATIONS OF PLANNED SOURCING, EITHER FROM A BORROW AREA OR MANUFACTURER.
- IF TESTING VOLUME NOTED IN TABLE 6 EXCEEDS THE VOLUME OF PLACED FILL FOR A SPECIFIC AREA, THEN PERFORM A MINIMUM OF 1 TEST PER AREA.

- C. If in the judgement of the Engineer, the volume of material represented by a failed control test is anticipated to result in work that deviates from design intent, remove, or dispose of the non-complying material. Rework shall be performed at the Contractor's expense.
- D. Material quality, including such fill parameters as frozen/unfrozen state and inclusion of topsoil, shall be verified by the Engineer prior to fill placement.
- E. Aggregate Moisture Control:

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1. Moisture Adjustment: Moisture content shall be adjusted as necessary to facilitate compaction. Moisture control shall be achieved by either windrowing, scarifying or adding water to achieve workable moisture content.
 2. Water may be added to the material at the source or after the material has been brought into its final position, whichever is more practical. The Contractor shall obtain uniform moisture distribution in the lift by disking, blading, or other approved methods. The amount of water applied shall be controlled so that free water will not appear on the surface during or subsequent to compaction operations.
 3. Material deposited on fill that is too wet shall be removed or spread and permitted to dry, assisted by disking or blading, if necessary, until the moisture content is reduced to the specified limits.
 4. When the top surface of a layer becomes too dry or too smooth to permit suitable bonding with the subsequent layer, the Contractor shall loosen the material by scarifying or disking. The Contractor shall then moisten the loosened material to acceptable moisture content and re-compact the material to the specified density.
- F. Any omissions or failure on the part of the Engineer to reject the work or materials shall not be construed as acceptance of unsuitable materials.
- G. A testing laboratory will furnish test data on all materials manufactured for incorporation into permanent project structures. Certification shall meet the relevant state requirements.

END OF SECTION 31 05 00