

**Sterling Ranch Development  
Briargate Boulevard Bridge  
Supplemental Technical Specifications**

**El Paso County, Colorado**

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For all new drainageway construction, the following sections of the *Mile High Flood District Standard Specifications, latest edition*, shall apply to this project and supplement or supercede the latest editions of the El Paso County Development Services Department Standards and Specifications, and the Colorado Department of Transportation (CDOT) Standard Specifications for Road and Bridge Construction.

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See also Bridge Specifications by Contech.



## **SECTION 31 23 00**

### **EXCAVATION AND FILL**

#### **PART 1 GENERAL**

##### **1.01 SECTION INCLUDES**

- A. This WORK shall consist of excavation, embankment fill, disposal of excess material, shaping, and compaction of all material encountered within the limits of WORK, including excavation and fill for structures. The excavation shall include, but is not limited to, the native soils which shall be excavated for the PROJECT WORK. All WORK shall be completed in accordance with these SPECIFICATIONS, the lines and grades, and typical cross-sections shown on the DRAWINGS.
- B. All excavation shall be classified, "unclassified excavation," or "muck excavation" or "rock excavation," as hereafter described. All embankment shall be classified "embankment material" as hereafter described.

##### **1.02 RELATED SECTIONS**

- A. The following is a list of SPECIFICATIONS which may be related to this section:
  - 1. Section 01 57 19, Temporary Environmental Controls
  - 2. Section 31 11 00, Clearing and Grubbing.
  - 3. Section 31 23 19, Dewatering.
  - 4. Section 31 25 00, Erosion and Sedimentation Control

##### **1.03 REFERENCES**

- A. The following is a list of standards which may be referenced in this section:
  - 1. ASTM International (ASTM):
    - a. D698, Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12 400 ft-lbf/ft<sup>3</sup> (600 kN-m/m<sup>3</sup>)).
    - b. D4253, Standard Test Methods for Maximum Index Density and Unit Weight of Soils Using a Vibratory Table.

##### **1.04 DEFINITIONS**

- A. Embankment Material shall consist of approved material acquired from excavation or from outside sources, hauled and placed in embankments.
- B. Muck Excavation shall consist of the removal of mixtures of soils and organic matter not suitable for foundation material and replacement with approved material.
- C. Rock Excavation shall consist of igneous, metamorphic and sedimentary rock which cannot be excavated without the use of rippers, and all boulders or other detached



stones each having a volume of one-half (1/2) cubic yard or more, as determined by physical or visual measurement. It shall also include replacement with approved material as required.

- D. Unclassified Excavation shall consist of the excavation of all materials of whatever character required of the WORK, obtained within the PROJECT limits.

#### 1.05 QUALITY ASSURANCE

- A. Final topography and/or cross-sections shall be surveyed of areas that are to finished grade and compared to the design section for accuracy.
- B. Final grade shall match design grades within the tolerances discussed in PART 3 EXECUTION.

### PART 2 PRODUCTS

#### 2.01 MATERIALS

- A. Embankment Material may consist of approved material acquired from excavations or material hauled from outside the PROJECT limits.
- B. Suitable material identified onsite shall be used first for embankments and backfill.
- C. Excess excavated native soils which are not used as embankment or backfill shall become the property of CONTRACTOR and shall be disposed of offsite by CONTRACTOR, in a location acceptable to ENGINEER.
- D. Muck Excavation shall also include the replacement of excavated muck with uniformly graded rock, riprap, onsite or imported soils, or other material, whichever is most suitable for the specific situation encountered.
- E. ENGINEER will determine which type of aggregate or other material which shall be used after observing the specific site conditions.
- F. Structural Backfill:
1. When specified on the DRAWINGS or as required by ENGINEER, Class I structural backfill shall meet the following gradation requirements:

Sieve Size	% By Weight Passing Square Mesh Sieves
2-inch	100
No. 4	30 - 100
No. 50	10 - 60
No. 200	5 - 20

2. In addition, this material shall have a liquid limit not exceeding thirty five (35) and a plasticity index of not over six (6).



3. Impervious structural backfill, where shown or specified, shall consist of material having one hundred percent (100%) finer than two (2) inches in diameter and a minimum of thirty-five percent (35%) passing a No. 200 U.S. Standard Sieve.

## **PART 3 EXECUTION**

### **3.01 GENERAL EXCAVATION/EMBANKMENT**

#### **A. General:**

1. The excavation and embankment shall be finished to reasonably smooth and uniform surfaces.
2. Variation from the subgrade plane shall not be more than eight-tenths (0.08) foot in soil or more than eight-tenths (0.08) foot above or one-half (0.50) foot below in rock.
3. Where bituminous or concrete surfacing materials are to be placed directly on the subgrade, the subgrade plane shall not vary more than four-tenths (0.04) foot.
4. Materials shall not be wasted without permission of ENGINEER.
5. Excavation operations shall be conducted so that material outside of the limits of slopes will not be disturbed.
6. Prior to beginning grading operations in any area, all necessary clearing and grubbing in that area shall have been performed in accordance with Section 31 11 00, Clearing and Grubbing, of these SPECIFICATIONS.
7. CONTRACTOR shall notify ENGINEER in sufficient time before beginning excavation or embankment such that the necessary topography and/or cross-sections may be taken. CONTRACTOR shall not excavate beyond the dimensions and elevations established, and material shall not be removed prior to surveying the site.
8. When CONTRACTOR's excavating operations encounter remains of prehistoric people's dwelling sites or artifacts of historical or archaeological significance, the operations shall be temporarily discontinued.
  - a. ENGINEER will contact archaeological authorities to determine the disposition thereof.
  - b. When directed, CONTRACTOR shall excavate the site in such a manner as to preserve the artifacts encountered and shall remove them for delivery to the custody of the proper state authorities.
  - c. Such excavation will be considered and paid for as extra WORK.



B. Excavation:

1. Unclassified:

- a. All excess suitable material excavated from the PROJECT site and not used for embankment shall be removed from the PROJECT site and become the property of CONTRACTOR.
- b. Where material encountered within the limits of the WORK is considered unsuitable for embankment (fills) on any portion of this PROJECT WORK, such material shall be excavated as directed by ENGINEER and replaced with suitable fill material.
- c. All unsuitable excavated material from excavation consisting of any type of debris (surface or buried), excavated rock, bedrock or rocks larger than six (6) inches in diameter, and boulders shall be hauled from the PROJECT site and disposed of by CONTRACTOR at CONTRACTOR's expense.
- d. Debris is defined as "anything that is not earth which exists at the job site."

2. Muck:

- a. Where excavation to the finished grade section results in a subgrade or slopes of unsuitable soil, ENGINEER may require CONTRACTOR to remove the unsuitable materials and backfill to the finished graded section with approved material.
- b. Disposal of the unsuitable material and replacement with suitable material shall be at CONTRACTOR's expense.

3. Good surface drainage shall be provided around all permanent cuts to direct surface runoff away from the cut face.

4. Rock:

- a. Unless otherwise specified, rock shall be excavated to a minimum depth of 0.5 foot below subgrade within the limits of the channel area, and the excavation shall be backfilled with material shown on the DRAWINGS or as designated by ENGINEER.
- b. Disposal of material and replacement with suitable approved material shall be at CONTRACTOR's expense.

C. Embankment Construction:

1. Embankment construction shall consist of constructing all fill areas, including preparation of the areas upon which they are to be placed, the placing and compacting of approved material within areas where unsuitable materials have been removed, and the placing and compacting of Embankment Material in holes, pits and other depressions within the PROJECT area.
2. Only approved materials shall be used in the construction of embankments and backfills.



3. Approved materials shall consist of clean onsite cohesive soils or approved imported soils.
4. Onsite cohesive soils or imported soils shall be placed and compacted in horizontal lifts, using equipment and procedures that produce recommended moisture contents and densities throughout the lift and embankment height. Onsite or imported cohesive soils shall be compacted within a moisture content range of two percent (2%) below, to two percent (2%) above optimum moisture content and compacted to ninety-five percent (95%) of the Maximum Standard Proctor Density (ASTM D698).
5. When embankment is to be placed and compacted on hillsides, or when new embankment is to be compacted against existing embankments, or when embankment is built one-half (1/2) width at a time, the slopes that are steeper than four-to-one (4:1) when measured longitudinally or at right angles to the adjacent ground shall be continuously benched over those areas where it is required as the WORK is brought up in layers.
  - a. Benching shall be well "keyed" and where practical a minimum of eight (8) feet. Each horizontal cut shall begin at the intersection of the original ground and the vertical sides of the previous cuts.
  - b. Material thus cut out shall be recompacted along with the new Embankment Material at CONTRACTOR's expense.
6. The ground surface underlying all fills shall be carefully prepared by removing all organic matter, scarification to a depth of eight (8) inches and recompacting to ninety-five percent (95%) of the Maximum Standard Proctor Density (ASTM D698) at optimum moisture content + or - two percent (2%) prior to fill placement.
7. Embankment Material shall be placed in horizontal layers not exceeding 8 inches (loose measurement) and shall be compacted to ninety five percent (95%) of the Maximum Standard Proctor Density (ASTM D698) at optimum moisture content + or - two percent (2%).
  - a. Effective spreading equipment shall be used on each lift to obtain uniform thickness prior to compacting.
  - b. As the compaction of each layer progresses, continuous leveling and manipulating required to ensure uniform density.
8. For embankments which serve as berms, the downstream portion shall be keyed into the subsurface soils a minimum of three (3) feet to enhance the stability of the slope.
9. Materials which are removed from excavations beneath the water table may be over the optimum moisture content and shall be required to be dried out prior to reusing them.
10. Cross hauling or other action as appropriate will be ordered when necessary to ensure that the best available material is placed in critical areas of embankments,



including the top two (2) feet of all embankments. No additional payment will be made for cross hauling ordered by ENGINEER.

11. Frozen materials shall not be used in construction of embankments.
12. During the construction of the channels, the channel bottom shall be maintained in such condition that it will be well drained at all times.
13. Excavation or embankment (fill), and structural backfill WORK either completed or in a stage of completion that is either eroded or washed away or becomes unstable as a result of either rains, snow, snow melt, channel flows, or lack of proper water control shall be either removed and replaced, recompact, or reshaped as directed by ENGINEER and in accordance with the DRAWINGS and SPECIFICATIONS at CONTRACTOR's sole expense.
14. Removed unsuitable materials shall be hauled away and disposed of at CONTRACTOR's expense. Placing of replacement materials for removed unsuitable materials shall be purchased, placed, and compacted at CONTRACTOR's expense.

D. Proof Rolling:

1. Proof rolling with a heavy rubber tired roller shall be required, if designated on the DRAWINGS or when ordered by ENGINEER.
2. Proof rolling shall be done after specified compaction has been obtained. Areas found to be weak and those areas which failed shall be ripped, scarified, wetted if necessary, and recompact to the requirements for density and moisture at CONTRACTOR's expense.
3. Proof rolling shall be done with equipment and in a manner acceptable to ENGINEER. Proof rolling as shown on the DRAWINGS or as ordered by ENGINEER shall not be measured and paid for separately, but shall be included in the unit prices bid for the WORK.

### 3.02 EXCAVATION AND BACKFILL FOR STRUCTURES

- A. Poor foundation material for any of the WORK shall be removed, by CONTRACTOR, as directed by ENGINEER.
  1. CONTRACTOR will be compensated for removal and replacement of such materials in accordance with Muck Excavation.
- B. CONTRACTOR is cautioned that construction equipment may cause the natural soils to pump or deform while performing excavation WORK inside and on footings, structural floor slabs, or other structure foundation areas.
- C. CONTRACTOR shall remove and replace at CONTRACTOR's expense any foundation materials which are:
  1. Saturated by either surface or subsurface flows because of the lack of adequate water control or dewatering work by CONTRACTOR;





2. Frozen for any reason; or
  3. Disturbed by CONTRACTOR's WORK or caused to become unacceptable for foundation material purposes by means of CONTRACTOR's equipment, manpower, or methods of WORK.
- D. Dewatering shall not be conducted by pumping from inside footings, structural floor slabs, or other structure foundation limits. This may decrease the supporting capacity of the soils.
- E. Care shall be taken when excavating the foundations to avoid disturbing the supporting materials. Excavation by either hand or careful backhoe soil removal, may be required in excavating the last few inches of material to obtain the subgrade of any item of the concrete WORK.
- F. Any over-excavated subgrades that are due to CONTRACTOR's actions, shall be brought back to subgrade elevations, as indicated on the DRAWINGS, by CONTRACTOR and at CONTRACTOR's expense in the following manner:
- G. For over-excavations of two (2) inches or less, either backfill and compact with approved granular materials; backfill with one-half (1/2) inch crushed rock; or fill with concrete at the time of the appurtenant structure concrete pour.
- H. For over-excavations greater than two (2) inches, backfill and compact with an approved granular material.
1. All granular footings, structural floor slabs, or other structure areas shall be compacted with a vibratory plate compactor prior to placement of concrete, reinforcing, or bedding materials.
  2. Backfill, and fill within three (3) feet adjacent to all structures and for the full height of walls, shall be selected non-swelling material.
    - a. It shall be granular, well graded, and free from stones larger than two (2) inches.
    - b. Material may be job excavated, but shall selectivity be required as determined by ENGINEER.
    - c. Stockpiled material, other than topsoil from the excavation, shall be used for backfilling unless an impervious structural backfill is specified.
    - d. The backfill material shall consist of either clean onsite granular material free of stones larger than two (2) inches in diameter with no more than twenty percent (20%) passing the No. 200 sieve, or equivalent imported materials.
    - e. All backfill around the structures shall be consolidated by mechanical tamping.
    - f. The material shall be placed in six-inch (6") loose lifts within a range of two percent (2%) above to two percent (2%) below the optimum moisture content and compacted to ninety-five percent (95%) of Maximum Standard



Proctor Density (ASTM D698) for cohesive soils, or to seventy-five percent (75%) relative density for pervious material as determined by the relative density of cohesionless soils test, ASTM D4253.

3. Impervious structural backfill shall be placed in six-inch (6") loose lifts within a range of two percent (2%) above to two percent (2%) below the optimum moisture content and compacted to ninety-five percent (95%) of Maximum Standard Proctor Density for cohesive soils as determined by ASTM D698.

**END OF SECTION**



## **SECTION 31 37 00**

### **RIPRAP, BOULDERS, AND BEDDING**

#### **PART 1 GENERAL**

##### **1.01 SECTION INCLUDES**

- A. The WORK includes excavation, grading, and installation of riprap, boulders, soil riprap, void-filled riprap, and bedding placed at the locations shown on the DRAWINGS. The materials to be used and the construction of such structures shall be as specified herein.

##### **1.02 RELATED SECTIONS**

- A. The following is a list of SPECIFICATIONS, which may be related to this section:

1. Section 01 57 19, Temporary Environmental Controls
2. Section 31 23 00, Excavation and Fill.
3. Section 31 23 19, Dewatering.
4. Section 31 23 33, Trenching and Backfilling.
5. Section 31 25 00, Erosion and Sedimentation Controls
6. Section 31 37 19, Grouted Boulders, Stacked Grouted Boulders, and Grouted Rock Retaining Walls

##### **1.03 REFERENCES**

- A. The following is a list of standards which may be referenced in this section:

1. American Association of State Highway and Transportation Officials (AASHTO):
  - a. T85, Standard Method of Test for Specific Gravity and Absorption of Coarse Aggregate.
  - b. T96, Standard Method of Test for Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine.
  - c. T103, Standard Method of Test for Soundness of Aggregates by Freezing and Thawing.
  - d. T104, Standard Method of Test for Soundness of Aggregate by Use of Sodium Sulfate or Magnesium Sulfate.
  - e. T248, Reducing Field Samples of Aggregate Test Size.



2. ASTM International (ASTM): D698, Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12 400 ft-lbf/ft<sup>3</sup> (600 kN-m/m<sup>3</sup>)).

#### 1.04 SUBMITTALS

- A. CONTRACTOR shall cooperate with ENGINEER in obtaining and providing samples of all specified materials.
- B. CONTRACTOR shall submit certified laboratory test certificates for all items required in this section.

### PART 2 PRODUCTS

#### 2.01 MATERIALS

##### A. RIPRAP

1. Riprap used shall be the type designated on the DRAWINGS and shall conform to Table 1.

**Table 1: Riprap Gradation**

<b>Riprap Designation</b>	<b>% Smaller Than Given Size By Weight</b>	<b>Intermediate Rock Dimension (inches)</b>	<b>d<sub>50</sub>* (inches)</b>
Type VL	70 - 100 50 - 70 35 - 50 2 - 10	12 9 6 2	6**
Type L	70 - 100 50 - 70 35 - 50 2 - 10	15 12 9 3	9**
Type M	70 - 100 50 - 70 35 - 50 2 - 10	21 18 12 4	12**
Type H	70 - 100 50 - 70 35 - 50 2 - 10	30 24 18 6	18
Type VH	70 - 100 50 - 70 35 - 50 2 - 10	41 33 24 9	24
*d <sub>50</sub> = Mean Particle Size			
**Mix VL, L and M riprap with 35% topsoil (by volume) and bury it with 4 to 6 inches of topsoil, all vibration compacted, and revegetate.			



2. The riprap designation and total thickness of riprap shall be as shown on the DRAWINGS. The maximum stone size shall not be larger than the thickness of the riprap.
3. Neither width nor thickness of a single stone of riprap shall be less than one-third (1/3) of its length.
4. The specific gravity of the riprap shall be two and one-half (2.5) or greater.
5. Riprap specific gravity shall be according to the bulk-saturated, surface-dry basis, in accordance with AASHTO T85.
6. The bulk density for the riprap shall be 1.3 ton/cy or greater.
7. The riprap shall have a percentage loss of not more than forty percent (40%) after five hundred (500) revolutions when tested in accordance with AASHTO T96.
8. The riprap shall have a percentage loss of not more than ten percent (10%) after five (5) cycles when tested in accordance with AASHTO T104 for ledge rock using sodium sulfate.
9. The riprap shall have a percentage loss of not more than ten percent (10%) after twelve (12) cycles of freezing and thawing when tested in accordance with AASHTO T103 for ledge rock, procedure A.
10. Rock shall be free of calcite intrusions.
11. Gradation:
  - a. Each load of riprap shall be reasonably well graded from the smallest to the largest size specified.
  - b. Stones smaller than the two to ten percent (2 to 10%) size will not be permitted in an amount exceeding ten percent (10%) by weight of each load.
  - c. Control of gradation shall be by visual inspection. However in the event ENGINEER determines the riprap to be unacceptable, ENGINEER shall pick two (2) random truckloads to be dumped and checked for gradation.
    - 1) Mechanical equipment and labor needed to assist in checking gradation shall be provided by CONTRACTOR at no additional cost.
12. Color:
  - a. The color of the riprap shall approved by ENGINEER prior to delivery to the PROJECT site.
  - b. Color shall be consistent on the entire PROJECT and shall match the color of rock to be used for all other portions of the WORK.



13. Broken concrete or asphalt pavement shall not be acceptable for use in the WORK.
14. Rounded riprap (river rock) is not acceptable, unless specifically designated on the DRAWINGS.

## B. BOULDERS

1. Boulders used shall be the type designated on the DRAWINGS and shall conform to Table 2.

**Table 2: Boulder Properties**

<b>Boulder Classification</b>	<b>Nominal Size (inches)</b>	<b>Range in Smallest Dimension of Individual Rock Boulders (inches)</b>	<b>Maximum Ratio of Largest to Smallest Rock Dimension of Individual Boulders</b>
B24	24	20 - 28	1.50
B30	30	26 - 34	1.50
B36	36	32 - 40	1.50
B42	42	38 - 46	1.50
B48	48	44 - 52	1.50

2. The specific gravity of the boulders shall be two and one-half (2.5) or greater.
3. Boulder specific gravity shall be according to the bulk-saturated, surface-dry basis, in accordance with AASHTO T85.
4. The bulk density for the boulder shall be 1.3 ton/cy or greater.
5. The boulders shall have a percentage loss of not more than forty percent (40%) after five hundred (500) revolutions when tested in accordance with AASHTO T96.
6. The boulders shall have a percentage loss of not more than ten percent (10%) after five (5) cycles when tested in accordance with AASHTO T104 for ledge rock using sodium sulfate.
7. The boulders shall have a percentage loss of not more than ten percent (10%) after twelve (12) cycles of freezing and thawing when tested in accordance with AASHTO T103 for ledge rock, procedure A.
8. Rock shall be free of calcite intrusions.
9. Color:
  - a. The color of the boulders shall approved by ENGINEER prior to delivery to the PROJECT site.



- b. Color shall be consistent on the entire PROJECT and shall match the color of rock to be used for all other portions of the WORK.

#### C. SOIL RIPRAP

1. Rock requirements are to comply with riprap as specified in Article Materials.
2. The soil material shall be native or topsoil and mixed with sixty-five percent (65%) riprap and thirty five percent (35%) soil by volume.
3. Soil riprap shall consist of a uniform mixture of soil and riprap without voids.

#### D. VOID-FILLED RIPRAP

1. Rock requirements are to comply with riprap material specifications in Paragraph A.
2. Samples of riprap and void-fill materials shall be submitted for the review and approval of the ENGINEER prior to construction.
3. Where "Void-Filled Riprap" is designated on the DRAWINGS, riprap shall be mixed with the materials and associated proportions listed in Table 3 and Table 4 to fill the voids of the riprap.
4. If specified, an alternate void-filled riprap mix that includes river cobble shall be used; this mix appears in Table 5 and Table 6.
5. Mix proportions and material gradations in Tables 3 through 6 are approximate and are subject to adjustment by the ENGINEER. No adjustment in unit price for void-filled riprap will be allowed based on modifications to the mix proportions.



**Table 3: Mix Requirements for Type VL and L Void-Filled Riprap without River Cobble**

<b>Approximate Proportions (loader buckets)</b>	<b>Material Type</b>	<b>Material Description</b>
6	Riprap	Type VL or L
1	Void-fill material	VTC (Vehicle Tracking Control) rock (crushed rock with 100% passing 4-inch sieve, 50-70% passing 3-inch sieve, 0-10% passing 2-inch sieve)
1	Void-fill material	4-inch minus pit run surge (round river rock and sand, well graded, 90-100% passing 4-inch sieve, 70-80% passing 1.5-inch sieve, 40-60% passing 3/8-inch sieve, 10-30% passing #16 sieve).
1	Void-fill material	Type II bedding
½ to 1	Void-fill material	Native topsoil

Note: Mix proportions and material gradations are approximate and are subject to adjustment by the ENGINEER.

**Table 4: Mix Requirements for Type M and H Void-Filled Riprap without River Cobble**

<b>Approximate Proportions (loader buckets)</b>	<b>Material Type</b>	<b>Material Description</b>
6	Riprap	Type M or H
2	Void-fill material	7-inch minus crushed rock surge (100% passing 7-inch sieve, 80-100% passing 6-inch sieve, 35-50% passing 3-inch sieve, 10-20% passing 1.5-inch sieve)
1	Void-fill material	VTC (Vehicle Tracking Control) rock (crushed rock with 100% passing 4-inch sieve, 50-70% passing 3-inch sieve, 0-10% passing 2-inch sieve)
1	Void-fill material	4-inch minus pit run surge (round river rock and sand, well graded, 90-100% passing 4-inch sieve, 70-80% passing 1.5-inch sieve, 40-60% passing 3/8-inch sieve, 10-30% passing #16 sieve).
1	Void-fill material	Type II bedding
½ to 1	Void-fill material	Native topsoil

Note: Mix proportions and material gradations are approximate and are subject to adjustment by the ENGINEER.





**Table 5: Mix Requirements for Type VL and L Void-Filled Riprap with River Cobble**

<b>Approximate Proportions (loader buckets)</b>	<b>Material Type</b>	<b>Material Description</b>
6	Riprap	Type VL or L
1	Void-fill material	2 to 4-inch cobble (round washed river rock that is well-graded, 100% passing 6-inch sieve, 35-50% passing 3-inch sieve, 5-20% passing 2-inch sieve)
1	Void-fill material	4-inch minus pit run surge (round river rock and sand, well graded, 90-100% passing 4-inch sieve, 70-80% passing 1.5-inch sieve, 40-60% passing 3/8-inch sieve, 10-30% passing #16 sieve).
1	Void-fill material	Type II bedding
½ to 1	Void-fill material	Native topsoil
Top layer	Top dressing	Additional 4 to 12-inch cobbles (round washed river rock that is well graded, 80-100% passing 12-inch sieve, 35-50% passing 6-inch sieve, 5-20% passing 4-inch sieve) shall be mixed in on the surface of exposed sections of void-filled riprap (covering approximately 15% of the surface) prior to compaction of the void-filled riprap. Cobbles shall be fully embedded into the mass of the void-filled riprap.

Note: Mix proportions and material gradations are approximate and are subject to adjustment by the ENGINEER.



**Table 6: Mix Requirements for Type M and H Void-Filled Riprap with River Cobble**

Approximate Proportions (loader buckets)	Material Type	Material Description
6	Riprap	Type M or H
2	Void-fill material	7-inch minus crushed rock surge (100% passing 7-inch sieve, 80-100% passing 6-inch sieve, 35-50% passing 3-inch sieve, 10-20% passing 1.5-inch sieve)
1	Void-fill material	2 to 4-inch cobble (round washed river rock that is well-graded, 100% passing 6-inch sieve, 35-50% passing 3-inch sieve, 5-20% passing 2-inch sieve)
1	Void-fill material	4-inch minus pit run surge (round river rock and sand, well graded, 90-100% passing 4-inch sieve, 70-80% passing 1.5-inch sieve, 40-60% passing 3/8-inch sieve, 10-30% passing #16 sieve).
1	Void-fill material	Type II bedding
½ to 1	Void-fill material	Native topsoil
Top layer	Top dressing	Additional 4 to 12-inch cobbles (round washed river rock that is well graded, 80-100% passing 12-inch sieve, 35-50% passing 6-inch sieve, 5-20% passing 4-inch sieve) shall be mixed in on the surface of exposed sections of void-filled riprap (covering approximately 15% of the surface) prior to compaction of the void-filled riprap. Cobbles shall be fully embedded into the mass of the void-filled riprap.

Note: Mix proportions and material gradations are approximate and are subject to adjustment by the ENGINEER.

#### E. BEDDING:

1. Gradation for granular bedding shall conform to Table 7.
2. Granular bedding designation and total thickness of bedding shall be as shown on the DRAWINGS.
3. Granular bedding shall meet the same requirements for specific gravity, absorption, abrasion, sodium sulfate soundness, calcite intrusion, and freeze-thaw durability as required for riprap.
  - a. Broken concrete asphalt pavement or sledge, shall not be acceptable for use in the WORK. Rounded river rock is not acceptable unless specifically designated on the DRAWINGS.



- b. The requirements for the wear test in AASHTO T96 shall not apply.

**Table 7: Granular Bedding Gradation**

U.S. Standard Sieve Size	Percent by Weight Passing Square-Mesh Sieves	
	Type I (CDOT Sect. 703.01)	Type II (CDOT Sect. 703.09 Class A)
3 inches	-	90 - 100
1½ inches	-	-
¾ inch	-	20 - 90
⅜ inch	100	-
No. 4	95 - 100	0 - 20
No. 16	45 - 80	-
No. 50	10 - 30	-
No. 100	2 - 10	-
No. 200	0 - 2	0 - 3

**F. FEATURE BOULDERS:**

1. Feature Boulders shall consist of the same material as boulders, differing only by size.
2. Feature Boulders shall meet the same requirements for specific gravity, absorption, abrasion, sodium sulfate soundness, calcite intrusion, and freeze-thaw durability as required for boulders
3. Feature Boulders shall have a minimum dimension of four (4) feet, or as shown on the DRAWINGS.

**PART 3 EXECUTION**

**3.01 PREPARATION**

- A. Channel slope, bottom, or other areas that are to be protected with riprap, boulders, soil riprap, or void-filled riprap shall be free of brush, trees, stumps, and other objectionable material and be graded to a smooth compacted surface as shown on the DRAWINGS.
- B. CONTRACTOR shall excavate areas to receive riprap to the subgrade as shown on the DRAWINGS accounting for granular bedding.
- C. CONTRACTOR shall excavate areas to receive boulders, soil riprap, or void-filled riprap to the specified depth (bedding material is not required for boulders, soil riprap, or void-filled riprap).
- D. Subgrade Materials:



1. The subgrade materials shall be stable.
2. If unsuitable materials are encountered, they shall be removed and replaced as Muck Excavation in accordance with Section 31 23 00, Excavation and Fill, for subgrade that has been excavated in undisturbed soil.

E. Additional Compaction:

1. Additional compaction shall not be required unless specified by ENGINEER.
2. When subgrade is built up with embankment material it shall be compacted to ninety five percent (95%) maximum density (ASTM D698).

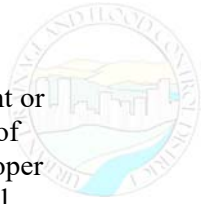
F. Bedding:

1. After an acceptable subgrade is established, bedding shall be immediately placed and leveled to the specified elevation on the DRAWINGS.
2. Immediately following the placement of the bedding material, the riprap shall be placed.
3. If bedding material is disturbed for any reason, it shall be replaced and graded at CONTRACTOR's expense.
4. Contamination:
  - a. In-place bedding materials shall not be contaminated with soils, debris or vegetation before the riprap is placed.
  - b. If contaminated, the bedding material shall be removed and replaced at CONTRACTOR's expense.

### 3.02 PLACEMENT

A. RIPRAP

1. Following acceptable placement of granular bedding, riprap placement shall commence as follows:
  - a. Machine Placed Riprap:
    - 1) Riprap shall be placed on the prepared slope or channel bottom areas in a manner which will produce a reasonably well graded mass of stone with the minimum practicable percentage of voids.
    - 2) Riprap shall be machine placed, unless otherwise stipulated in the DRAWINGS or SPECIFICATIONS.
    - 3) It is the intent of these SPECIFICATIONS to produce a fairly compact riprap protection in which all sizes of material are placed in their proper proportions. Unless otherwise authorized by ENGINEER, the riprap protection shall be



placed in conjunction with the construction of embankment or channel bottom with only sufficient delay in construction of the riprap protection, as may be necessary, to allow for proper construction of the portion of the embankment and channel bottom which is to be protected.

b. Slope Placement:

- 1) When riprap is placed on slope, placement shall commence at the bottom of the slope working up the slope.
- c. The entire mass of riprap shall be placed on either channel slope or bottom so as to be in conformance with the required gradation mixture and to line, grade, and thickness shown on the DRAWINGS.
- d. Riprap shall be placed to full course thickness at one operation and in such a manner as to avoid displacing the underlying bedding material. Placing of riprap in layers, or by dumping into chutes, or by similar methods shall not be permitted.
- e. All material used for riprap protection for channel slope or bottom shall be placed and distributed such that there shall be no large accumulations of either the larger or smaller sizes of stone. Some hand placement may be required to achieve this distribution.
- f. The basic procedure shall result in larger materials flush to the top surface with faces and shapes arranged to minimize voids, and smaller material below and between larger materials.
- g. Surface grade shall be a plane or as indicated, but projections above or depressions under the finished design grade by more than ten percent (10%) of the rock layer thickness shall not be allowed.
- h. Smaller rock shall be securely locked between the larger stone. It is essential that the material between the larger stones not be loose or easily displaced by flow or by vandalism.
- i. The stone shall be consolidated by the bucket of the backhoe or other means that will cause interlocking of the material.
- j. All rock is to be placed in a dewatered condition beginning at the toe of the slope or other lowest point.
- k. CONTRACTOR shall maintain the riprap protection until accepted. Any material displaced for any reason shall be replaced to the lines and grades shown on the DRAWINGS at no additional cost to OWNER. If the bedding materials are removed or disturbed, such material shall be replaced prior to replacing the displaced riprap.

2. Hand Placed Riprap:



- a. Hand placed riprap shall be performed during machine placement of riprap and shall conform to all the requirements of PART 2, above.
- b. Hand placed riprap shall also be required when the depth of riprap is less than two (2) times the nominal stone size, or when required by the DRAWINGS or SPECIFICATIONS.
- c. After the riprap has been placed, hand placing or rearranging of individual stones by mechanical equipment shall be required to the extent necessary to secure a flat uniform surface and the specified depth of riprap, to the lines and grades as shown on the DRAWINGS.

3. Soil Replacement Over Riprap:

- a. Where riprap is designated to be buried, place onsite excavated material that is free from trash and organic matter in riprap voids by washing and rodding.
- b. Prevent excessive washing of material into stream.
- c. When voids are filled and the surface accepted by ENGINEER, place a nominal six (6) inches of topsoil over the area, or as designated on the DRAWINGS.
- d. Fine grade, seed, and mulch per the SPECIFICATIONS.

B. BOULDERS

1. Following excavation and acceptance of subgrade by ENGINEER Boulder placement shall commence as follows:
  - a. Boulders shall be placed on the prepared subgrade in a manner which will minimize voids.
  - b. Voids between boulders exceeding 4" shall be chinked.
2. If Boulders are to be grouted, boulders shall be installed according to Section 31 37 19, Grouted Boulders, Stacked Grouted Boulders and grouted Boulder Retaining Walls.

C. SOIL RIPRAP

1. Adjacent stockpiles of riprap and soil shall be created and mixing done at the stockpile location, not at the location where soil riprap is to be placed.
2. Mix thirty-five percent (35%) soil by volume with stockpiled riprap, using additional moisture and control procedures that ensure a homogenous mixture; where the soil fills the inherent voids in the riprap without displacing riprap.



3. With prior approval of ENGINEER, layering the riprap and soil instead of premixing may be allowed if the native soil is granular.
4. Place a first layer of smaller soil riprap of approximate  $d_{50}$  thickness. Then place the top layer with surface rocks that are largely  $d_{50}$  or greater, filling voids as necessary with smaller planted riprap. Create a smooth plane as described in Paragraph A.
5. The mixture shall be consolidated by large vibratory equipment or backhoe bucket to create a tight, dense interlocking mass.
6. The soil shall be further wetted to encourage void filling with soil.
7. Any large voids shall be filled with rock and small voids filled with soil.
8. Excessively thick zones of soil prone to washing away shall not be created (for example, no thicknesses greater than six (6) inches).
9. For buried soil riprap, the top surface shall be covered with four (4) inches of topsoil such that no rock points are protruding.
10. The final surface shall be thoroughly wetted for good compaction, smoothed and compacted by vibrating equipment; the surface shall then be hand raked to receive planting or seeding.

#### D. VOID-FILLED RIPRAP

1. The ENGINEER and/or CONSTRUCTION INSPECTOR shall observe mixing and placing of the material.
2. Approved individual component materials of void-filled riprap mix shall be delivered to site in separate marked stockpiles. Mixing shall be accomplished using a front end loader or other approved means to add the specified number of "loader buckets" of each material to a mixing stockpile. Ensure that each loader bucket comprises an approximately equal volume. If the loader operator is only able to fill the bucket partially full with large riprap (due to the force required to push the bucket into the pile), but uses full buckets of finer material, the mix proportions will not be correct. Avoid picking up excessive amounts of native soil from the subgrade under the stockpiled materials during the loader bucket mixing operations. The ENGINEER may reduce or eliminate the volume of topsoil added to the mixture based on the amount of native soil was incorporated during the bucket mixing operation.
3. Once all the materials have been added to the mixing stockpile in the specified proportions, thoroughly mix the pile using a loader, large track-hoe excavator, or other approved means to fill the voids of the riprap **without displacing the riprap** or creating pockets of finer material absent of riprap.
4. Segregation of materials shall be minimized when hauling from the stockpile to the installation location. Remixing shall occur as necessary to correct for any segregation as the material is placed.



5. The loose material shall be placed in a single lift of sufficient height such that final grade will be achieved upon compaction. Additional mixing with a track excavator shall be required after initial placement to ensure that the void-filled riprap is thoroughly mixed and no segregation or excessive amount of smaller void-fill material is present on the surface. The mixing and placement process shall result in larger riprap ( $D_{50}$  size or larger) flush to the top surface with faces and shapes arranged to minimize voids, and smaller material between and below larger materials.
6. If the top of the compacted material is below final grade, placement of only the smaller void-fill materials to achieve final grade will not be permitted. Additional void-filled riprap shall be added and the entire section mixed with a track excavator to eliminate the presence of smaller void-fill material on the surface.
7. Avoid segregation of materials and remix any section where the combined material consists primarily of the void-fill materials. The density and interlocking nature of riprap in the mixed material shall essentially be the same as if the riprap was placed without filling the voids. This requires care and persistence on the part of the CONTRACTOR to install the work and on the part of the ENGINEER to assure that the work is installed correctly.
8. At the direction of the ENGINEER, a 50:50 mixture of pit run and Type II bedding shall be sprinkled on the surface of the void-filled riprap and washed-in with water using a high pressure hose to fill-in small voids. This shall be done just prior to compaction of the void-filled riprap.
9. If specified as part of the cobble mix, the top dressing of cobbles shall also be mixed in on the surface of exposed sections of void-filled riprap material prior to compaction of the riprap material.
10. Compaction of the void-filled riprap shall be performed by running over the void-filled riprap with a large, heavy duty track excavator or dozer. The moisture content of the mixture shall be at optimum conditions prior to compaction and water shall be added, as necessary, at the direction of the ENGINEER. Compaction of void-filled riprap shall be reviewed and approved by the ENGINEER.
11. Where indicated on the DRAWINGS, a surface layer of 4 to 6 inches moist topsoil shall be placed over the void-filled riprap. The topsoil surface layer shall be compacted to approximately 85% of maximum density and within two percentage points of optimum moisture in accordance with ASTM D698. Topsoil shall be added to any areas that settle.
12. CONTRACTOR shall install a test section of at least 100 square feet of void-filled riprap for the review and approval of the ENGINEER prior to installation of the remaining void filled-riprap.
13. Elevation tolerance for the void-filled riprap shall be 0.10 feet. Thickness of void-filled riprap shall be no less than thickness shown and no more than 2-inches greater than the thickness shown.





**E. FEATURE BOULDERS**

1. Feature Boulders serve an aesthetic function and as such shall be placed and rotated into final position as directed by ENGINEER in order to achieve the desired result.

**3.03 REJECTION OF WORK AND MATERIALS:**

- A. ENGINEER will reject placed riprap, boulders, soil riprap and bedding that do not conform to this section. CONTRACTOR shall immediately remove and re-lay the riprap, boulders, soil riprap, void-filled riprap, and bedding to conform to SPECIFICATIONS.
- B. Riprap, boulders, soil riprap, void-filled riprap and bedding that do not conform to this section shall be rejected, whether delivered to the job site or placed.
- C. Rejected riprap, boulders, soil riprap and bedding shall be removed from the PROJECT site by CONTRACTOR at CONTRACTOR's expense.

**END OF SECTION**



## **SECTION 31 37 19**

### **GROUTED BOULDERS, STACKED GROUTED BOULDERS, AND GROUTED BOULDER RETAINING WALLS**

#### **PART 1 GENERAL**

##### **1.01 SECTION INCLUDES**

- A. This WORK shall consist of subgrade preparation, installing grouted boulders, stacked grouted boulders, and grouted rock retaining walls constructed at the location (s) shown on the DRAWINGS.

##### **1.02 RELATED SECTIONS**

- A. The following is a list of SPECIFICATIONS which may be related to this section:

1. Section 01 57 19, Temporary Environmental Controls
2. Section 03 31 00, Structural Concrete
3. Section 03 60 00, Grouting
4. Section 31 23 00, Excavation and Fill.
5. Section 31 23 19, Dewatering.
6. Section 31 23 33, Trenching and Backfilling.
7. Section 31 25 00, Erosion and Sedimentation Controls
8. Section 31 37 00, Riprap, Boulders, and Bedding

##### **1.03 REFERENCES**

- A. The following is a list of standards which may be referenced in this section:

1. American Association of State Highway and Transportation Officials (AASHTO):
  - a. T85, Standard Method of Test for Specific Gravity and Absorption of Coarse Aggregate.
  - b. T103, Standard Method of Test for Soundness of Aggregates by Freezing and Thawing.
  - c. T104, Standard Method of Test for Soundness of Aggregate by Use of Sodium Sulfate or Magnesium Sulfate.
2. ASTM International (ASTM):
  - a. C39, Standard Test Method for Compressive Cylindrical Concrete Specimens.



- b. C150, Standard Specification for Portland Cement.
- c. D698, Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12 400 ft-lbf/ft<sup>3</sup> (600 kN-m/m<sup>3</sup>)).

#### 1.04 DEFINITIONS

- A. Terms "boulders" and "rock" may be used interchangeably in this section.

#### 1.05 SUBMITTALS

- A. CONTRACTOR shall submit a mix design in writing to ENGINEER for approval prior to placement of any grout.
- B. CONTRACTOR shall cooperate with ENGINEER in obtaining and providing samples of all specified materials.
- C. CONTRACTOR shall submit certified laboratory test certificates for all items required in this section.

#### 1.06 QUALITY ASSURANCE

- A. Mock-up:
  - 1. Prior to the construction of any grouted rock walls, CONTRACTOR or SUBCONTRACTOR who is constructing the walls for CONTRACTOR shall show ENGINEER an example of similar rock walls that they had constructed previously.
  - 2. After acceptance of this previous WORK, CONTRACTOR or SUBCONTRACTOR shall construct approximately one hundred (100) square feet of grouted rock wall as shown on the DRAWINGS for approval by ENGINEER.
  - 3. If the construction is approved, CONTRACTOR or SUBCONTRACTOR shall construct the rest of the grouted rock wall. If the construction is not approved, CONTRACTOR shall make any changes required by OWNER and ENGINEER to obtain approval, and construct the remainder of the wall as approved.

### **PART 2 PRODUCTS**

#### 2.01 MATERIALS

- A. Boulders
  - 1. Boulders shall meet the requirements of Section 31 37 00 Riprap, Boulders, Soil Riprap and Bedding
  - 2. Rhyolite rock shall not be used for any DISTRICT work.
  - 3. Gradation:



- a. Each load of boulders shall conform to the dimensions specified on the DRAWINGS and in Section 31 37 00 Riprap, Boulders, and Bedding
  - b. Boulders for a boulder edge shall have a maximum ratio of largest to smallest rock dimension shall be 1.5 or as shown on the DRAWINGS. Grouted walls shall be constructed of rock size specified on DRAWINGS.
  - c. Control of gradation will be by visual inspection.
    - 1) In the event ENGINEER determines the boulders to be unacceptable, ENGINEER will pick two random truckloads to be dumped and checked for gradation.
    - 2) Mechanical equipment and labor needed to assist in checking gradation shall be provided by CONTRACTOR at no additional cost to OWNER.
4. Color:
- a. The color of boulders shall meet the requirements of Section 31 37 00, Riprap, Boulders, and Bedding.
- B. Grout:
1. Concrete for the grout shall be an approved batch meeting the following requirements:
    - a. All grout shall have a minimum 28-day compressive strength equal to 3,200 psi.
    - b. One cubic yard of grout shall contain a minimum of six (6) sacks of Type II Portland cement.
    - c. A maximum of 25% Type F Fly Ash may be substituted for the Portland cement.
    - d. Aggregate for the grout shall consist of 70% natural sand (fines) and 30% 3/8-inch rock (coarse).
    - e. Slump shall be four (4) inches to six (6) inches.
    - f. Air entrainment shall be 5.5% - 7.5%.
    - g. Grout shall contain one and one-half (1-1/2) pounds of Fibermesh, or approved equivalent, per cubic yard of grout.
    - h. Color Additive in required amounts shall be used when so specified by contract.



## **PART 3 EXECUTION**

### **3.01 GROUTED BOULDERS AND STACKED GROUTED BOULDERS**

- A. Grouted boulders shall be placed at the locations as shown on the DRAWINGS and installed with the following requirements:
1. Subgrade:
    - a. The subgrade to receive each boulder shall be excavated and any unstable material shall be removed and replaced to achieve a stable subgrade.
    - b. Grouted Boulders shall be placed on subgrade without granular bedding or riprap unless approved by ENGINEER. Boulders shall not be perched on any material in order to meet design grade; appropriate boulder dimension is required.
    - c. Material approved by ENGINEER shall be placed and compacted in a minimum of six-inch (6") compacted lifts to ninety five percent (95%) of Maximum Standard Proctor Density (ASTM D698) and tested every foot to re-establish the subgrade of each boulder.
    - d. Unstable material shall be removed from the PROJECT site and disposed of by CONTRACTOR. Removal and replacement of unstable material shall only be completed at the direction of ENGINEER and shall be paid for under Muck Excavation. Failure to provide adequate water control measures shall not be cause for CONTRACTOR to apply Muck Excavation.
    - e. Subgrade shall be excavated a minimum of 6" to a maximum of 12" behind boulders.
    - f. Backfill behind boulders shall be compacted to ENGINEER's satisfaction. Care shall be taken during compaction to avoid disturbing and/or damaging the integrity of the boulder channel edge.
    - g. Finished grades and subgrade for boulders shall be determined from the height of each boulder used.
  2. Boulders
    - a. The top of all boulders shall be as indicated on the DRAWINGS.
    - b. The boulders shall be carefully picked and arranged so that adjacent rock surfaces match within two (2) inches in top elevation and two (2) inches along the vertical exposed face or channel side of rock.
    - c. Boulders shall be placed such that adjacent boulders are one and one-half (1-1/2) to three and one-half (3-1/2) inches away and voids do not exceed four (4) inches to allow grout to penetrate and lock boulders in. It is the intent of construction to minimize voids and grout placed between boulders.



- d. CONTRACTOR shall, if deemed necessary, support the boulders from falling over before and during the placement of grout, backfill, and completing compaction WORK on either side of the boulder.
- e. Smaller rocks shall be "chinked in" to fill all voids behind the boulders. Smaller rocks shall also be used to "chink in gaps larger than four (4) inches. Placement shall be approved by ENGINEER prior to grouting.
- f. Subsequent lifts of boulders should be battered no more than four (4) to six (6) inches back from the lower boulder level face.
- g. Boulders shall be installed a minimum of twelve (12) inches below the final channel invert elevation, unless specified differently.
- h. Subsequent lifts of boulders may not be perched on riprap or chinking rock, however, one or two smaller pieces of riprap may be used to help level the edge of a boulder so that the top surface is relatively flat.

3. Grouting:

- a. Prior to placing the grout, any type of debris, fines, smaller rock, or silt shall be removed from around or under and on the boulders.
- b. Dewatering shall be implemented to guarantee that the grout will not be placed in water and for a period of twenty-four (24) hours after the grout has been placed.
- c. Keep grout contact surfaces on boulders wet at all times prior to receiving grout.
- d. The concrete grout shall be placed by injection methods by pumping under low pressure, to ensure complete penetration of the grout into the void area as detailed on the DRAWINGS. The grout mix shall be stiffened and other measures taken to retain the grout between the boulders. A vibrator shall not be used to "move" grout horizontally.
- e. Grout placement shall begin at the bottom of the lowest boulder and proceed upward to ensure no air voids exist between the grout, subbase, and boulders.
- f. Grout shall be placed up to a height of two-thirds (2/3) of the diameter of the top row of boulders or as directed by ENGINEER and shall be placed in the voids and behind the boulders and not on the surface of the rocks.
- g. A "pencil" vibrator shall be used to make sure all voids are filled between the boulders from the subgrade and around the boulders to a depth as shown on the DRAWINGS. CONTRACTOR shall use a wood float or brush, when approved by ENGINEER, to smooth and grade the grout around the boulders.



- h. Grout between boulders shall be recessed one third (1/3) the diameter of the boulders on the side facing the channel.
  - i. Grout should be raked out and finished to minimize visibility.
  - j. Clean and wash any spillage before the grout sets so the visual surfaces of boulders will be free of grout to provide a clean, natural appearance, or if washing does not clean off grout residue, CONTRACTOR shall wash off any grout residue with a wire brush or muriatic acid and water, using a brush to scrub off the residue.
  - k. Grout shall receive cold or hot weather protection in accordance with Section 03 31 00, Structural Concrete.
4. Cold Joints:
- a. No cold joints shall be allowed in the basin area.
  - b. A piece of #4 rebar, three feet (3') long, shall be installed between each boulder embedded 18" into the initial pour.
  - c. The cold joint shall have a roughened edge and be cleaned of all dirt and debris to allow the pours to bond.
  - d. All cold joints on cutoff walls must have a keyway formed in the top of the initial pour that shall be two inches (2") deep and four inches (4") wide and shall have #4 rebar placed every two feet (2') horizontally, which extends a minimum of 12 inches from the initial pour height.
  - e. CONTRACTOR shall leave the cold joint in a non-linear, jigsaw manner.

### 3.02 GROUTED BOULDER RETAINING WALLS

- A. Grouted boulder retaining walls shall be placed at locations as shown on the DRAWINGS and installed with the following requirements:
- 1. The grouted boulder walls shall be constructed to the dimensions shown on the DRAWINGS and shall be constructed with a one (1) horizontal to four (4) vertical batter on the front and back face, with a minimum width of one (1) foot at the top of the wall.
  - 2. The stone of the wall shall be laid to form substantial masonry presenting a neat, finished appearance.
  - 3. Headers shall hold the heart of the wall to the face and shall occupy at least twenty percent (20%) of the area and they shall be evenly distributed.
  - 4. The length of stretchers shall not exceed three (3) times their rise.
  - 5. Spalls and pinnars shall be used in the backing only where necessary and will not be allowed in the face.



6. Face Stones:

- a. Face stones shall be laid to break joints so that each rock laid rests on two beneath it.
- b. Rock shall be hand graded so that only the larger stones are used in the face.
- c. All face stones shall be pitched to a string line on straight walls or laid to batter stakes for curved walls such that the batter is consistent with respect to all parts of the wall and shall meet the minimum requirements set forth in the detail.
- d. The degree of roughness on the exposed face shall be measured with a six-foot (6') straightedge supported between adjacent projections and stone face.
- e. Variations in excess of three (3) inches, measured from the straight edge to the extreme depression in the stone, will not be permitted.
- f. Rear faces shall present approximately plane surfaces and shall in general conform to the detail.

7. Grouting:

- a. Prior to placing the grout, any type of debris, fines, smaller rock, or silt shall be removed from around or under and on the boulders.
- b. Dewatering shall be implemented to guarantee that the grout will not be placed in water and the area will remain dewatered for a period of twenty-four (24) hours after the grout has been placed.
- c. The grout contact surfaces on boulders shall be wet at all times prior to receiving grout.
- d. Grout shall be placed to fill all voids between, under, and throughout the boulder walls and shall be recessed approximately one-third (1/3) the diameter of the boulders from the face of the wall in order to give a "dry stacked" appearance. This may require a gloved finish to accomplish.
- e. A "pencil" vibrator shall be used to make sure all voids are filled between the boulders from the subgrade and around the boulders to a depth as shown on the DRAWINGS. CONTRACTOR shall use a wood float or brush, when approved by ENGINEER, to smooth and grade the grout around the boulders.
- f. Any "loose" rocks shall be regouted by machine or hand methods.
- g. Clean and wash any spillage before the grout sets on the outside face and top of walls such that the visual surfaces of the rocks are free of grout to provide a clean natural appearance, or, if washing does not clean off grout residue, then CONTRACTOR shall wash off any





grout residue with muriatic acid and water, using a brush to scrub off the residue.

- h. Grout shall receive cold or hot weather protection in accordance with Section 03 31 00, Structural Concrete.

8. Cold Joints:

- a. A piece of #4 rebar, three (3) feet long, shall be installed between each boulder embedded 18" into the initial pour.
- b. For top row, cut bar length to provide three (3) inches of grout cover over bar.
- c. The cold joint shall have a roughened edge and be cleaned of all dirt and debris to allow the pours to bond.

**END OF SECTION**



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