DIVISION 21.  EARTHWORK, SUBGRADES, AND SUBBASES

This work consists of grading and construction of subgrades and subbases as required for the various types of work in the following sections. Complete the work in conformance with the lines, grades, thicknesses, and typical cross sections shown in the contract documents or as established by the Engineer.

2101.  Clearing and Grubbing.
2102.  Roadway and Borrow Excavation.
2103.  Presplitting and Production Blasting of Rock Slope Cuts.
2104.  Channel Excavation.
2105.  Stripping, Salvaging, and Spreading Topsoil.
2106.  Settlement Plates.
2107.  Embankments.
2108.  Overhaul.
2109.  Natural Subgrade.
2110.  Soil Aggregate Subbase.
2111.  Granular Subbase.
2112.  Wick Drains.
2113.  Subgrade Stabilization Material.
2115.  Modified Subbase.
2116.  Full Depth Reclamation.
2120.  Fuel Adjustment.
2121.  Granular Shoulders.
2122.  Paved Shoulders.
2123.  Earth Shoulders for Pavements and Bases.
2125.  Reshaping Ditches.
2126.  Reclaiming Present Surfacing Material.
2127.  Reconstruction of Roadbed.
2128.  Furnish and Apply Granular Shoulder Material.

Section 2101.  Clearing and Grubbing

2101.01  DESCRIPTION.

A.  Clearing: Cut and remove trees 3 inches (75 mm) or more in diameter.

B.  Grubbing: Remove stumps, including roots, to a depth of at least 12 inches (300 mm).

C.  Removal of Logs and Down Timber: Remove logs and down timber encountered on the work.

D.  Hedge Removal: Pull or grub hedge fences of Osage Orange or shrubs planted close together in rows. If any individual tree, of those composing a hedge, has a diameter greater than 6 inches (150 mm), it will be measured separately as a tree.

E.  Brush and Shrub Removal: Pull or grub trees and shrubs less than 3 inches (75 mm) in diameter, including roots, which are not classified as hedge.
F. **Removal of Growing Corn:** Cut stalks to a maximum height of 5 inches (125 mm) above the ground, remove the stalks, and thoroughly disk the corn stubble.

G. **Vegetation and Rubbish Removal:** Remove vegetation and all rubbish encountered on the right-of-way.

H. **Field Fence:** Remove field fence from the project.

2101.02 **MATERIALS.**
None.

2101.03 **CONSTRUCTION.**

A. Remove woody and other herbaceous vegetation, field fences, and rubbish from the right-of-way and from borrow pits furnished by the Contracting Authority. Do not remove field fences, trees, shrubs, and grasses that are to be preserved as indicated in the contract documents or as designated by the Engineer.

B. Unless shown otherwise in the contract documents or ordered by the Engineer, clear and grub the area within the need line, or the entire right-of-way including borrow pits and the area covered by embankments. All of this material which is removed from the project remains the property of the Contractor.

C. Material from clearing and grubbing may be burned according to IAC 567-23.2 and additional local ordinances. The unburned materials may be buried on State of Iowa right of way at locations approved by the Engineer.

D. Material from clearing and grubbing may be processed by such means as chipping of logs, down timber, or brush, for mulching material, or salvaging of logs and down timber for firewood. Other vegetation including corn stubble may be disked into the existing ground surface.

E. Haul the materials from clearing and grubbing (other than field fence) that are not handled on the project to a "yard waste" landfill.

F. Remove field fence from the project. Field fence may be deposited in an appropriate landfill.

2101.04 **METHOD OF MEASUREMENT.**
Measurement for Clearing and Grubbing, removal, and clean-up of other material in units (calculated to the 0.1 unit) or by area will be as follows:

A. **Units.**

1. Clearing and Grubbing will be the quantity shown in the contract documents.
   a. Trees 3 inches (75 mm) in diameter or greater will be counted and the circumference will be measured at a height of 18 inches (450 mm) above the ground. The diameter will be calculated by
measuring the circumference to the nearest inch (10 mm) and dividing by 3.14. See Table 2101.04-1 for identification of units per tree for clearing, grubbing, and clearing and grubbing.

b. Stumps 3 inches (75 mm) in diameter or greater will be counted and the diameter, in inches (millimeters), calculated by determining the average diameter at cutoff. See Table 2101.04-1 for identification of units per stump for grubbing.

c. Logs and down timber 3 inches (75 mm) in diameter or greater will be measured in a manner similar to that used for trees (Item a above). Measurement will be at a point 18 inches (450 mm) from the end of the log with greatest diameter or 18 inches (450 mm) from the base of the tree for down timber for clearing. See Table 2101.04-1 for identification of units per log and down timber for clearing.

d. Hedge rows will be measured in linear feet (meters) and converted to units using a rate of 30 units per station1 unit per meter of hedge row.

e. Brush will be measured in square feet (square meters) and converted to units by using a rate of 0.8 units per 100 square feet (0.1 unit per square meter) of brush.

f. Growing corn will be measured in square feet (square meter) and converted to units by using a rate of 0.2 units per 100 square feet (0.02 units per square meter) of growing corn.

g. Vegetation removal will not be measured for payment.

h. Field fence removal, included in clearing and grubbing, will be measured in stations (meters) and converted to units at a rate of 6.0 units per station (0.2 units per meter) of fence.

2. For each tree or stump counted as identified in Items a, b, and c in Paragraph 1 above, units will be determined as identified in Table 2101.04-1.

<table>
<thead>
<tr>
<th>Table 2101.04-1: Clearing and Grubbing Units</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Size Diameter</strong></td>
</tr>
<tr>
<td>3 in. to 6 in. inclusive (75 mm to 150 mm inclusive)</td>
</tr>
<tr>
<td>Over 6 in. to 9 in. inclusive (Over 150 mm to 225 mm inclusive)</td>
</tr>
<tr>
<td>Over 9 in. to 12 in. inclusive (Over 225 mm to 300 mm inclusive)</td>
</tr>
<tr>
<td>Over 12 in. to 15 in. inclusive (Over 300 mm to 375 mm inclusive)</td>
</tr>
<tr>
<td>Diameter Range</td>
</tr>
<tr>
<td>------------------------------------</td>
</tr>
<tr>
<td>Over 15 in. to 18 in. inclusive</td>
</tr>
<tr>
<td>(Over 375 mm to 450 mm inclusive)</td>
</tr>
<tr>
<td>Over 18 in. to 24 in. inclusive</td>
</tr>
<tr>
<td>(Over 450 mm to 600 mm inclusive)</td>
</tr>
<tr>
<td>Over 24 in. to 30 in. inclusive</td>
</tr>
<tr>
<td>(Over 600 mm to 750 mm inclusive)</td>
</tr>
<tr>
<td>Over 30 in. to 36 in. inclusive</td>
</tr>
<tr>
<td>(Over 750 mm to 1000 mm inclusive)</td>
</tr>
<tr>
<td>Over 36 in. to 42 in. inclusive</td>
</tr>
<tr>
<td>(Over 1000 mm to 1150 mm inclusive)</td>
</tr>
<tr>
<td>Over 42 in. to 48 in. inclusive</td>
</tr>
<tr>
<td>(Over 1150 mm to 1300 mm inclusive)</td>
</tr>
<tr>
<td>Over 48 in. to 60 in. inclusive</td>
</tr>
<tr>
<td>(Over 1300 mm to 1600 mm inclusive)</td>
</tr>
<tr>
<td>Over 60 in. to 72 in. inclusive</td>
</tr>
<tr>
<td>(Over 1600 mm to 2000 mm inclusive)</td>
</tr>
<tr>
<td>Over 72 in. (Over 2000 mm)</td>
</tr>
<tr>
<td></td>
</tr>
</tbody>
</table>

**B. Area.**

1. The area in acres (hectares) will be based on that shown in the contract documents, computed from a need line, or computed from a right-of-way line if the limits are not shown for this item in the contract documents.

2. Within these limits, an item for clearing and grubbing in units will not be measured for payment.

**2101.05 BASIS OF PAYMENT.**

Payment for Clearing and Grubbing, removal of trees, stumps, logs and down timber, hedge rows, brush, field fence, and growing corn will be made at the contract unit price per unit or per acre (hectare) as indicated below. If the Contractor is required to save material less than 6 inches (150 mm) in diameter or to process material saved to an extent greater than is necessary to produce neat piles, this extra saving and processing is considered extra work and payment will be as provided in Article 1109.03, B. Removal and disposal of household rubbish and other nonhazardous...
rubbish is considered extra work and payment will be as provided in Article 1109.03, B.

A. Units.
Number of units satisfactorily completed.

B. Area.
Number of acres (hectares) satisfactorily completed.

Section 2102. Roadway and Borrow Excavation

2102.01 DESCRIPTION.
Excavate, haul, place, compact, and shape construction materials.

2102.02 MATERIALS.

A. Class 10.
Includes:
- Normal earth materials such as loam, silt, gumbo, peat, clay, soft shale, sand, and gravel.
- Fragmentary rock or boulders handled in the manner normal to this class of excavation.
- Any combination of the above described materials and any other material not classified as Class 12 or Class 13.

B. Class 12.
Includes:
- Granite, trap, quartzite, chert, limestone, sandstone, hard shale, or slate in natural ledges or displaced masses.
- Rock fragments or boulders which occur on the surface or in subsurface deposits mixed with earth, sand, or gravel when their size, number, or location prevents them from being handled in a manner normal to Class 10 excavation.

C. Class 13.
Includes all materials included under the definitions of Classes 10 and 12 and any other material encountered, regardless of its nature.

D. Borrow.

1. Select Treatment Material.
   a. Cohesive Soils.
      Meet all of the following requirements:
      1) 45% or less silt size fraction.
      2) 110pcf (1750 kg/m^3) or greater density (AASHTO T 99 Proctor Density).
      3) Plasticity index greater than 10.
      4) A-6 or A-7-6 soils of glacial origin.
   b. Granular Soils.
      Meet all of the following requirements:
2102.02 Roadway and Borrow Excavation

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1) 15% or less silt and clay.
2) 110 pcf (1750 kg/m³) or greater density (AASHTO T 99 Proctor Density).
3) Plasticity index, 3 or less.
4) A-1, A-2, or A-3 (0).

**c. Special Backfill Material Material.**
Meet the requirements of Section 4132

2. **Suitable Soils.**
   a. Ensure all soils provided for the construction of embankments meet the requirements below. They are suitable when moisture control or moisture and density control is designated.
   1) 95 pounds per cubic foot (1500 kg/m³) or greater density (AASHTO T 99 Proctor Density).
   2) AASHTO M 145-91 index of less than 30.
   b. Soils not meeting these requirements are considered unsuitable soils.
   c. When placing soil below water, use clean granular material.

3. **Unsuitable Soils.**
Unsuitable soils shall be placed in the work only as specified by Standard Road Plan RL-1B or shall be removed as directed by the Engineer. Use in the work will be according to the definitions in Table 2102.02-1:

<table>
<thead>
<tr>
<th>Table 2102.02-1: Uses for Unsuitable Soils</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Definition</strong></td>
</tr>
<tr>
<td>1. Peat or Muck.</td>
</tr>
<tr>
<td>2. Soils with a plasticity index of 35 or</td>
</tr>
<tr>
<td>greater</td>
</tr>
<tr>
<td>3. A-7-5 or A-5 having a density less than</td>
</tr>
<tr>
<td>85 pcf (1350 kg/m³) (AASHTO T 99 Proctor</td>
</tr>
<tr>
<td>Density).</td>
</tr>
<tr>
<td>1. All soils other than A-7-5 or A-5</td>
</tr>
<tr>
<td>having a density of 95 pcf (1500 kg/m³) or</td>
</tr>
<tr>
<td>less (AASHTO T 99 Proctor Density).</td>
</tr>
<tr>
<td>2. All soils other than A-7-5 or A-5</td>
</tr>
<tr>
<td>containing 3.0% or more carbon.</td>
</tr>
<tr>
<td>1. A-7-6 (30 or greater).</td>
</tr>
<tr>
<td>2. Residual clays (overlying bedrock)</td>
</tr>
<tr>
<td>regardless of classification.</td>
</tr>
<tr>
<td>1. Shale.</td>
</tr>
<tr>
<td>2. A-7-5 or A-5 soils having a density</td>
</tr>
<tr>
<td>greater than 86 pcf (1351 kg/m³) but less</td>
</tr>
<tr>
<td>than 95 pcf (1500 kg/m³) (AASHTO T 99</td>
</tr>
</tbody>
</table>

**E. Selected Backfill Material.**
Shown in the contract documents.
F. Special Backfill Material.
Meet the requirements of Section 4132.

2102.03 CONSTRUCTION.

A. General.

1. Prepare the site and construct the embankment according to Section 2107.

2. Remove materials as indicated in the contract documents and from borrow pits, exclusive of that designated as channel excavation.

3. Remove material necessary to provide suitable approaches from intersecting highways and private entrances.

4. Shape and slope materials for construction of the roadbed, slopes, gutters, and inlet and outlet ditches according to these specifications and the alignment, grade, and cross sections shown in the contract documents or established by the Engineer.

5. Before beginning construction, remove grass, weeds, other herbaceous vegetation, and rubbish as provided in Article 2102.03, G.

6. Work around utility poles if it is impractical to remove them before excavation or embankment construction.

B. Classification of Excavation.

1. Class 10 Excavation.
Excavate Class 10 material.

2. Class 12 Excavation.
Excavate Class 12 material.

3. Class 13 Excavation.
   a. Excavate Class 13 material. This classification covers work commonly referred to as "Unclassified Excavation". Use or remove Class 13 material as provided for in the contract documents.
   b. The contract documents will specify the limits for Class 13 excavation. Excavation within these limits will not be classified as Class 10 or Class 12 excavation.

C. Removal and Placement of Boulders.

1. Remove or bury boulders. Remove, where necessary, surface collections of boulders within the limits of the work for satisfactory completion of the work.

2. After completion of excavation operations, collect loose boulders and rocks. Also collect pieces of broken PCC that have a vertical projection
4 inches (100 mm) or more above the surface or the ground, or have a minimum diameter of 6 inches (150 mm) and that appear during the finishing operation.

3. Boulders, except those handled in a way normal to Class 10 excavation, will be classified as Class 12 excavation. Unless otherwise specified, place boulders in any of the following ways:
   a. Boulders too large to be loaded and hauled with available equipment may be buried in locations where they will not be exposed by erosion. Ensure that boulders buried this way are covered with at least 1 foot (0.3 m) of earth. Excavation made for the purpose of burying boulders will not be measured or paid for.
   b. Boulders or rock fragments may be used in construction of embankments provided they are covered with at least 1 foot (0.3 m) of earth and they do not interfere with specified compaction of the embankment. If boulders delivered to the embankment in combination with finer material interfere with compaction, remove and place them as provided in this article.
   c. If the quantity of boulders or rock fragments available at any one time is more than 100 cubic yards (100 m$^3$), the material may be placed in the embankment no less than 2 feet (0.6 m) below the finished grade line according to Article 2107.03, J. Cover with at least 2 feet (0.6 m) of earth on slopes.

4. Boulders not placed as provided above may, with approval of the Engineer, be:
   a. Used for filling gullies.
   b. Racked in neat compact piles at locations the Engineer designates within the right-of-way and accessible from the traveled way.
   c. Buried within the right-of-way at locations the Engineer designates.

D. Removal of Unsuitable or Unstable Soil and Placement of Selected or Special Backfill Material.

1. Removal of unsuitable or unstable soil or placement of selected or special backfill material, or both, may be required in the contract documents or by the Engineer.

2. If the finished grade line leaves a subgrade of unsuitable or unstable soil, the Engineer may require the Contractor to remove that soil as below grade excavation and place backfill material to the finished grade line. Material encountered above the elevation of finished subgrade which cannot be properly consolidated in the embankment may be designated as unstable soil by the Engineer. If the surface on which the plans indicate that selected or special backfill material is to be placed is such that it will be seriously distorted by hauling equipment, the Engineer may designate this material as unstable.

3. Remove unsuitable or unstable soil and place selected or special backfill material according to the following requirements:
a. **Removal of Unsuitable or Unstable Soil.**
   1) Remove these soils to the elevation shown in the contracts documents or as directed by the Engineer. Remove and place them as directed in the contract documents or by the Engineer and, in the case of unsuitable soils, according to Article 2107.03, N.
   2) Conduct operations so that the Engineer is given the opportunity to take cross sectional measurements required before the backfill material is placed.

b. **Backfill Materials.**
   1) Obtain selected backfill materials from locations shown in the contract documents or as directed by the Engineer.
   2) Furnish special backfill material that meets the requirements of Article 2102.02, F. Place salvaged materials used as special backfill material in uniform lifts no more than 6 inches (150 mm) thick. Place salvaged composite material used as special backfill material in uniform lifts of no more than 6 inches (150 mm) thick.

c. **Placement of Backfill Material.**
   1) Place special or selected backfill material in areas shown in the contract documents or as directed by the Engineer. Place and compact as provided in Section 2107 with the following modification:
      Where compaction with moisture and density control or with moisture control is required, ensure the moisture content of special backfill material is within the limits specified.
   2) Ensure the moisture content of backfill material is uniform. If necessary, adjust by processing in an approved pugmill or by adding water and road mixing in place prior to spreading and compacting.
      a) Use selected backfill material that at the time of spreading and compacting is no drier than 2.5 percentage points below the optimum moisture shown in the contract documents. If not shown, the Engineer will determine the optimum moisture.
      b) Use special backfill material that at the time of spreading and rolling is no drier than 2 percentage points below, and does not exceed, the maximum amount that will permit obtaining required compaction without rutting.
   3) When 2 feet (0.6 m) or more of selected or special backfill material is placed in areas where unstable soils have been excavated, the condition of the underlying soil may limit the amount of compaction to be done in the bottom 1 foot (0.3 m) of subgrade treatment. In exceptionally wet or unstable areas, the Contractor may be permitted to end dump the first 1 foot (0.3 m) of treatment material and doze it into position with only partial compaction, as directed by the Engineer. Compact the material above the bottom 1 foot (0.3 m) as provided above.
   4) When less than 2 feet (0.6 m) of selected or special backfill material is placed in areas of exceptionally wet or unstable soils, the Engineer may require a tamping type roller to be
used for compaction of the material placed in the first foot (0.3 m) of thickness.

E. Rock Cuts.

1. When excavation to the finished grade line results in a roadbed surface consisting of loose or solid rock, excavate 1 foot (0.3 m) below the finished grade of the roadbed. Place backfill material to the required grade with suitable earth. Subject to the Engineer’s approval, the earth backfill material may be obtained from any point within the right-of-way where suitable backfill material material is available. Conduct operations so that the Engineer is given the opportunity to take cross section measurements required before backfill material is placed.

2. When presplitting of rock cuts is required, refer to Section 2103.

3. The contract documents may require that part or all of the Class 12 Excavation be crushed. When crushing is required, crush the rock to the size or gradation, or both, specified in the contract documents. Stockpile or use the crushed materials as specified in the contract documents.

F. Borrow.

1. General.
   a. Unless provided otherwise in the contract documents, when the quantity of material required for embankments is not available within the limits of the roadway cross sections or specific borrow areas as indicated, make up the deficiency from borrow areas the Contracting Authority provides or furnish equivalent material from alternate borrow areas.
   b. The following definitions apply to this specification:
      1) Mandatory Borrow Areas.  
         An area provided by the Contracting Authority from which the Contractor is expected to obtain borrow material and to operate in the area according to the contract documents. Mandatory borrow areas will be designated in the contract documents.
      2) Optional Borrow Area.  
         An area provided by the Contracting Authority from which the Contractor may obtain borrow material. If so obtained, the Contractor is expected to operate in the area according to the contract documents. Borrow areas are optional borrow areas unless specifically designated as mandatory borrow areas.
      3) Alternate Borrow Areas.  
         An area outside the highway right-of-way provided or to be provided by the Contractor from which the Contractor may obtain borrow material. Use according to the contract documents. The Contractor is responsible for obtaining all rights associated with this area and for use of this material.
      4) Designated Borrow Area.  
         A general term for borrow areas the Contracting Authority provides, including mandatory and optional borrow areas.
c. Provide borrow areas that are regular in cross section to permit accurate measurement. Carefully blend to natural land forms and avoid unnecessary damage to the land. Do not turn natural drainage of surface water on to adjoining owners. Use diligence in draining the surface water in its natural course or channel. Complete excavation consistent with the existing natural drainage conditions.

d. Where a mandatory borrow area is designated in the contract documents, it is mandatory that borrow material be obtained from the borrow location designated unless permission is obtained from the Engineer to obtain borrow from another location.

e. Unless the contract documents designate borrow areas as mandatory borrow areas, borrow areas will be considered optional borrow areas. The Contractor has the option of either using the optional borrow areas or proposing to furnish equivalent material from alternate borrow areas.

f. The Contractor may be required to compensate the Contracting Authority for material removed from optional borrow areas. If so, the rate of compensation per cubic yard (cubic meter) to be charged will be shown in the contract documents. Compensation will not be required for topsoil that is removed and replaced. Compensation will be based on quantities shown in the contract documents, as corrected. However, when only a portion of the designated quantity is taken from the area, the quantity will be calculated from cross section measurements. When the contract documents do not identify an amount per cubic yard (cubic meter) for compensation, the material in the optional borrow area is available to the Contractor at no cost.

2. Contractor’s Plan.

a. When specified in the contract documents, submit a plan to the Engineer for use of all alternate borrow areas. Include in this plan designated borrow areas that are intended to be used in a manner different from that shown in the contract documents. Also, when required, sample the proposed alternate borrow areas by core drilling in the presence of a representative from the Office of Design, Soils Design Section. Provide samples to this representative for the Department to test. A minimum of 10 working days is necessary for this testing.

b. A plan for use of alternate borrow areas may be submitted only once. The submission shall include all such areas necessary or contemplated for completion of the planned work.

c. Generally, optional borrow areas shall be used as intended or not at all. Obtain the Engineer’s approval before using an optional borrow area in a manner different from that shown in the contract documents.

d. Approval of materials and their use will be based on AASHTO M 145-91 and includes the following:

1) Select Treatment Materials.
   a) The Engineer’s approval is required for all soils required for select subgrade treatments. The Contractor may elect to substitute special backfill material (Section 4132) at
one-half the required rate at no additional cost to the Contracting Authority. If special backfill material is substituted, the Contractor shall provide for suitable drainage of this material at no additional cost to the Contracting Authority.

(1) **Cohesive Soils.**
Meet the requirements of Article 2102.02, D, 1, a.

(2) **Granular Soils.**
Meet the requirements of Article 2102.02, D, 1, b.

(3) **Special Backfill Material.**
Meet the requirements of Section 4132.

b) Use select treatment sources with sufficient uniformity and size to assure that complete individual treatment areas will be constructed with similar material. Substitution of treatment types (cohesive, granular, or special backfill material) will be allowed only with the Engineer’s permission.

2) **Suitable Soils.**
Meet the requirements of Article 2102.02, D, 2.

3) **Unsuitable Soils.**
Meet the requirements of Article 2102.02, D, 3.

4) **Other Materials.**
Place materials not covered above as required by Standard Specifications.

3. **Clearances.**

a. Obtain necessary environmental, archaeological, and historic preservation clearances and comply with all restrictions attached to these clearances. The Engineer will provide assistance in identification of permit procedures and expediting consideration of these requests. Obtain other licenses and permits and comply with all other Federal, State, and local laws, ordinances, rules, and regulations involved in the proposed use of the alternate borrow areas.

b. The Engineer may decline approval of an alternate borrow area when:

1) Necessary clearances cannot be obtained prior to the time scheduled for commencement of the work.

2) Restrictions attached to these clearances will delay or interfere with the scheduled completion of work or may result in less than necessary quantities of the required borrow materials.

3) The Contractor's plan for the use of borrow areas, including the Contractor's verification of quantity and quality of required material, is not sufficient to assure the availability of required material.

4) The Contractor's proposed plans fail to meet requirements of the law or this specification.

c. The Contracting Authority will not be responsible for damages due to a delay in approval of an alternate borrow area or when approval of an alternate borrow area is declined.
4. **Restoration.**
   a. Optional borrow areas shown on the Contractor's plan shall be left in at least as good a condition as that required by the contract documents for designated borrow areas. This applies whether all or only a part of the site or the material is used for borrow.
   b. Use and rehabilitate optional and, unless the landowner consents and agrees otherwise, alternate borrow areas so that:
      1) The sites can continue to be used for the purpose for which they were used prior to removal of borrow.
      2) The sites may still be used for those higher and more profitable or better potential uses to which the site might have been put to prior to removal of borrow material.
   c. The Engineer will require restoration according to 314.12, Code of Iowa, to meet the above requirement. The overall Contractor's plan shall neither detract from nor interfere with the air, light, and view of motorists nor of adjacent landowners.

5. **Obligations and Payment.**
   Use of an alternate borrow area shall not increase future obligations or total cost to the Contracting Authority. Complete all excavation from the roadway and the mandatory borrow areas.

6. **Consideration of Proposal.**
   a. The Engineer will be allowed time to evaluate each alternate borrow area. If the clearance is not obtained within 30 calendar days, the proposed use of that borrow area may be rejected. During this evaluation period, the Contractor will not be charged for working days the Contractor does not work because the Contractor cannot use the borrow area.
   b. The maximum allowance for each contract is not to exceed 30 working days. This allowance will not apply to work for which an intermediate completion time is specified. It will be given only when the delay will not interfere with others authorized to work on the project. It does not increase the Engineer's responsibility to provide coordination.

7. **Starting Work.**
   Except for exploratory purposes, do not start work and take material from an alternate borrow until after:
   - The Engineer approves the proposal in writing, and
   - Providing the Engineer with a written release executed by the property owner and the Contractor relieving the Contracting Authority of any and all obligations to the property owner and saving the Contracting Authority harmless from all claims for injury to persons or damage to property resulting from the Contractor’s operations.

8. **Material Verification.**
   Material supplied from alternate borrow areas may be verified for compliance with these requirements. When the Engineer orders, remove and replace material verified not in close compliance with these requirements, at no additional cost to the Contracting Authority.
G. Placement of Surplus Material.
Place excavated surplus material as directed by the Engineer. Use to widen adjacent embankments, flatten sideslopes, or construct berms according to Article 2107.03, L.

H. Provisions for Drainage.

1. Construct intercepting ditches as shown in the contract documents.

2. In cuts along side hills where there is a possibility of surface water causing damage to the backslope of the cut, construct intercepting ditches with appropriate flume outlets to intercept surface water. Where surface water or water from side ditches would otherwise follow the toe of the embankment slope, direct the water away from the toe of the slope with runout ditches.

3. When the Engineer requires locating tile of lines, construct trenches and place backfill material at locations shown in the contract documents or as directed by the Engineer. Construct a continuous trench having a minimum depth of 5 feet (1.5 m) and a minimum width of 4 inches (100 mm). Construct trenches outside the limits of the embankment. The Engineer will examine the trench and excavated material to locate tile lines. Do not start placing backfill material without the Engineer’s approval. Place backfill material in all trenches.

4. If, during the course of the work, the natural flow of surface waters or artificial drains is interrupted, provide temporary drainage facilities needed to prevent damage to public or private property. Restore the original drainage facilities as soon as the work will permit. The Contractor is fully liable for all damages arising from action or inaction in providing for temporary drainage.

I. Protection of Trees and Shrubs.
Ensure trees and shrubs to be preserved are protected from injury during grading operations. The Engineer may require barricades or fences for this purpose.

J. Archaeological Salvage.
Temporarily discontinue operations at sites whenever remains of prehistoric people's dwelling sites, burial sites, or artifacts of historical or archaeological significance are encountered. The Engineer, in conjunction with proper archaeological authorities of the State of Iowa, will promptly examine the exposure and determine the disposition.

K. Finishing.

1. Finish excavation and embankment, including borrow pits, in a high quality manner to the specified or designed grade and cross section. On projects which do not involve a surface course other than a traffic compacted surface, the Engineer may waive setting finishing stakes if grade and cross section are within compliance and appearance and
riding qualities are satisfactory. Keep backslopes neatly finished as construction progresses.

2. Keep finishing work as close as possible to construction operations. Ensure stream pollution by soil erosion does not occur. When erosion control items are a part of the contract, the contract documents may specify a completion date for specific areas. When these dates are not specified, complete erosion control work on finished areas within 5 working days after completion of finishing. Keep finishing operations current with other construction operations.

3. Maintain partly finished work. If partly finished work is not maintained in a manner satisfactory to the Engineer, the Engineer may order, in writing, that all other work be discontinued until all finishing and maintenance work is in a satisfactory condition. Before the final acceptance, finish the roadway to the specified or designed line, grade, and cross section.

4. Grade slopes, shoulders, and ditches to the degree obtainable using power equipment operating under favorable conditions and operated by skilled workers. Hand methods of finishing will be required only when satisfactory results are not otherwise obtained.

5. Finish backslopes and foreslopes to conform to the cross section. Remove bulges and fill sags. Unless specifically excluded, roughen backslopes and foreslopes as a final finishing operation, except those which contain sufficient sand or rock to make roughening impractical. Roughen to a minimum depth of 3 inches (75 mm) by scarification, use of a heavy disk, or other suitable means.

6. Operate surface roughening equipment parallel with the toe of the slope. If an objectionable amount of material being roughened rolls down the slope, start the roughening operation at the toe of the slope and proceed in parallel strips up the slope.

7. Construct temporary water pollution control according to Section 2602.

L. Grading for Paving.

1. When grading work is done immediately prior to paving work covered by a separate contract, build the rough grade to the full width of the roadbed. Build with a crown to provide sufficient surface drainage. Construct the roadbed so that the surface is:
   a. Not lower at any point than the elevation of the corresponding pavement subgrade.
   b. Not above this elevation by more than 3 inches (75 mm), except at structures or when required by the contract documents.

2. Earth moving equipment with legal axle loads will be permitted to operate on new pavements or resurfaced roads if the road is not open to general traffic. Earth moving equipment will not be permitted to operate on pavements or resurfaced roads open to general traffic.
3. The above restrictions will not be construed to:
   a. Prevent the Contractor from hauling across pavement with legal loads at locations the Engineer designates.
   b. Prohibit the Contractor from turning across pavement to the opposite shoulder when embankment height or ditch depth prevents turning in the opposite direction.

4. Furnish flaggers as necessary for safe operations, at no additional cost to the Contracting Authority.

2102.04 METHOD OF MEASUREMENT.

A. Measurement for Roadway and Borrow Excavation will be as follows:

1. Excavation.
   a. Cubic yards (cubic meters), as determined by the Engineer, for the quantity of Class 10, Class 12, or Class 13 material excavated from:
      • The roadway,
      • Borrow pits,
      • Areas where unsuitable or unstable soil is shown in the contract documents or designated by the Engineer, and
      • Drainage channels, other than intercepting ditches and flumes.
   b. Except as provided in this article, measurements will be made by cross sectioning of the area excavated before and after excavation. Quantities will be computed from the cross section measurements by the average end area method, which may be generated from aerial photography. The volume of topsoil stripped and salvaged as provided in Section 2105 will be excluded from quantities measured as provided above.
   c. Payment will be made for the quantity of Class 10 excavation shown in the contract documents, adjusted by an increase or decrease in borrow excavation or change in backslope. Should the Contractor or the Engineer desire actual measurement, written notice shall be given to the other party at any time during the construction period. If actual measurement is requested, the preliminary cross sections and the balance points shown in the contract documents will be used. This method shall be used in conjunction with the quantities shown in the contract documents related to work as provided for in Articles 2107.04 and 2108.04.
   d. When embankment-in-place is specified, the Engineer will determine the quantity of materials placed using cross section and end area methods. The quantity for which payment is made will not exceed that necessary to construct the embankment to the neat cross section shown in the contract documents, adjusted for settlement. The Engineer may elect to measure the embankment after selected backfill material and topsoil have been spread and deduct the computed quantities of selected backfill material and topsoils from the quantities of total embankment.
   e. Overhaul will not be measured or paid for when excavation is paid for as embankment-in-place. Prior to computation of embankment
quantities, the original ground profile and original ground elevations shown on the cross sections will be adjusted to conform as nearly as practical to information obtained from taking elevations on settlement plates.

f. Measurement for boulders or rock fragments classified as Class 12 excavation will be as follows:
   1) Boulders buried near the site: individually.
   2) Boulders or rock fragments deposited in piles: by the volume of the pile.
   3) Boulders or rock fragments handled separately from fine material and placed in embankments or in gullies: in the transporting vehicle.
   4) All boulders, rocks, or PCC collected as part of the finishing operations: in the transporting vehicle or in piles.
   5) When boulders or rock fragments are mixed with earth, sand, gravel, or other fine material and cannot be handled in a way normal to Class 10 excavation, the total volume of the mixture of rock and fine material will be determined by cross sectional measurements, if practical. If not, the Engineer will estimate total volume. The quantity thus determined will be considered as Class 12 excavation.
   6) Boulders or rock fragments handled and deposited in final position in a manner normal to Class 10 excavation will not be measured as Class 12 excavation.

2. Intercepting Ditches and Flumes.
   Feet (meters) along their center lines.

   Quantity shown in the contract documents.

4. Special Backfill Material.
   a. Tons (megagrams) or cubic yards (cubic meters) of material placed.
   b. If measurement by weight (mass) is impractical, the material may be measured by volume in the transporting vehicle. This volume will be converted to tons (megagrams) using a conversion factor the Engineer determines.

5. Water for Embankment Construction.
   a. Water for Embankment Construction required by the Engineer: thousands of gallons (kiloliters) by gauging the contents of the transporting vehicle or by metering the supply.
   b. Water used in connection with specified compaction with moisture and density control or with moisture control: not measured for payment.

   Distance in stations (meters) of constructing trenches and placing backfill material.
7. **Crushing of Class 12 Excavation.**  
   a. Cubic yards (cubic meters) shown in the contract documents.  
   b. Prior to the start of this work, if either the Engineer or the Contractor desires actual measurement, the Engineer will determine in cubic yards (cubic meters) the quantity of Class 12 Excavation that will be crushed computed from the cross section measurements by the average end area method based on soil borings.

B. Removal of pipe culverts that are not encased in concrete are incidental to excavation and will not be measured or paid for.

**2102.05 BASIS OF PAYMENT.**

A. Payment for Roadway and Borrow Excavation will be the contract unit price as follows:

1. **Roadway and Borrow Excavation.**  
   a. Class 10, Class 12, and Class 13 excavation or embankment-in-place:  
      1) Per cubic yard (cubic meter).  
      2) Payments are full compensation for:  
         - Material excavated in the manner prescribed in these specifications, the preparation of the site for embankment, and the formation and compaction of embankment.  
         - Finishing the earth roadway, side ditches, and slopes.  
         - Repairing and replacing fences that have been unnecessarily damaged or removed by the Contractor.  
         - Incidental work required to make the grading work complete.  
   b. Excavation work done prior to the staking and cross sectioning of the work by the Engineer: no payment will be made.  
   c. Below grade excavation:  
      1) When the contract contains a separate unit price for below grade excavation, all excavation made below grade according to the contract documents or on order of the Engineer will be paid for at the contract unit price for the class of excavation involved.  
      2) When the contract does not contain a unit price for below grade excavation, the Engineer orders below grade excavation, and the contract documents do not indicate that below grade excavation will be required, it will be paid for:  
         - At double the contract unit price for Class 10 and Class 13 excavation to a maximum depth of 3 feet (1 m).  
         - As extra work as provided in Article 1109.03, B, if the depth of Class 10 or Class 13 excavation exceeds 3 feet (1 m).  
         - At the contract unit price for Class 12 excavation.  
   d. Excavation involved in rebuilding embankments: by class of excavation involved.
Roadway and Borrow Excavation

2. **Intercepting Ditches and Flumes.**
   For removal of surface water from side hill cuts into side ditches: per linear foot (meter).

3. **Selected Backfill Material.**
   a. Per cubic yard (cubic meter).
   b. Except for water added, payment is full compensation for all work involved in excavating, hauling, and incorporating this material into the roadway.

4. **Special Backfill Material.**
   a. Per ton (megagram) or cubic yard (cubic meter) including water naturally present in the material.
   b. Except for water added, payment is full compensation for all work involved in:
      - Furnishing material,
      - Excavating material,
      - Processing material, when the source is designated in the contract documents,
      - Hauling this material, and
      - Incorporating material into the roadway.
   c. If furnished by the Contractor and processed in an approved pugmill to a moisture content satisfactory to the Engineer: per ton (megagram) based on scale weights, including water. If payment is made in the above manner, no separate payment will be allowed for water or its incorporation into the mixture.
   d. The contract will have a separate item for Special Backfill, Place Only, in tons (Mg) or cubic yards (m³), when the Contracting Authority is providing the material or if the material is available from mandatory crushing of pavement or pavement scarification on the contract. The cost of crushing or pavement scarification should be included in the Contractor's price for special backfill material if recycling is not required but the Contractor chooses to crush the pavement removed or scarify the HMA surfacing for special backfill material.

5. **Water for Embankment Construction.**
   a. Water for Embankment Construction added by order of the Engineer: per 1000 gallons (kiloliter).
b. Payment is full compensation for furnishing, transporting, and manipulation to incorporate the water ordered by the Engineer to be applied.

c. If the contract does not contain a unit price for water, and moistening of the material is authorized or ordered, water will be paid for as extra work at the rate of $12.00 per 1000 gallons ($3.20 per kiloliter).

d. Payment will not be made for water used in connection with specified compaction with moisture and density control or with moisture control.

   Per station (meter).

7. Crushing of Class 12 Excavation.
   Per cubic yard (cubic meter).

B. When Type B compaction is specified, work performed at the Engineer’s direction to dry the material in excess of that obtained by the maximum number of diskings specified in Article 2107.03, F shall be performed as extra work as provided in Article 1109.03, B.

C. Extra compensation will not be allowed for working around utilities.

D. Work performed in connection with preservation of archaeological salvage will be paid for as provided in Article 1109.03, B.

E. If the contract does not include an item for Stripping, Salvaging, and Spreading Topsoil (Section 2105), such work the Engineer orders will be paid for at 1.5 times the contract unit price for Class 10 excavation.

Section 2103. Presplitting and Production Blasting of Rock Slope Cuts

2103.01 DESCRIPTION.

A. These specifications cover the work of presplitting a rock slope cut by establishing a free surface in the rock by the controlled use of explosives placed in properly aligned and spaced drill holes. The contract documents may specify more than one elevation level of pre-split holes.

B. These specifications also cover the work of production blasting an area to be excavated by the controlled use of explosives placed in properly aligned and spaced drill holes.

2103.02 MATERIALS.

A. Furnish blasting material for presplitting complying with the explosive manufacturer’s instructions.

B. Furnish granular stemming material specified by the explosive manufacturer.
2103.03 CONSTRUCTION.

A. Removal of Material above the Top Pre-Split Hole Line Elevation.
Remove all material above the top elevation of the first level of pre-split drill holes according to Section 2102.

B. Presplitting.

1. For each elevation level of pre-split holes, align the pre-split holes so that a finish slope is cut within reasonably close conformity with the design slope specified in the contract documents. Space a line of pre-split holes so that uniform shear occurs between holes with minimum disturbance of the rock cut face. Use a maximum spacing between pre-split holes of 48 inches (1.2 m).

2. For each elevation level of pre-split holes, drill each hole with a maximum length of 40 feet (10.5 m). Drill each pre-split hole with a maximum diameter of 3.5 inches (90 mm).

3. Use blasting procedures for presplitting complying with the explosive manufacturer's instructions. Before placing the explosive charge, determine that the hole is free of obstructions for the depth of the required cut. Do not use explosives for which the maximum diameter is greater than one-half the diameter of the hole.

4. After explosive charges have been placed in the pre-split holes and prior to detonation, place backfill consisting of granular stemming material in the holes to contain the explosion. Ensure backfill consisting of stemming material is placed in all voids that may be present in the pre-split holes. If it is not possible to place this backfill material in a void, place the explosive charges in the hole so that detonation does not occur within the void area.

5. For each elevation level of pre-split holes, the Contractor may set or detonate explosive charges the full length of the pre-split line or sections of the pre-split line. If detonation is by sections, extend the detonation for each section of pre-split line at least 50 feet (15 m) past each production blast area or to the end of the pre-split line. Simultaneously detonate all explosive charges within the pre-split line or section.

C. Production Blasting.

1. For each elevation level of pre-split holes, place production blasting holes in a pattern so that material suitable for excavation will be produced adjacent to the pre-split hole lines. Do not place production holes within 8 feet (2.4 m) of the pre-split hole line, except when otherwise approved by the Engineer. For each elevation level of pre-split holes, drill production blasting holes no deeper than the minimum depth pre-split hole.

2. Use blasting materials and procedures for production blasting that comply with the explosive manufacturer's instructions. Contain the
explosion by placing backfill material consisting of granular stemming material (or use another suitable method), as specified by the explosive manufacturer and as approved by the Engineer, in the production blasting holes after placing the explosive charges and prior to detonation.

3. Detonate the explosive charges in a production blast area separately from the detonation of explosive charges of an adjacent pre-split line section. The Contractor may use appropriate time delays when detonating the explosive charges of the production blast area and an adjacent pre-split line section if:
   - The pre-split line section is fired first, and
   - Production blasting progresses so that the holes nearest the pre-split line are fired last.

4. After detonation, excavate material in the production blast area as Class 12 Excavation according to Section 2102.

2103.04 METHOD OF MEASUREMENT.

A. Measurement for Presplitting of Rock Cuts will be square yards (square meters) determined by calculating the area of the pre-split face.

B. Measurement for the work of removing material above the top elevation of the first level of pre-split holes will be for the specified class of excavation according to Article 2102.04, A.

C. Production blasting (including drilling holes, setting and detonating explosive charges, and removing material from the production blast area) will not be measured separately, but will be measured as part of the Class 12 Excavation according to Article 2102.04, A.

2103.05 BASIS OF PAYMENT.

A. Payment for Presplitting of Rock Cuts will be the contract unit price per square yard (square meter) as determined according to Article 2103.04 of this specification.

B. Payment is full compensation for:
   - All labor, equipment, and materials necessary to drill the pre-split holes,
   - Placing explosive charges, and
   - Detonating explosive charges to produce a finished acceptable slope cut for each elevation level of pre-split holes.

C. Payment for the work of removing material above the top elevation of the first level of pre-split holes will be for the class of excavation specified in the contract documents according to Article 2102.05, A, 1.

D. Payment for the work of production blasting, including drilling holes, setting and detonating explosive charges, and removing material from the
production blast area, will be as part of Class 12 Excavation according to Article 2102.05, A, 1.

Section 2104. Channel Excavation

2104.01 DESCRIPTION.
Excavate channels or remove and place material involved in channel changes, or similar excavation not normal to Class 10, Class 12, or Class 13 excavation.

2104.02 MATERIALS.
Specified in the contract documents or designated by the Engineer.

2104.03 CONSTRUCTION.
A. Excavate channels or remove and place material involved in channel changes, or similar excavation not normal to Class 10, Class 12, or Class 13 excavation, as shown in the contract documents. Place this material as shown in the contract documents or as directed by the Engineer.

B. Channel excavation is classified as follows:
   1. Class 10 Channel Excavation: refer to Article 2102.03, B, 1.
   2. Class 12 Channel Excavation: refer to Article 2102.03, B, 2.
   3. Class 13 Channel Excavation: refer to Article 2102.03, B, 3.

2104.04 METHOD OF MEASUREMENT.
Measurement for Class 10, Class 12, and Class 13 Channel Excavation will be the number of cubic yards (cubic meters) determined as prescribed in Article 2102.04.

2104.05 BASIS OF PAYMENT.
A. Payment for Class 10, Class 12, and Class 13 Channel Excavation will be the contract unit price per cubic yard (cubic meter).

B. Payment is full compensation for excavating and placement of the material within the free haul limit of 1000 feet (300 m), and for furnishing all equipment, tools, labor, and incidentals necessary to complete the work.

Section 2105. Stripping, Salvaging, and Spreading Topsoil

2105.01 DESCRIPTION.
A. Strip topsoil and prepare sod.

B. Haul, deposit, and spread topsoil.

2105.02 MATERIALS.
None.
2105.03 CONSTRUCTION.
Remove topsoil from borrow pits, cuts, or areas to be covered by embankments. Prepare sod. Haul, deposit, and spread topsoil on shoulders, slopes, excavated areas, borrow pits, and other designated areas according to the contract documents.

A. Sod Preparation.
Mow, burn, or remove, weeds, grass and growing crops or other herbaceous vegetation close to the ground as directed by the Engineer. Shred sod by shallow plowing or blading and thoroughly disking. Shred sod thoroughly enough to permit the soil to be easily spread in a thin layer over areas to be covered.

B. Topsoil Excavation.
After existing sod has been prepared, remove the topsoil to the depth specified. If not otherwise specified, the depth shall be 12 inches (0.3 m). The topsoil may be moved directly to an area where it will be used or may be stockpiled for future use.

C. Placing Topsoil.
Spread topsoil uniformly over the area to be covered. Smooth the surface of the topsoil and leave in a finished condition so that it will drain properly.

2105.04 METHOD OF MEASUREMENT.
A. The number of cubic yards (cubic meters) of topsoil moved will be computed on the basis of a uniform 12 inch (0.3 m) cut, or the depth as specified in the contract documents, over the area involved. Sufficient field measurements will be taken to assure reasonable conformity with the required depth of cut.

B. Topsoil salvaged from excavated areas and paid for as topsoil will not be included in excavation quantities for which payment is made.

2105.05 BASIS OF PAYMENT.
A. Payment will be the contract unit price per cubic yard (cubic meter).

B. Payment is full compensation for preparing, stripping, transporting, and placing the topsoil according to the contract documents.

C. Overhaul will not be paid for this item.

Section 2106. Settlement Plates

2106.01 DESCRIPTION.
A. Furnish and install settlement plates consisting of a base plate, steel bar, steel riser pipe sections, PVC casing, inspection cover, and additional hardware and couplers which may be required as shown in the contract documents. The number of settlement plates will be shown in the contract documents.
B. Monitor settlement plate installations and report settlement results.

2106.02 MATERIALS.
Meet the requirements of Division 41.

A. Base Plate and Steel Bar.
   Apply Section 4153.

B. PVC Casing.
   Apply Article 4146.04.

2106.03 CONSTRUCTION.

A. General.

1. Furnish and install settlement plates at the locations specified in the contract documents.

2. Establish benchmarks in the adjacent area before installing settlement plates.
   a. Obtain the Engineer’s approval for the method of determining alignments and elevations and the method of preserving control points. This approval does not act to relieve the Contractor of the responsibility for the correctness of the survey work.
   b. Do not use plan cross-sections for vertical or horizontal control.

3. Obtain the Engineer’s approval for settlement plates before beginning embankment construction.

B. Initial Installation.

1. Install the base plate at least 6 inches (150 mm) below natural ground, firmly seated on a level surface. Place the PVC casing on the base plate, centered on the steel bar attached to the base plate. Fill the void between the casing and bar with commercial grade oakum, tightly packed, in order to keep the casing centered on the bar.

2. Construct an inspection cover as shown in the contract documents and place over the top of the casing. Leave the cover in place at all times, except when inspecting or monitoring the riser pipe.

C. Adding Extensions.

1. Add riser pipe extensions and couplers, as necessary, in 3 foot (1 m) increments as construction of the embankment progresses. Install extensions in a plumb line.

2. Add sections of PVC casing and couplers, as necessary, in order to prevent fill material from coming into contact with the steel pipe extensions.
D. Final Cleanup.

1. After all embankment construction and monitoring has been completed, adjust the tops of the riser pipe and PVC casing so they terminate below the final elevation of the embankment.

2. Remove riser pipe sections protruding above the surface of the embankment. Then cut the PVC casing at a point below the surface of the embankment. Cover with a PVC cap, solvent welded to the casing, in order to prevent the intrusion of soil and water.

E. Monitoring.

1. Monitoring consists of:
   - Inspecting the riser pipe,
   - Accurately measuring the elevation of top of the riser pipe, and
   - Recording, to the nearest 0.01 foot (0.3 mm), the elevation readings on a form supplied by the Engineer.

2. Record elevation readings daily during normal construction and weekly during delays and following the completion of embankment construction. During the course of embankment construction, submit completed forms to the Engineer weekly. Following the completion of embankment construction, submit forms weekly unless the Engineer instructs otherwise.

3. During periods of work suspension, the Engineer will record elevation readings.

F. Limitations.

1. Take all necessary precautions to keep the alignment of the riser pipe and PVC casing in a plumb position.

2. Operate equipment so that the riser pipe and PVC casing are not damaged, displaced, or tilted out of plumb. Repair or replace all pipes that are damaged, displaced, or tilted out of plumb, at the discretion of the Engineer (at no additional cost to the Contracting Authority.)

Section 2107. Embankments

2106.04 METHOD OF MEASUREMENT.
 Settlement plates will not be measured directly for payment.

2106.05 BASIS OF PAYMENT.
 Furnishing, installing, extending, and monitoring settlement plates is incidental to embankment or excavation.
B. Place and compact excavated materials.

2107.02 MATERIALS.
Specified in the contract documents.

2107.03 CONSTRUCTION.

A. General.

1. Prepare the site, and place and compact excavated materials to the required elevation and cross section shown in the contract documents.

2. If the type of compaction is not specified, Type A compaction will be required.

B. Equipment.
Use equipment that meets the requirements of Section 2001 and the following:

1. Compaction Equipment.
   a. When compaction with moisture and density control is not specified, use equipment that meets the requirements of Article 2001.05, A. Other types of compacting equipment may be used as provided in Article 2107.03, G.
   b. For compaction of sand or other granular material, use either a:
      - Self propelled pneumatic roller meeting the requirements of Article 2001.05, C, or
      - Self propelled vibratory roller meeting the requirements of Article 2001.05, F.
   c. Compact special backfill material with equipment meeting the requirements of Article 2001.05, Paragraphs B, C, D, F, or other types of compacting equipment as provided in Article 2107.03, G.
   d. When compaction with moisture and density control is specified, any type of equipment which will produce the desired results may be used for compaction.

2. Equipment for Applying Water.
   Apply Article 2001.09.

C. Preparation of the Site.

1. Where the height of proposed embankment at the center line is 5 feet (1.5 m) or less, remove sod (after thorough disking) from the area. Place the sod on the area to be occupied by the outer portion of the embankment as provided in Article 2107.03, D.

2. When an embankment is placed on or against an existing slope which is generally steeper than 3 horizontal to 1 vertical and is more than 10 feet (3 m) high, cut the slope into steps as the construction of the new embankment progresses. Assure that sod or other potential sliding surfaces are removed. Cut each step or series of steps to approximate horizontal planes with vertical slope cut dimensions of no less than 3 feet (1 m).
D. Depositing Embankment Material.

1. Comply with the following:
   a. Except for rock fills and granular blankets, deposit embankments in horizontal layers not over 8 inches (200 mm) in loose thickness.
   b. Keep the outer portion lower than its center.
   c. When construction will be suspended for a period during which rain is likely to occur, smooth the surface to produce a smooth and compact surface to shed water.
   d. Deposit soils containing quantities of roots, sod, or other vegetable matter outside of the shoulder line and within the outer 3 feet (1 m) of the embankment.
   e. Do not deposit tree stumps and other large woody objects in embankments.
   f. Alternate layers of drier soils with wetter soils whenever it is practical to do so without an increase in average haul.
   g. Do not construct embankments on frozen ground. Do not use frozen material to construct embankments.

2. Apply the following where Type A or Type B compaction operations are to be used:
   a. When the width at the attained height is 30 feet (10 m) or more, divide the area upon which the layer is to be placed into separate and distinct dump areas having widths no less than 15 feet (5 m). If hauling equipment is operated within a dump area, disk the area with at least one pass of a tandem axle disk or two passes with a single axle disk prior to compaction.
   b. During compacting operations, keep hauling equipment off dump areas of embankments 36 feet (11 m) wide or more. Empty hauling units may travel on the dump area during compaction operations as necessary to pass loaded hauling units if:
      - Within 36 feet (11 m) of a bridge or other limiting structure.
      - The width of the embankment is less than 36 feet (11 m) at the attained height.
   c. If the design width of embankment is less than 30 feet (10 m) at the attained height, hauling units will be allowed to travel through areas where compaction operations are in progress. Ensure hauling equipment passing through compaction operations does not force water, disking, and compacting equipment to deviate from their intended paths.
   d. Deposit the material over the dump area as a separate and distinct operation. If the material, as deposited, contains an average of more than 1 lump per square yard (square meter) large enough to have at least one dimension greater than 12 inches (0.3 m), disk the area with at least one pass of a tandem axle disk or two passes of a single axle disk. Use a disk designed and operated to cut and stir to the full depth of the layer.

3. After depositing and diskimg (if required), smooth the material to a uniform depth using a suitable motor patrol, bulldozer, or self propelled sheepfoot type roller with a blade attachment. In addition to the initial smoothing, continue smoothing and leveling during compaction as
necessary to provide a surface area free from ruts and other objectionable irregularities. The self propelled, sheepsfoot type roller with blade attachment may be used under the following conditions:
   a. Leveling is completed according to the prescribed rolling pattern.
   b. Compaction is the major function of this unit.
   c. Power drums are prevented from spinning.

4. When, in the Engineer’s opinion, the unit cannot satisfactorily accomplish both leveling and rolling, use a separate dozer or motor patrol for the leveling operation prior to initiation of compaction.

E. Type A Compaction.

1. Type A compaction refers to compaction requiring a minimum of one rolling per inch (25 mm) depth of each lift. A further requirement is that the roller continues operation until it is supported on its feet, or the equivalent.

2. After smoothing the surface of the layer and before depositing material for the next layer, compact the layer with at least one pass of the sheepsfoot type roller for each inch (25 mm) of loose thickness of the layer. Compact until the roller is supported entirely on its feet. This occurs when the tamping feet penetrate no more than 3 inches (75 mm) into an 8 inch (200 mm) lift or 33% of the depth of the layer being placed.

3. Determine if the moisture content of the material is excessive or suitable for satisfactory compaction. The Contractor may elect to start rolling operations immediately after the smoothing operation, or may elect to delay rolling operations, and instead, aerate the material in preparation for rolling. Proceed with aeration and compaction operations in an orderly fashion without unreasonable and unnecessary delay. Rolling operations made prior to any aeration operations for a lift will not be counted as any of the required coverages.

4. Should the material be dry to the extent that it is likely to fail to be satisfactorily compacted by rolling, the Contractor may moisten the material. The Engineer may order the material to be moistened uniformly before compacting. Authorization may be given for the use of water in the final finishing of the roadbed.

5. Compensation will not be allowed for delays occasioned by the ordering of moistening or by drying.

6. The Contractor may request approval of other methods and equipment according to Article 2107.03, G.

F. Type B Compaction.

1. Type B compaction refers to compaction requiring a specified number of diskings and roller coverages, or the equivalent.
2. After smoothing the surface of the layer and before depositing the next layer, compact or smooth and compact the layer.

3. If the entire weight (mass) of the roller is supported on its feet after one pass of the roller for each inch (25 mm) of loose thickness of the layer, no further compacting is necessary. A roller will be considered to be supported entirely on its feet when the feet penetrate no more than 3 inches (75 mm) into an 8 inch (200 mm) lift or 33% of the depth of the layer being placed.

4. If the soil in the layer is too wet when it is deposited to compact to the degree that the entire weight (mass) of the roller is supported on its feet, the Engineer may require one disking per 2 inches (50 mm) of loose thickness of the layer in addition to the disking required in the smoothing operation. A disking consists of a complete coverage of the layer with either a tandem axle disk or a single axle disk. Use a disk designed and operated to cut and stir to the full depth of the layer. The Engineer may require an interval no longer than 2 hours between successive diskings. After the disking has been completed, compact the layer with one pass of a sheepsfoot type roller per inch (25 mm) of loose thickness of the layer.

5. The manipulation and compaction specified above is incidental to Class 10 or Class 13 excavation. The Engineer may require additional manipulation and compaction as extra work. If the soil is so dry that it will fail to be satisfactorily compacted by rolling, the Engineer may require the Contractor to moisten the material uniformly before it is compacted.

6. Compensation will not be allowed for delays caused by the ordering of moistening or by disking.

7. The Contractor may substitute Type A compaction at no additional cost to the Contracting Authority where Type B compaction is specified, by written notification to the Engineer, or the Contractor may request approval of other methods and equipment according to Article 2107.03, G.

G. Compaction by Other Methods and Equipment.

1. Other methods of compaction may be used. Demonstrate they will obtain suitable compaction of a variety of soil types and moistures normally encountered. Compaction will be considered suitable if the resulting density, with adequate moisture, is both:
   - Reasonably uniform throughout the compacted lift.
   - At least 95% of maximum density, determined according to Materials Laboratory Test Method No. Iowa 103.

2. Other types of compacting equipment may be used. Demonstrate they will obtain equivalent compaction results using a variety of soil types and moistures normally encountered. Demonstrations are to be such that results can be compared.
3. For Type A compaction, equivalent compaction must be recognizable by roller penetration or other significant characteristic.

4. For other methods or other equipment, a definite approval will be necessary, including any limitations the Engineer deems advisable.

5. Use of other methods and equipment prior to approval, except for demonstration tests, must provide 6 inch (150 mm) compacted lifts at 95% of maximum density, during which moisture is maintained no drier than 3 percentage points below optimum moisture.

H. Compaction with Moisture and Density Control.

1. The contract documents will show areas in which embankments shall be constructed with moisture and density control. The contract documents will also show the distance below the elevation of the completed grading work to which such methods are to be applied.

2. Where construction with moisture and density control is indicated in cut sections:
   a. Excavate the roadbed below proposed subgrade elevation to a plane 6 inches (150 mm) above the elevation shown for the bottom of the moisture and density control section.
   b. Thoroughly scarify the remaining 6 inch (150 mm) layer.
   c. Increase or reduce the moisture content as necessary to bring the moisture throughout this 6 inch (150 mm) layer within the moisture limits specified.
   d. Compact this 6 inch (150 mm) layer to no less than 90% of maximum density determined according to Materials Laboratory Test Method No. Iowa 03.
   e. Deposit the remainder of the cut section to the completed grade elevation in layers according to Article 2107.03, D.
   f. Uniformly moisten each layer as necessary to bring to within the specified moisture limits.
   g. Compact each layer to no less than 95% of maximum density.

3. Where construction with moisture and density control is indicated in embankment sections outside cuts:
   a. Deposit in layers, according to Article 2107.03, D, all material in fill above the designated elevation for compaction with moisture and density control.
   b. Uniformly moisten or dry as necessary to bring each layer within the specified moisture limits.
   c. Compact the first layer placed with moisture and density control to no less than 90% of maximum determined according to Materials Laboratory Test Method No. Iowa 103.
   d. Compact each succeeding layer to no less than 95% of maximum density.

4. Prior to compaction, bring the moisture content of each layer of earth to be compacted with controlled moisture and density to within the specified limits of the optimum moisture content. After field tests
determine that a layer is within the specified moisture limits, begin compaction and continue until the required density is obtained. If compaction is interrupted or delayed on a layer, bring the moisture of the layer to within the specified limits before resuming compaction.

I. Compaction with Moisture Control.

1. The contract documents will show:
   a. Areas in which embankments are to be constructed with moisture control.
   b. The distance below the elevation of the completed grading work to which such methods are to be applied.
   c. The moisture limits.

2. Where construction with moisture control is indicated in cut sections:
   a. Excavate the roadbed below proposed subgrade elevation to a plane 6 inches (150 mm) above the elevation shown for the bottom of the moisture control section.
   b. Thoroughly scarify the remaining 6 inch (150 mm) layer.
   c. Increase or reduce the moisture content as necessary to bring the moisture throughout this 6 inch (150 mm) layer within the moisture limits specified.
   d. Compact this 6 inch (150 mm) layer as specified in Article 2107.03, E.
   e. Deposit the remainder of the cut section in layers according to Article 2107.03, D.
   f. Uniformly moisten or dry as necessary to bring each layer within the specified moisture limits.
   g. Compact each succeeding layer as specified in Article 2107.03, E.

3. Where construction with moisture control is indicated in embankment sections outside cuts:
   a. Deposit in layers, according to Article 2107.03, D, all material in fill above the designated elevation for compaction with moisture control.
   b. Uniformly moisten or dry as necessary to bring each layer within the specified moisture limits.
   c. Compact layers placed with moisture control as specified in Article 2107.03, E.

4. Prior to compaction, bring the moisture content of each layer of earth to be compacted with controlled moisture within the specified limits of the optimum moisture content. After field tests determine that a layer is within the specified moisture limits, begin compaction and continue unit the requirements of Article 2107.03, E, are obtained. If compaction is interrupted or delayed for more than 1 hour on a layer, bring the layer within the specified moisture limits before resuming compaction.

J. Rock Fills.

1. When the excavated material consists of rock fragments too large to be placed in layers of the thickness prescribed without further breaking
them down, it may be placed in the embankment in horizontal layers 4 feet (1.2 m) or less in thickness. Place each layer to avoid future water entrapment. In most cases, this will require placement to full embankment width, except for topsoil on the foreslope. Level each layer with a suitable dozer. Smooth each layer by choking the surface of the rock with spalls and finer fragments or earth.

2. Do not construct the 4 foot (1.2 m) lifts above an elevation 2 feet (0.6 m) below the finished grade line. The next foot (0.3 m) of embankment height may be placed in one layer using rock spalls and finer fragments which may be satisfactorily consolidated by the dozer and tractor. For the last foot (0.3 m) below the finished grade line, use either:
   - Earth smoothed and placed in layers not exceeding 8 inches (200 mm) thickness and rolled as described above, or
   - Special backfill material placed as shown in the contract documents.

3. Conduct operations in such a way that the Engineer is given the opportunity to take cross sectional measurements required before the earth cover is placed.

K. Granular Blankets.

1. Where a granular blanket is specified, spread material meeting the requirements of Section 4133 to the width and thickness shown in the contract documents. Do not use compaction equipment. The blanket may be constructed in several lifts. Do not incorporate foreign material from hauling equipment or other sources.

2. In areas requiring both granular blanket and subdrain backfill material, the sequence of operations will be the option of the Contractor. Ensure that contact areas between porous backfill material, granular material for subdrains, and granular blankets are free from clay or silt.

L. Rebuilding Embankments.

1. Do not place a pavement partly on an old and partly on a newly constructed embankment. Remove the part of the old embankment that would be under the pavement as below grade excavation to the natural ground line, or to a depth of 5 feet (1.5 m) below the proposed grade line, whichever is higher. Rebuild as prescribed for new embankments.

2. Rebuild embankments according to Article 2107.03, C, unless otherwise specified in the contract documents. Compact the material according to Article 2107.03, E.

3. At locations where the width of embankment widening is less than 4 feet (1.2 m), widening material may be placed and shaped to the bottom of pavement or base elevation without compaction other than that obtained with wheels of motor graders and hauling equipment. Placement and compaction may be accomplished in 8 inch (200 mm) lifts parallel to the
finished slope, provided the existing slope has been roughened by
disking or scarification.

4. In all cases of embankment widening, remove surface vegetation from
slopes against which the widening material is to be placed. Deposit this
material according to Article 2107.03, D.

M. Compacting Trench Bottom.
When designated in the contract documents, excavate the roadbed for the
width shown to 1 foot (0.3 m) below subgrade elevation. Scarify the next 6
inch (150 mm) depth and compact as for Type B compaction, unless
otherwise specified. When the bottom of the trench has been compacted,
place suitable backfill material in the excavation and compact. If the type of
compaction is not specified for this upper 1 foot (0.3 m), Type A compaction
will be required on Primary projects and Type B compaction on Secondary
projects.

N. Use of Unsuitable Soils.

1. Unsuitable soils may be used in embankments according to Standard
Road Plan RL-1B, unless the Engineer directs otherwise.

2. Unless otherwise specified, when used in embankments, spread
unsuitable material in uniform layers no more than 8 inches (200 mm) in
loose thickness. Cover each layer with a layer or layers of suitable
material.

O. Embankments Adjacent to Culverts and Structures.

1. When the contract documents require embankment construction
adjacent to a bridge, culvert, or other structure, construct the compacted
embankment to the height shown and to the full width of the roadway.
Secure material for constructing these embankments from within the
right-of-way or authorized borrow area as directed by the Engineer.
Waste the material from within the waterway of bridges or culverts
which is too wet to be suitable for compaction. Do not place this material
in the embankment.

2. Place embankments adjacent to bridges, culverts, and structures with
the same precautions and methods described in Article 2402.03, H. The
contract documents may require moisture control.

3. Use mechanical or pneumatic tampers for compaction in areas
occupied by embankments which are too narrow for the operation of
rollers. The Contractor may elect to enlarge the area in which the
embankment is to be constructed by cutting down the elevation of the
old fill to permit rolling equipment to operate efficiently. When old fill is
removed for this purpose, step it up to its original height such that each
step has a horizontal dimension no less than 3 feet (1 m) with a vertical
rise.
4. Flowable mortar may be placed as backfill material adjacent to bridges, culverts, and structures, at no additional cost to the Contracting Authority. Place this backfill material according to Section 2506.

2107.04 METHOD OF MEASUREMENT.

A. Measurement will be as provided in Article 2102.04. The following will be included in Class 10 excavation:

1. Excavation in preparation for constructing embankment by compaction with moisture control.

2. Excavation in preparation for constructing embankment by compaction with moisture and density control.

3. Excavation in preparation for compacting trench bottom.


B. Embankment construction will not be measured separately for payment except as follows:

1. Compaction with Moisture and Density Control.
   Cubic yards (cubic meters) shown on the contract documents.

2. Compaction with Moisture Control.
   a. Cubic yards (cubic meters) shown on the contract documents.
   b. When moisture control is required adjacent to culverts and stockpasses (Article 2107.03, O) the volume will be computed using the formula in Article 2107.04, B, 4. When moisture control is required adjacent to pipe culverts, the volume will be computed as provided in Article 2402.04.

3. Compacting Trench Bottom.
   Stations (meters) shown on the contract documents as determined along the center line of the roadbed.

4. Compacting Backfill Adjacent to Bridges, Culverts, or Structures.
   The quantity of backfill material placed and compacted by the grading contractor adjacent to bridges, box culverts, or structures or their extensions will be the quantity obtained by the following formula:

   English
   \[ Q = \frac{4 \text{ ft.} \times L \times H}{27} \]

   Metric
   \[ Q = \frac{1.2 \text{ m} \times L \times H}{27} \]

   Where: \( Q \) = quantity of compacted backfill material in cubic yards (cubic meters);
L = (1) length in feet (meters) of the culvert or stock pass from back to back of parapet, or
(2) length in feet (meters) from back of existing parapet to back of parapet of the extension;
H = nominal height of structure opening, feet (meters).

5. **Granular Material for Blanket and Subdrain.**
Cubic yards (cubic meters) according to Article 2312.04, A.

6. **Water for Embankment Construction.**
Except when compaction with control of moisture and density or moisture is specified, water for embankment construction required for moistening materials to be placed in embankment will be measured in thousands of gallons (kiloliters) by gauging the contents of the transporting vehicle or by metering the supply. Authorized water for finishing the roadbed will not be measured for payment if a period in excess of 2 calendar days has elapsed between final compaction of a dump area and final finishing of the same area.

### 2107.05 BASIS OF PAYMENT.

**A.** Payment for embankment construction will be contract unit price as for Embankment-In-Place according to Article 2102.05, with the following additions:

1. **Compaction with Moisture and Density Control.**
   a. Per cubic yard (cubic meter).
   b. Payment is full compensation for the work of drying material, furnishing and applying water, controlling moisture content of the materials, and compacting the materials to the specified density.

2. **Compaction with Moisture Control.**
   a. Per cubic yard (cubic meter).
   b. Payment is full compensation for the work of drying material, furnishing and applying water, controlling moisture content of the materials, and compacting the materials, as specified.

3. **Compacting Trench Bottom.**
   a. Per station (meter).
   b. Payment is full compensation for the work of scarifying, drying material, furnishing and applying water, controlling moisture content of the materials, and compacting the materials, as specified.

4. **Compacting Backfill Adjacent to Bridges, Culverts, or Structures.**
   Per cubic yard (cubic meter).

5. **Granular Material for Blanket and Subdrain.**
   Per cubic yard (cubic meter).
6. **Water for Embankment Construction.**
   a. Except when compaction with moisture and density control or moisture control is specified, payment for water for embankment construction added at the Engineer's direction will be the contract unit price per 1000 gallons (kiloliter).
   b. In case the contract does not contain a unit price for water, and moistening of the material is authorized or ordered, payment for water will be as extra work at the rate of $12.00 per 1000 gallons ($3.20 per kiloliter).
   c. When Type A compaction or compacting embankments with moisture and density control or moisture control is specified, manipulation necessary to incorporate water or work necessary to dry the material will be considered as incidental work and will not be paid for separately.
   d. When Type B compaction is specified, manipulation necessary to incorporate water will be considered incidental to other work. Work performed at the Engineer's direction to dry or compact the material, in excess of that obtained by the maximum number of diskings and roller coverages specified for Type B compaction, will be paid for as extra work according to Article 1109.03, B.

   **B.** Payment for Compaction with Moisture and Density Control, Compaction with Moisture Control, Compacting Trench Bottom, and Compacting Backfill Adjacent to Culverts and Stockpasses will be for plan quantities in conjunction with quantities shown in the contract documents described in Article 2102.04 and under the conditions described therein.

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**Section 2108. Overhaul**

**2108.01 DESCRIPTION.**
Transport excavated material from roadway and borrow excavation, from channel excavation, and from excavation for structures a distance in excess of the free haul limit for the kind of excavation involved.

**2108.02 MATERIALS.**
Specified in the contract documents.

**2108.03 CONSTRUCTION.**
None.

**2108.04 METHOD OF MEASUREMENT.**

   **A.** In determining what constitutes necessary haul, it will be assumed that material taken from excavation will be deposited in embankment after having been hauled the minimum possible distance. The haul distance for material moved from borrow outside the roadway will be measured from the center of mass along the shortest route the Engineer determines to be feasible and satisfactory. The haul distance for material obtained from the roadway, including interchanges and intersections, and placed inside the main roadway will be measured along the center line of the roadway.
B. If pavement equipment crossings are designated by the Contractor as provided in Article 1105.12, B, and the contract provides for payment of overhaul on the material involved, overhaul on the material obtained within the roadway will be computed and measured along the center line as described above. Overhaul will be computed and measured on the basis that material taken from excavation was deposited in adjacent embankment after having been hauled the minimum possible distance, irrespective of the number and location of equipment crossings designated by the Contractor. The haul distance for material moved from outside the roadway will be measured along the shortest route the Engineer determines feasible and satisfactory. It will be assumed that an equipment crossing was designated opposite the point where the haul road enters the roadway.

C. The limits of free haul will be determined from a mass diagram by fixing two points on the volume curve, one on each side of the neutral grade point. One point is placed in excavation and the other in embankment so that the distance between them equals the free haul distance and the included quantity of excavation and embankment balance. Materials within the free haul limit will be eliminated from further consideration. The distance between the center of gravity of the remaining mass of excavation and the remaining mass of embankment, minus the free haul distance, will be the overhaul distance. The quantity of overhaul will be measured in station yards. A station yard is defined as the product of an overhaul distance of 1 station multiplied by 1 cubic yard of material hauled a distance greater than the free haul distance.

E. Unless provided otherwise in the contract documents, the free haul distance will be 1000 feet (300 m).

F. Payment for Overhaul will be for quantities shown in the contract documents in conjunction with quantities shown in the contract documents described in Article 2102.04 and under the conditions described therein. If Class 10 excavation quantities are changed, overhaul quantities will also be subject to change. The Engineer will compute the overhaul change if it can be identified. If not, it will be adjusted by the ratio of adjusted quantities to original quantities shown in the contract documents of Class 10 excavation.

2108.05 BASIS OF PAYMENT.
Payment for the quantity of overhaul, measured as provided above, will be the contract unit price per station yard (station meter) with the following exceptions:

A. Overhaul will not be paid for selected backfill material if it can be secured and used as shown in the contract documents. Should changes from the contract documents cause an increase or decrease in necessary haul, payment will be adjusted for such increase or decrease at the contract unit price per station yard (station meter).

B. If no bid price appears in the contract for overhaul, increased overhaul will be paid for at a unit price agreed to by the Contractor and Engineer, but not to exceed $0.02 per station yard ($0.09 per station meter).
Section 2109. Natural Subgrade

2109.01 DESCRIPTION.
Shape and consolidate a prescribed portion of the subgrade in preparation for the placement of a pavement, pavement widening, base course, or subbase.

2109.02 MATERIALS.
Specified in the contract documents.

2109.03 CONSTRUCTION.

A. Natural Subgrade for Pavement, Pavement Widening, Base Course, or Subbase.

1. Construct the subgrade to have uniform stability for a width at least equal to that of the proposed pavement or base, plus 2 feet (1 m) on each side. Bring to an elevation such that after being rolled the surface is at the required elevation. Before preparing the subgrade, construct the roadbed to the full width and at least to the elevation of the finished subgrade.

2. When the composition or stability of the materials in the top 6 inches (150 mm) below the elevation of the subgrade is not reasonably uniform for the full width of the subgrade, scarify, mix and recompact, or otherwise treat the materials to produce a uniform condition. Meet the requirements of Article 2107.03, E, for recompaction on Primary projects and Article 2107.03, F, for recompaction on Secondary projects. Remove stones 4 inches (100 mm) or larger from the loosened portion of the subgrade. Remove the stones from the project as directed by the Engineer.

3. Fill depressions that develop during rolling with suitable material meeting the requirements of subgrade treatment as specified in the contract documents. Continue rolling until the subgrade is uniformly firm, properly shaped, and true to grade and cross section. Maintain the subgrade as constructed until the pavement is placed. Remove material, other than sand, which will not compact readily under the roller and replace with material which will compact readily. Roll that portion of the subgrade again. Use a roller that meets the requirements of Article 2001.05, B, except for work involving widening of such a width as to make use of a conventional roller impractical. Where a conventional roller is impractical, use a trench type roller meeting the requirements of Article 2001.05, E.

4. Extend rolling of the subgrade for at least 12 inches (0.3 m) outside each edge of the proposed pavement. Do not leave piles or ridges of earth or material on the shoulders that would seriously interfere with the operations of finishing pavement.

5. During the process of constructing subgrade, maintain the soil in a condition sufficiently moist to facilitate compaction and produce a firm, compact surface. Sprinkle or wet the finished subgrade as necessary to
ensure a reasonable moisture content at the time pavement or base is placed upon it.

6. If, in preparation of subgrade, it becomes necessary to excavate below the elevation of the earth shoulders, provide ditches or drains at frequent intervals to permit ready drainage of surface water from subgrade to side ditches.

7. Maintain the completed subgrade during subsequent construction activities. Loads in excess of the legal axle load will not be allowed on the completed subgrade. If rutting or any other damage occurs to the subgrade as a result of hauling operations, immediately repair the subgrade. This repair will include, if necessary, scarifying to a depth of 6 inches (150 mm), aerating, and recompacting, all at no additional cost to the Contracting Authority. Meet the requirements of Article 2107.03, E, for recompacting on Primary projects and Article 2107.03, F, for recompacting on Secondary projects.

8. Should traffic by others authorized to do work on the project be specifically permitted by the Engineer to exceed the Contractor’s self imposed limit, the Contracting Authority will pay a share of repair costs set by the Engineer representing an increase in cost of repair of damage, if any, caused by such traffic.

9. Complete subgrade preparation sufficiently in advance of pavement or base work so that normal progress can be maintained.

10. Before the final template shape is made, proof roll the subgrade with equipment meeting the requirements of Article 2001.05. Correct depressions that develop using the same procedure as in Article 2109.03, A, 3. If the subgrade is to be cut to the final grade elevation with an automatically controlled subgrade machine, grade the prepared subgrade to an elevation that will permit the machine to accomplish the final cut in one continuous forward pass. The elevation of the subgrade surface will be indicated by grade stakes. Correct the surface in both profile and cross section to within 0.05 foot (15 mm) of the desired elevation. In irregular or short sections, check the subgrade by the most accurate practical method, subject to the Engineer’s approval.

B. Treatment of Subgrade for Concrete Pavement.

Unless the Engineer orders otherwise, ensure the subgrade, at the time of placing concrete for Concrete Pavement (Section 2301) or Concrete Base (Section 2201), is either:

- In a uniform moist, but not muddy condition to a depth of not less than 1 inch (25 mm), or
- Covered with a single layer of plastic film meeting the requirements of Section 4107. Lap adjacent strips of plastic film by at least 12 inches (0.3 m). Do not stretch plastic film to the extent that its width is noticeably reduced. Plastic film which has been used for curing concrete, salvaged in usable condition, may be used for subgrade treatment.
C. Special Compaction of Subgrade.
When special compaction of subgrade is required in the contract documents, construct the portion of the roadbed to be covered by the pavement or base course, plus 3 feet (1 m) beyond the outer limits of the pavement or base course, in the following manner:

1. Expose a planed surface 6 inches (150 mm) below the finished grade line. Soil removed in the operation may be placed along the sides of the roadbed. Place the soil as backfill material in the excavation. Scarify the underlying exposed surface for a depth of 6 inches (150 mm).

2. Pulverize the scarified material to the extent that, when tested, no soil particles will remain on the 2 inch (50 mm) sieve. Uniformly dry or wet the scarified material to a moisture condition which will permit obtaining the required compaction without subsequent rutting from the batch trucks or other paving equipment in the paving area. Immediately stop construction of the pavement if rutting occurs to the extent that the thickness of the flexible or rigid pavement being spread does not conform to the design dimensions. Rework the rutted subgrade before resuming construction of the pavement.

3. Ensure the material at the time of compaction is not drier than 6 percentage points below its optimum moisture. Also ensure the density is not less than 95% of maximum density as determined by Materials Laboratory Test Method No. Iowa 103.

4. Place the material used to bring the subgrade to the required finished profile and cross section according to the above requirements for pulverization, moisture content, density, and stability.

2109.04 METHOD OF MEASUREMENT.

A. Unless provided otherwise, work connected with construction of natural subgrade for pavement, base course, pavement widening, or subbase will not be measured for payment.

B. Special Compaction of Subgrade, in stations (meters), will be the quantity shown on the contract documents. This quantity will be determined along the center line of the roadbed.

2109.05 BASIS OF PAYMENT.

A. Unless otherwise provided, work connected with construction of natural subgrade for pavement, base course, pavement widening, or subbase will not be paid for directly. It is considered as associated work and incidental to the contract unit price for construction of the pavement, base course, or widening.

B. Special Compaction of Subgrade:

1. Payment will be the contract unit price per station (meter).
2110.03 Soil Aggregate Subbase

2. Payment is full compensation for excavating, manipulating, replacing, and compacting the material, and for furnishing all water required for the work.

C. Payment for excavation or filling in excess of 3 inches (75 mm) for either elevation adjustment or subgrade correction at locations other than structures or existing pavement will be:
   • According to Article 2102.05, or
   • If no contract unit price is provided, as extra work, except when both grading and paving are the responsibility of the same Contractor.

Section 2110. Soil Aggregate Subbase

2110.01 DESCRIPTION.
Construct soil aggregate subbase using soil from the subgrade combined with mineral aggregate present on the road surface, with the possible addition of aggregate.

2110.02 MATERIALS.
Use granular material that may be present on the roadbed plus the specified quantity of material meeting the requirements of Section 4120.

2110.03 CONSTRUCTION.

A. Soil Aggregate Subbase Equipment.
Use equipment that meets the requirements of Section 2001 and the following:

1. Weighing Equipment.
   Apply Article 2001.07.

2. Compaction Equipment.
   Apply Article 2001.05 except that other types of equipment may be used provided it is demonstrated they will consistently produce the specified density. Use equipment designed so that its operation will not distort the subgrade.

3. Equipment for Applying Water.
   Apply Article 2001.09.

4. Field Laboratory.
   Apply Section 2520.

B. Roadbed Correction.
Correct the portion of the roadbed to be used for soil aggregate subbase according to Article 2111.03, B.

C. Soil Aggregate Subbase Construction.

1. The Contractor may be required by the contract documents to furnish granular material for subbase construction in addition to that present on
the existing roadbed. Uniformly distribute this additional material over the area to be occupied by the subbase at the rates specified.

2. Blade or scarify the roadbed to the depth necessary to:
   • Produce a smooth subgrade matching the cross section shown in the contract documents, and
   • Provide the quantity of material which, when combined with the granular material to be added, will produce a compacted subbase of the thickness designated.

3. Adapt the methods and sequence of operations to the width of roadbed and the quantity of granular material to be added in order to achieve the following results:
   a. Mix road surface materials and added granular material to the degree that there are no seams or streaks of separate material in evidence from visual inspection, and pulverize so that there are no soil particles larger than 2 inches (50 mm) in greatest dimension.
   b. The moisture content of the soil aggregate mixture will be approved on the basis of visual inspection. Uniformly wet or dry the material so that at the time it is spread and compacted it contains the amount of water necessary to obtain the required density, together with stability, with the field compaction process. Maintain the moisture content in the mixture until compaction is completed. Place wetted material in windrows prior to spreading for compaction. Smooth and roll to correct subgrade distortions greater than 1 inch (25 mm) above or below the intended plane of the bottom of the subbase.
   c. At railroad crossings, junctions with existing pavement, bridges, and similar structures, excavate the subgrade to permit the full thickness of subbase, base, and surface courses to be constructed to the proper elevation. Omit soil aggregate subbase for a distance of 50 feet (15 m) from railroad crossings, bridges, and existing intersection pavements. In these areas, thicken the specified base sufficiently to replace the omitted subbase.
   d. Sprinkle the surface on which the subbase is to be constructed with water as necessary to assure a moist condition to a depth of at least 1/2 inch (15 mm).

4. Spread and shape the prepared subbase material to assure conformance, after compaction, with the cross section shown in the contract documents. Compact the subbase at the moisture content specified in Article 2110.03, C, 3, b, to a density no less than 95% of maximum density as determined by Materials Laboratory Test Method No. Iowa 103. During compaction operations, perform additional shaping as necessary. Apply Article 2111.03, D, to the profile and cross-section.

D. Maintenance of Completed Subbase.
   Apply Article 2111.03, E.
2110.04 METHOD OF MEASUREMENT.
Measurement for the quantities of the items associated with soil aggregate subbase will be as follows:

A. Construction of Soil Aggregate Subbase.
Miles (kilometers) shown on the contract documents. This will be determined along the center line of the subbase, including approaches to railroad crossings, bridges, and similar structures. At intersections, the length of subbase will not include that portion of centerline which overlaps previously determined pavement, base course, or subbase.

B. Granular Material.
Tons (megagrams) as computed by the Engineer from the weights (mass) of material delivered. No deduction will be made for moisture naturally occurring in the material.

2110.05 BASIS OF PAYMENT.
Payment will be the contract unit price for the items associated with soil aggregate subbase as follows:

A. Construction of Soil Aggregate Subbase.
   1. Per mile (kilometer).
   2. Payment is full compensation for:
      • Roadbed correction.
      • Furnishing and applying water.
      • For doing all work necessary for completion of the soil aggregate subbase in compliance with the contract documents except for furnishing and hauling granular material.

B. Granular Material.
   1. Per ton (megagram) for the granular material for soil aggregate subbase furnished and incorporated in the work.
   2. Excavation or filling for roadbed correction in excess of 3 inches (75 mm) at locations other than structures or existing pavement will be paid for according to Article 2102.05, or if no contract unit price is provided, as extra work.

Section 2111. Granular Subbase

2111.01 DESCRIPTION.
Construct a subbase consisting of a uniform mixture of granular material.

2111.02 MATERIALS.
Use either of the following:

A. Materials meeting the requirements of Section 4121, or
B. Recycled PCC material of the specified gradation. Use material reclaimed from an Interstate or Primary roadbed under the jurisdiction of the Department. Recycled PCC pavement, meeting the specified gradation, obtained from other sources may be used for granular subbase with the Engineer’s approval.

2111.03 CONSTRUCTION.

A. Equipment.

1. Use equipment that meets the requirements of Section 2001.

2. Apply Article 2001.05, Paragraphs B, C, D, and E, to compaction equipment, except that other types of equipment may be used provided it is demonstrated they will consistently produce the required compaction.

B. Preparation of Subgrade.

1. Prepare subgrade for granular subbase according to Section 2109 with the following modifications:
   a. Secondary and Local Projects.
      1) Check the cross section with an accurate template extending at least halfway across the width of the subgrade. Repair template deviations of more than 1 inch (25 mm). Prepare the subgrade to remove dips or humps from the general profile. Ensure the subgrade has a good riding surface after preparation is completed.
      2) When PCC pavement is to be placed on the subbase, use the same preparation requirements as for Primary projects.
   b. Interstate and Primary Projects, State Parks, and Institutions.
      1) Use grade stakes to indicate the elevation of the subgrade surface.
      2) Correct the surface of the subgrade in both profile and cross section to within 0.05 foot (15 mm) of the desired elevation as indicated by the grade stakes.

2. Ensure the subgrade surface is in an undisturbed condition after final subgrade trimming. In areas where this condition does not exist, recom pact according to Section 2109.

C. Delivery of Materials.

1. Operate trucks off the subgrade except in the area of unloading.

2. Maintain a clean aggregate interface between the granular subbase material and the porous backfill material of longitudinal subdrains.
D. Construction of Granular Subbase.

1. Ensure granular subbase material is uniformly moist prior to and during compaction. Place subbase material according to the contract documents.

2. Compact granular subbase with a maximum of three passes of a self-propelled, non-vibratory steel or pneumatic roller. Use a roller with a compactive effort of 150 to 200 pounds per lineal inch (2.7 to 3.5 kg/mm) of contact surface.

3. Placing and compaction procedures will be evaluated on an initial trial section approximately 500 feet (150 m) long. This evaluation is to assess the extent of material degradation, consolidation, and permeability.

4. Profile and cross section tolerances for granular subbase are +0 to -0.05 foot (+0 mm to -15 mm).

5. At the Contractor's option, the subbase may be constructed to a general elevation higher than the required design elevation and cut back to design elevation. In this case, excess material removed may be salvaged. It may be processed as required and used for any purpose for which it can be approved under the specifications. The price paid for salvaged and reused material will be the contract unit price for the material as used. If the exposed portions of the subbase are damaged or disturbed, restore them to an acceptable condition (at no additional cost to the Contracting Authority) prior to any subsequent operation that will cover or conceal these portions of the subbase.

6. For sections of pavement more than 600 feet (180 m) long, complete the subbase no less than 600 feet (180 m) in advance of the concrete placing operation. Do not place granular subbase more than 2 months before the pavement is placed. The granular subbase may be placed in areas where the Engineer and the Contractor agree it is reasonable to expect pavement construction can be accomplished prior to winter shutdown. Restrict granular subbase trimming to 1 mile (1.6 km) ahead of the paving operation when winter shutdown is eminent.

E. Maintenance of Completed Granular Subbase.
Do not operate hauling equipment and other traffic on the granular subbase material.

2111.04 METHOD OF MEASUREMENT.

A. Measurement for Granular Subbase material furnished and placed in accepted portions of work will be in square yards (square meters) for the specified design thickness. The measured area will be based on plan dimensions for the finished surface but will exclude fillets.

B. The design thickness of the placed material will be verified by spot checks of the grade.
2111.05 BASIS OF PAYMENT.

A. Payment will be the contract unit price per square yard (square meter) for each specified design thickness of Granular Subbase as measured above.

B. The contract will have a separate item for Granular Subbase, Place Only, in square yards (square meters), when the Contracting Authority is providing the material or if the material is available from mandatory crushing on the contract. The cost of crushing shall be included in the Contractor's price bid for Granular Subbase if recycling is not required, but the Contractor chooses to crush the pavement removed for granular subbase.

C. Payment is full compensation for furnishing all materials, water, preparation of subgrade, and for doing all work necessary to complete the Granular Subbase in compliance with the contract documents.

D. Excavation in excess of 3 inches (75 mm) for preparation of subgrade at locations other than structures or existing pavements will be paid for according to Article 2102.05, or, if no contract unit price is provided, Article 1109.03, B.

E. When adjustments to profile grades cannot be made, fill required for preparation of subgrade at locations other than structures or existing pavements will be paid for according to Article 2102.14, or, if no contract price is provided, Article 1109.03, B.

F. When grading of the subgrade is a part of the contract, additional payment will not be made for excavation or fill necessary for preparation of subgrade.

Section 2112. Wick Drains

2112.01 DESCRIPTION.

A. Furnish all necessary labor, equipment, and materials and perform operations necessary for installation of prefabricated vertical drainage wicks (wick drains) according to the contract documents.

B. Wick drains consist of a band-shaped plastic case which permits continuous vertical drainage, wrapped in a filter material, installed in the subsoils by displacement methods, and spaced and arranged as shown on the plans.

2112.02 MATERIALS AND EQUIPMENT.

At least two weeks prior to construction, submit wick drain samples and certification indicating the source and material properties of the drain materials. At the Preconstruction Conference, submit to the Engineer for review and approval details of the sequence and method of installation. Approval by the Engineer does not relieve the Contractor of the responsibility of installing the wick drains according to the contract documents.
A. **Materials.**

Install prefabricated wick drains consisting of a plastic drainage core encased in or integrated with a filter jacket. Ensure it is band-shaped with an aspect ratio (width divided by thickness) not exceeding 50. Prefabricated wick drains meeting this specification are listed in Materials I.M. 442.01.

1. **Core**

   Meet the following requirements:
   - Provide continuous vertical drainage.
   - Continuous plastic material fabricated to promote drainage along the axis of the vertical drain.

2. **Jacket.**

   a. Install a jacket that allows free passage of pore water to the core without loss of soil material or piping. Meet the following requirements for jacket material:
      - Manufactured from a synthetic non-woven geotextile capable of resisting all bending, punching, and tensile forces imposed during installation and during the design life of the drain.
      - Sufficiently rigid to withstand lateral earth pressures due to embedment and surcharge so that the vertical flow capacity through the core will not be adversely affected.
      - Sufficiently flexible to bend smoothly during installation and induced consolidation settlement without damage.
      - Comply with the following specifications:

<table>
<thead>
<tr>
<th>Test Item</th>
<th>Designation</th>
<th>Minimum Roll Value*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grab Tensile Strength</td>
<td>ASTM D 4632</td>
<td>80 lb. (355 N)</td>
</tr>
<tr>
<td>Trapezoidal Tear</td>
<td>ASTM D 4533</td>
<td>25 lb. (110 N)</td>
</tr>
<tr>
<td>Puncture Strength</td>
<td>ASTM D 4833</td>
<td>50 lb. (220 N)</td>
</tr>
<tr>
<td>Burst Strength</td>
<td>ASTM D 3796</td>
<td>130 psi (900 kPa)</td>
</tr>
<tr>
<td>Permittivity</td>
<td>ASTM D 4491</td>
<td>100 gal/min/ft²</td>
</tr>
</tbody>
</table>

   *Ensure the jacket material is tested in saturated and dry conditions.

   b. Do not allow the jacket material to be subject to localized damage (for example, punching through the filter by sand/gravel particles). Ensure the jacket material does not undergo cracking and peeling during installation of the drain.

3. **Assembled Drain.**

   Meet the requirements below. The Engineer may reject material that is damaged during shipment, storage, or handling, or which does not meet the minimum requirements of the drain material.
   - One single type of assembled drain used on the project, unless the Engineer approves otherwise.
   - Mechanical properties (strength and modulus) of the assembled vertical drain equal to or greater than those specified for the component jacket and core.
Resistant against wet rot, mildew, bacterial action, insects, salts in solution in the groundwater, acids, alkalis, solvents, and any other significant components in the site groundwater.

- Minimum discharge capacity of 3500 cubic feet per year (100 m³/yr) when measured under a gradient of one at a lateral confining pressure of 25 psi (172 kPa).
- Minimum equivalent diameter of 2 inches (50 mm) using the following definition of equivalent diameter:
  \[ dw = \frac{(a+b)}{2}. \]
  \[ dw = \text{diameter of a circular drain equivalent to the band shaped drain (inches (mm))}. \]
  \[ a = \text{width of the band shaped drain (inches (mm))}. \]
  \[ b = \text{thickness of the band shaped drain (inches (mm))}. \]

Drain material labeled or tagged in such a manner that the information for sample identification and other quality control purposes can be read from the label. Ensure, as a minimum, each roll is identified by the manufacturer as to lot or control numbers, individual roll number, date of manufacture, manufacturer, and product identification of the jacket and core.

Ensure during shipment and storage the drain is wrapped in heavy paper, burlap, or similar heavy duty protective covering and according to the manufacturer's recommendations.

B. Equipment.

1. Install wick drains using equipment of a type that will cause minimum disturbance of the subsoil during the installation operation.

2. Install the wick drains using a mandrel. Push (in one continuous movement) the mandrel through the sand blanket and into the soil. Vibrating or driving are options if the Engineer approves. Ensure the mandrel:
   - Protects the wick material from tears, cuts, and abrasions during installation,
   - Is rectangular in shape and of a cross sectional area not to exceed 10 square inches (6500 mm²), and
   - Is provided with an “anchor” rod or plate at the bottom to prevent soil from entering the bottom of the mandrel during installation of the drain and to anchor the bottom of the drain at the required depth at the time of mandrel removal.

2112.03 CONSTRUCTION.

A. Familiarity with site conditions and the available geotechnical information is a necessity. Prior to installation of the wick drains, demonstrate the equipment, method, and materials produce a satisfactory drain installation. Drill at least two borings within the area designated on the plans in order to select the equipment, method, and materials: 1) suitable for the existing site conditions; and 2) capable of producing a satisfactory drain installation to the minimum elevation. Installation of up to ten trial drains may be required in each of two to four test locations designated by the Engineer. Compensation
will be made for each trial drain if the installation satisfies the requirements of the contract documents. No compensation will be allowed for installing unsatisfactory trial drains.

B. The Engineer’s approval of the method and equipment used to install the trial drains does not constitute acceptance of the method for the remainder of the project. If the Engineer considers that the method of installation does not produce a wick drain that satisfies the requirements of the contract documents, alter the method or equipment, or both, in order to achieve compliance.

C. Prior to installing the drains, grade the site sufficiently level (at no additional cost to the Contracting Authority) to allow vertical and proper drain installation.

D. Install the wick drains following placement of the sand blanket. Install a granular blanket of sufficiently coarse material and compact to provide a stable working surface.

E. Locate, number, and stake wick drains. Take all reasonable precautions to preserve the stakes. Ensure drain locations vary by no more than 3 inches (75 mm) from the locations indicated on the drawings. Two weeks prior to construction, submit drawings to the Engineer for approval showing the method of field locations, drain layout, and numbering plan.

F. Auguring or other methods may be used to loosen stiff upper soils prior to the installation of the drains, provided such operations do not extend more than 2 feet (600 mm) below the bottom of the sand blanket. After the wick drain has been satisfactorily installed, fill all holes or voids created by such operations with sand.

G. Check the installation equipment for plumbness prior to advancing each drain. Ensure the plumbness of the mandrel does not deviate more than 1/4 inch per foot (50 mm per meter) from vertical. Install the drains to the minimum elevation as shown on the plans. If the penetration shown on the plans is more than 1 foot (300 mm) into the underlying foundation layer and difficulties are encountered prior to achieving the indicated depths, install the drains to a depth of 1 foot (300 mm) below the bottom of the soil layer(s) being improved by wick drain installation as shown on the plans.

H. The Engineer will reject wick drains that vary from their proper location by more than 6 inches (150 mm) at the ground surface, drains that are damaged during installation or subsequent construction, or drains that are improperly completed. No compensation will be allowed for any materials furnished or for any work performed on such drains.

I. During installation, provide the Engineer with suitable means of measuring the vertical length of each wick drain installed at a given location and deriving a tip elevation for each drain.

J. Splices or connections in the wick drain material will not be allowed.
K. When obstructions that cannot be penetrated by the drain installation equipment are encountered below the working surface, notify the Engineer and complete the drain from the elevation of the obstruction to the working surface. At the direction of the Engineer, attempt to install a new drain (maximum of two attempts, as directed by the Engineer) within an 18 inch (450 mm) radius from the obstructed drain. The Contractor will be compensated for each obstructed drain unless the drain is improperly completed, in which case no compensation will be allowed.

L. After installation, cut each drain horizontally such that approximately 6 inches (150 mm) of drain material extends above the top of the sand blanket.

M. The Engineer will keep a daily log which lists for each drain the date of installation, top elevation, tip elevation, and pay length. A copy of each daily log will be provided to the Contractor.

**2112.04 METHOD OF MEASUREMENT.**

A. Measurement for Wick Drain (including trial wick drains) will be feet (meters) installed according to the contract documents, calculated from measurements taken from the top of the drain to the tip elevation of the drain.

B. In the case of obstructions, the Engineer will calculate the number of feet (meters) from measurements taken from the top of the drain to the elevation at which the obstruction was encountered.

**2112.05 BASIS OF PAYMENT.**

A. Payment for Wick Drain will be the contract unit price per foot (meter).

B. Payment includes:
   - Field staking for the location of wick drains, and
   - All labor, equipment, and materials necessary to complete the installation according to the contract documents.

C. No payment will be made for unacceptable drain or trial drain installations.

D. In instances where pre-auguring is permitted, the cost of pre-auguring and subsequent placing of sand backfill material is incidental to the price bid for Wick Drains.

E. The cost of borings drilled to select the equipment, method, and materials suitable for the existing site conditions to produce a satisfactory drain installation is incidental to the price bid for Wick Drains.
Section 2113. Subgrade Stabilization Material

2113.01 DESCRIPTION.
Place material to stabilize the subgrade under the pavement at locations specified in the contract documents.

2113.02 MATERIALS.
The type of subgrade stabilization material required will be specified in the contract documents. Use material that meets the requirements of Article 4196.01, B, 5.

2113.03 CONSTRUCTION.

A. Placement.
Place the subgrade stabilization material as shown in the contract documents (typically on subgrade with a specified backfill material placed on top). Overlap subgrade stabilization material sections a minimum of 2 feet (0.6 m) during placement operations. Place backfill material so the material remains in place or is not damaged.

B. Repair.
In the event of subgrade stabilization material failure or damage during construction:

1. Remove the damaged portion of material.

2. Replace the damaged portion with a patch of new material of the same type extending a minimum of 6 feet (2.0 m) in all directions beyond the edge of the failed area.

3. Replace the backfill material.

2113.04 METHOD OF MEASUREMENT.
Subgrade Stabilization Material of the type specified, in square yards (square meters), will be the quantity shown on the contract documents to the nearest square foot (0.1 m²).

2113.05 BASIS OF PAYMENT.

A. Payment for the type of Subgrade Stabilization Material specified will be the contract unit price per square yard (square meter).

B. Payment is full compensation for all work, materials, equipment, and labor necessary to furnish, install, place, repair and maintain the subgrade stabilization material.

Section 2115. Modified Subbase

2115.01 DESCRIPTION.
Construct a subbase consisting of a uniform mixture of uniformly moistened granular materials.
2115.02 MATERIALS.
Apply Section 4123.

2115.03 CONSTRUCTION.
Place, shape and compact materials according to the contract documents.

A. Equipment.

1. Apply Article 2001.05, Paragraphs B, C, D, and F, except use rollers having a minimum compactive effort of 300 pounds per inch (5.25 kg/mm) width.

2. Other types of equipment may be used provided it is demonstrated they will consistently produce the required compaction without excessive aggregate breakdown. For all other equipment used, meet the other requirements of Section 2001.

B. Modified Subbase Construction.

1. Preparation of Subgrade.
Apply the requirements of Section 2109. In addition, disk the subgrade to a depth of 6 inches (150 mm), aerate, and recompact. Recompact to the requirements of Article 2107.03, E, on Primary projects and Article 2107.03, F, on Secondary projects. Proof roll after preparing subgrade.

2. Proof Rolling of Subgrade.
Proof roll with a truck loaded to the maximum single legal axle gross weight (mass) of 20,000 pounds (9.1 Mg) or the maximum tandem axle gross weight (mass) of 34,000 pounds (15.4 Mg). Operate the truck at a speed less than 10 mph (16 km/h). Make one pass on every lane. The subgrade will be considered unstable if, under the operation of the loaded truck, the surface shows yielding or rutting of more than 2.0 inches (50 mm) measured from the top to the bottom of the rut at the outside edges. Correct unstable subgrade according to Section 2109.

Maintain a clean aggregate interface between the granular subbase material and the porous backfill material of longitudinal subdrains.

   a. Ensure modified subbase material is uniformly moist prior to and during compaction.
   b. Place modified subbase in uniform lifts no more than 6 inches (150 mm) thick.
   c. Compact modified subbase with a minimum of six roller passes.

2115.04 METHOD OF MEASUREMENT.
Modified Subbase will be the quantity shown in the contract documents.
2115.05 BASIS OF PAYMENT.

A. Payment for Modified Subbase will be the contract price per cubic yard (cubic meter).

B. Payment is full compensation for furnishing all materials, water, preparation of subgrade, and for all work necessary to complete the modified subbase in compliance with contract documents.

C. The contract will have a separate item for Modified Subbase, Place Only, in cubic yards (cubic meters), when the Contracting Authority is providing the material or if the material is available from mandatory crushing on the contract. The cost of crushing shall be included in the Contractor’s price bid for modified subbase if recycling is not required, but the Contractor chooses to crush the pavement removed for modified subbase.

D. Excavation or filling in excess of 3 inches (75 mm) for preparation of subgrade at locations other than structures or existing pavements will be paid for according to Article 2102.05, or if no contract unit price is provided, it will be paid as extra work according to Article 1109.03, B, except where grading is a part of the contract.

E. Correction of subgrade after proof rolling will be paid as extra work according to Article 1109.03, B, except where grading is a part of the contract.

Section 2116. Full Depth Reclamation

2116.01 DESCRIPTION.
Reclaim existing asphalt pavement to the width and depth specified in the contract documents. Mix the reclaimed material in-place with an asphalt stabilizing agent, additional materials (when specified), and water (if required). Compact this mixture.

2116.02 MATERIALS.

A. Asphalt Stabilizing Agent.

1. Unless specified otherwise in the contract documents, the asphalt stabilizing agent may, at the Contractor’s option, be either of the following:
   a. Emulsified Asphalt (HFMS-2s) meeting the requirements of Section 4140.
   b. Foamed Asphalt using PG 52 -34 or PG 46 -34 asphalt binder meeting the requirements of Section 4137.

2. Unless stated otherwise in the contract documents, use the residual asphalt application rate of 3.0%, by dry mass to determine the estimated plan quantity of asphalt stabilizing agent.
B. **Pulverized Bituminous Material.**
Ensure the reclaimed paving material conforms to the following gradation. The gradation may be revised with the Engineer’s approval, but ensure the top size of the material does not exceed 25% of the depth of the compacted recycled mat.

<table>
<thead>
<tr>
<th>Sieve Size</th>
<th>% Passing</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 1/2 inch (37.5 mm)</td>
<td>98 to 100</td>
</tr>
<tr>
<td>1 inch (25 mm)</td>
<td>90 to 100</td>
</tr>
</tbody>
</table>

C. **Mineral Stabilizing Agents.**
A mineral stabilizing agent may be required by the mix design. When specified, the agent may be from any locally available commercial source meeting the following criteria:

1. Portland cement meeting ASTM Type I.
2. Fly ash may come from any available source.
3. Hydrated lime meeting the requirements of Article 4193.
4. Limestone fines from limestone crushing operations.

D. **Mix Design.**
The contract documents will specify the mix design for the reclaimed mixture. The mix design establishes the depth of milling, the amount of added material, and the amount of residual asphalt to incorporate into the milled material and the optimum laboratory compaction moisture.

### 2116.03 CONSTRUCTION.

A. **General.**
1. Perform full depth reclamation between April 1 and November 1 unless otherwise specified in the contract documents.
2. Do not perform reclaiming operations when the weather conditions are such that proper mixing, shaping, and compacting the reclaiming material cannot be accomplished.

B. **Equipment.**
1. Furnish a self-propelled machine capable of reclaiming the existing paving material to the width and depth shown in the contract documents. Ensure the machine meets the following:
   a. Equipped with automatic depth control and maintain a constant cutting depth and width.
   b. Capable of pulverizing bituminous material to the required gradation.
   c. Capable of mixing the reclaimed material and asphalt stabilizing agent into a homogeneous mixture.
d. Provides a positive means for accurately controlling the rate of flow and total delivery of the asphalt stabilizing agent into the mixture in relation to the speed and quantity of material being recycled.

e. A delivery system meeting the requirements of Article 2001.22, F.

2. When foamed asphalt is used, use an asphalt foaming system that accurately and uniformly adds the specified percent of water to the hot asphalt binder. Use equipment fitted with a test nozzle to provide field samples of foamed asphalt. Equip tankers supplying the hot asphalt binder with a thermometer to continuously measure the temperature of the asphalt in the bottom third of the tank.

3. Use rollers meeting the requirements of Article 2001.05 for compacting the reclaimed material. As a minimum, have the following rollers available for use:
   a. Sheepfoot roller.
   b. Double drum steel roller (may be used in the static or vibratory mode).
   c. 25 ton (22.5 Mg) or greater pneumatic tire roller.

C. Preparation.
Prior to initiating the reclaiming operation, clear all vegetation and debris within the width of pavement to be reclaimed. Remove of this vegetation and debris from the project according to Article 1104.08.

D. Reclaiming the Existing Pavement.

1. During reclaiming operations, apply the asphalt stabilizing agent to the pulverized material at a rate that will achieve the residual asphalt content established by the mix design. The Engineer may vary the application rate of asphalt stabilizing agent as required by existing pavement conditions.

2. Determine the amount of additional water needed to facilitate uniform mixing with the asphalt stabilizing agent and achieve a stable reclaimed layer above the minimum specified density. The water may be added prior to or concurrently with the asphalt stabilizing agent. Ensure adding water to facilitate uniform mixing does not adversely affect the asphalt stabilizing agent.

3. The mineral stabilizing agent may be added dry or in slurry form.

4. If multiple passes of the equipment are required to reclaim the pavement material to the desired width, use a minimum 6 inch (150 mm) overlap. Use an asphalt stabilizer application system capable of being adjusted for the width of reclaiming so that overlapped mixture maintains the designed residual asphalt content.
E. Compaction and Shaping.

1. Ensure the following:
   - Field density for the reclaimed mat on Interstate and Primary roads is a minimum of 94% of laboratory density based on the dry weight of compacted material according to Materials I.M. 504.
   - Field density for the reclaimed mat on shoulders and all other roads is a minimum of 92%.
   - The surface density, based on the 2 inch depth nuclear probe density, is a minimum of 97% of the nuclear probe density measured at 75% of the reclaimed mat depth.

2. Perform initial rolling with a sheepsfoot roller until the roller pads walk out of the reclaimed mix. Shaping to achieve planned profile and cross slope should cut deep enough to remove the sheepsfoot roller marks.

3. Repeated reclaiming and rolling may be required within 2 calendar days after the initial processing and rolling to achieve the target density on the completed in-place recycled surface. Discontinue rolling that results in cracking, movement, or other types of distress until such time that the problem can be resolved. If there is a significant change in mix proportions, weather conditions, or other controlling factors, the Engineer may require construction of test strips to check target density.

F. Quality Control.

1. Control the residual asphalt content to be within ± 0.5% of the target establish by the design.

2. Control the mineral stabilizing agent to be within ± 0.5% of the target established by the design.

3. For foamed asphalt, ensure the asphalt binder is maintained at a temperature within ± 20°F (10°C) of the optimum temperature established by the design. The Engineer may verify the foaming characteristics of each new tanker load, by measuring a sample from the equipment's test nozzle.

4. Ensure the crown of the compacted reclaimed mat is within 6 inches (150 mm) of the centerline reestablished by construction survey, unless specified otherwise in the contract documents. Measure the profile along the center of each lane of the compacted reclaimed mat with a profilograph. Correct bumps and dips greater than 1 inch (25 mm). Ensure the cross-slope of the compacted reclaimed mat is within 1 inch (25 mm) of the designated slope.

5. Unless specified otherwise in the contract documents, perform nuclear gauge moisture and density tests every 500 feet (150 m) per lane at locations determined by the Engineer, according to Materials I.M. 504. The Quality Index for density will not apply. Remix and compact sections of reclaimed mat that do not achieve minimum density criteria.
2116.04 METHOD OF MEASUREMENT.
Measurement will be as follows:

A. Full Depth Reclamation.
Square yards (square meters) satisfactorily completed computed from the measured longitudinal length of pavement reclaimed to the nearest 0.1 foot (0.1 meter) and the width of pavement specified in the contract documents.

B. Asphalt Stabilizing Agent.
Tons (megagrams) or gallons (liters) measured through a calibrated pump used for metering the total delivery of the agent or by delivery tanker quantity.

C. Mineral Stabilizing Agent.
Dry tons (megagrams) by delivery tanker quantity.

2116.05 BASIS OF PAYMENT.
Payment will be the contract unit price as follows:

A. Full Depth Reclamation.
1. Per square yard (square meter).
2. Payment is full compensation for all labor, equipment, and materials necessary for preparation, reclaiming, shaping, and compaction of the reclaimed material.

B. Asphalt Stabilizing Agent.
1. Per ton (megagram) or gallon (liter).
2. Payment is full compensation for all labor, equipment, and materials necessary for furnishing the agent and application of the agent into the reclaimed material.

C. Mineral Stabilizing Agent.
1. Per dry ton (megagram).
2. Payment is full compensation for all labor, equipment, and material necessary for furnishing the agent and application of the agent into the reclaimed material.

Section 2120. Fuel Adjustment

2120.01 DESCRIPTION.
Factor applied to payments and partial payments for quantities of certain items of excavation work.

2120.02 APPLICATION.
A. Applied as the work is done, according to this specification when indicated in the contract documents.

B. Fuel adjustment will be applied to all Class 10, 12, and 13 Excavation, Embankment-In-Place (non-dredge material), Selected Backfill Material, and Topsoil which is work of the contract. A FUF of 0.20 gallon per cubic yard (1.0 L/m³) will be used for all excavation items of work covered by this specification. A FUF of 0.27 gallon per cubic yard (1.3 L/m³) will be used for Embankment-in-Place (non-dredge material).

C. Fuel adjustment will also be applied to Embankment-In-Place (dredge material). The fuel usage will be based on billed gallons (liters) of fuel used.

2120.03 PRICE INDEX.

A. A Current Price Index (CPI) in dollars per gallon (liter) will be established by the Department for each month. The CPI will be the price of No. 2 High Sulfur Diesel, as reported by the Oil Price Information Service, using the first weekday of the month and the average of all prices reported for Des Moines. This information will be printed in the Weekly Letting Report published by the Department.

B. The Base Price Index (BPI) for each contract will be the CPI in effect during the month previous to the month of letting of that contract.

2120.04 METHOD OF MEASUREMENT.

A. Provide the Engineer with a monthly spreadsheet (the Engineer will provide the format) with quantities, and the fuel adjustment for the month (even if there will be no adjustment).

B. If the contract quantity for an item is in tons (megagrams), convert the quantity to cubic yards (cubic meters) using an appropriate conversion factor the Engineer approves. The total quantity of cubic yards (cubic meters) for each month (Y) is the sum of these quantities.

C. If the work is not completed within the contract period or authorized extensions thereof, the CPI to be used for work done after the contract period is to be the CPI that applied during the last working day within the contract period, including authorized extensions.

D. Items Other Than Embankment-In-Place:

1. Compute the Gross Fuel Adjustment (GFA) for each item of work covered in this specification other than Embankment-In-Place using the following formula (the GFA may be positive or negative):

   \[ GFA = FUF(CPI-BPI)Y \]

2. Compute the first $0.15 per gallon ($0.04 per liter) of adjustment (FFA) for each item of work covered by this specification other than Embankment-In-Place (dredge material) using the following formula:
English  \[ \text{FFA} = \text{FUF}($0.15) \times \text{Y} \]

Metric  \[ \text{FFA} = \text{FUF}($0.04) \times \text{Y} \]

\[ \text{E. Embankment-In-Place:} \]

1. Compute the Gross Fuel Adjustment for Embankment-In-Place (dredge material) (GFA\text{Dredge}) using the following formula:

   \[ \text{English} \quad \text{GFA}_{\text{Dredge}} = (\text{CPI-BPI})(\text{Billed gallons of fuel used per month}) \]

   \[ \text{Metric} \quad \text{GFA}_{\text{Dredge}} = (\text{CPI-BPI})(\text{Billed liters of fuel used per month}) \]

2. Compute the first $0.15 per gallon ($0.04 per liter) of adjustment (FFA) for all items of work covered by this specification other than Embankment-In-Place (dredge material) (FFA\text{Dredge}) using the following formula:

   \[ \text{English} \quad \text{FFA}_{\text{Dredge}} = $0.15 \times (\text{Billed gallons of fuel used per month}) \]

   \[ \text{Metric} \quad \text{FFA}_{\text{Dredge}} = $0.04 \times (\text{Billed liters of fuel used per month}) \]

\[ \text{F. For each item of work covered by this specification, if the FFA is equal to or greater than the GFA, the Net Fuel Adjustment will be zero, and no fuel adjustment payment will be made. The same applies to FFA_{\text{Dredge}} and GFA_{\text{Dredge}}.} \]

\[ \text{G. For each item of work covered by this specification, if the GFA is greater than the FFA, the Net Fuel Adjustment will be determined as GFA-FFA. If the GFA is less than 0.0, the Net Fuel Adjustment will be determined as GFA+FFA. The same applies to GFA_{\text{Dredge}} and FFA_{\text{Dredge}}.} \]

\[ \text{2120.05 BASIS OF PAYMENT.} \]

\[ \text{A. Payment will be the Net Fuel Adjustment for each month, subject to the deduction for partial payments described in Article 1109.05. Should the Net Fuel Adjustment be negative, an equal amount will be deducted on payments made to the Contractor from sums otherwise due. This payment or deduction will be made by change order.} \]

\[ \text{B. On completion of the work of the contract:} \]

1. For all items covered in this specification other than Embankment-In-Place (dredge material) the sum of the total quantities (Y) for each monthly period will be adjusted, if necessary, to agree with the final quantities to be paid.

2. For Embankment-In-Place (dredge material), the sum of the total quantities for billed gallons (liters) of fuel used for each monthly period will be adjusted, if necessary, to agree with the final quantities to be paid. This adjustment will be made by either:
   - Subtracting the proper quantity from the last adjustment made, or
• Adding the proper quantity and computing the adjustment on the basis of the CPI in effect on the last working day any of this work was done.

C. On completion of the work of the contract, the monthly fuel adjustment will be revised by pro-rating any variance from the plan quantity.

D. Payment or deduction is full compensation for all fluctuations in fuel prices during the time the contract work is being done.

Section 2121. Granular Shoulders

2121.01 DESCRIPTION.
Prepare a shoulder area and furnish and place granular material as shown on the contract documents. This section may also apply to construction of paved shoulder fillets.

2121.02 MATERIALS.

A. For Type A and Type B shoulders, meet the following:

1. Crushed stone. Apply Article 4120.02.

2. Gravel/Limestone (if allowed in the contract documents). Apply Article 4120.02.

3. Crushed PCC or crushed composite HMA and PCC. Meet gradation No. 11 of the Aggregate Gradation Table in Section 4109 (Materials I.M. 209). Either salvaged or unclassified sources of material may be allowed. Other quality requirements of Section 4120 will not apply.

B. The Engineer may:
• Disallow short sections of material substitutions.
• Restrict the substitution to both sides of the pavement.

C. Use aggregate for paved shoulder fillets that meets the requirements of Article 4120.07.

D. RAP inspected according to Article 2303.02, C, may be used for Type A and B Granular Shoulders. When RAP is used for granular shoulders, process it so that 100% of the material passes the 1 1/2 inch (37.5 mm) sieve. When so processed, other gradation and quality requirements of Section 4120 will not apply.

E. Recycled crushed PCC, RAP, or crushed composite HMA and PCC may be uniformly blended with crushed stone. Limit recycled materials to total no more than:
• 30% of the shoulder aggregate for new construction, and
• 50% of the total for existing granular shoulders.
2121.03 CONSTRUCTION.

A. Equipment.
Use equipment that meets the requirements of Section 2001 and the following:

1. Trench Machine.
   Use a motor grader or other approved machinery to excavate for subgrade preparation.

2. Proportioning and Mixing Equipment.
   a. Type A Granular Shoulders.
      1) Prewetting will not be required when the quantity of Type A granular shoulders designated for the contract is less than 2000 tons (2000 Mg).
      2) Use proportioning equipment that accurately proportions each material.
         a) Mixing and Prewetting More Than One Aggregate: Apply Article 2001.08, B.
         b) Prewetting One Aggregate: Apply Article 2001.08, A.
         c) Prewetting One Premixed Aggregate: Apply Article 2001.08, A.
      3) A traveling mixer may be used on a road that is closed to through traffic if it meets all of the following conditions:
         a) Proportions water to a single or premixed aggregate.
         b) Mixes the material in a single pass operation.
         c) Achieves mixing equivalent to that required from a stationary mixer.
      4) Ensure mixing plants include a means of calibrating and adjusting the proportioning equipment. Make provisions for a periodic check.
   b. Type B Granular Shoulders.
      Proportioning, mixing, and prewetting equipment is not specified.

3. Equipment for Applying Water.
   Apply Article 2001.09.

   a. Apply Article 2001.05, B and C, for compaction of granular shoulder material. Also apply Article 2001.05, D, when the road or adjacent lane is closed to public traffic. Vibratory rollers, described in Article 2001.05, F, may be substituted for compaction, provided equivalent compaction is obtained and demonstrated to the Engineer. This equipment may also be used for compaction of earth fill.
   b. When the thickness of a Type B shoulder is 3 inches (80 mm) or less and the width is not more than 3 feet (1 m), the coverages may be with loaded truck tires having a weight (mass) not less than 200 pounds per inch (3.5 kg/mm) of tire width. Finish roll the surface of both types with one complete coverage by a steel tired roller.

5. Weighing Equipment.
   Apply Article 2001.07.
B. Type A Granular Shoulders.

1. Proportioning and Mixing.
   When more than one aggregate is to be combined, mix the aggregates before delivery to the road. Except as permitted in Article 2121.03, A, 2, a, premix aggregate with sufficient water, acceptable to the Engineer, so that all particles are uniformly wetted.

2. Surface Preparation.
   a. Prepare the surface by one of the following methods:
      1) Earth Shoulder Fill.
         a) Construct a shoulder fill to an elevation below that of the pavement edge to allow for placement of granular shoulders as shown in the contract documents. Use select treatment materials of Article 2102.02, D, 1, if available and coordinated with the Engineer, or use suitable soils of Article 2102.02, D, 2. Do not use unsuitable soils of Article 2102.02, D, 3 or topsoil.
         b) Spread and compact according to Articles 2107.03, D and E.
         c) Shape, smooth, and finish the fill. Correct shoulder fill elevation deviations exceeding 0.05 foot (15 mm).
         d) When unpaved side roads, drives, or entrances extend through the shoulder area, excavate them or fill them with earth as necessary, and as directed by the Engineer, to provide a suitable approach.
         e) Equivalent compaction with equipment specified in Article 2121.03, D, will be acceptable.
      2) Trenching and Reshaping.
         a) Remove the earth of the existing shoulder to the width and depth shown on the contract documents. Remove existing vegetation and deposit on the foreslope. Unless specified otherwise in the contract documents, remove excess excavated material from the project. Do not excavate for placement of shoulders at driveways and intersecting roads that have fillets or pavement of a higher type.
         b) Correct shoulder fill elevation deviations exceeding 0.05 foot (15 mm). If placing earth backfill material is necessary in preparing the subgrade, thoroughly compact the earth backfill material by tamping or rolling in layers not exceeding 3 inches (80 mm) in depth.
         c) For reshaping earth shoulders to the specified cross section adjacent to the granular shoulder, earth fill does not need to be rolled except for the 1 foot (0.3 m) adjacent to the granular shoulder.
   b. If earth fill is expected, it will be designated in the contract documents along with provisions for payment.

3. Shoulder Construction.
   a. Place granular shoulder material on the subgrade so no material is deposited on the adjacent pavement surface. Immediately remove
material inadvertently spilled on the adjacent pavement using shovels and brooms.

b. Spread and compact the granular shoulder material so the finished elevation and width conform to the specified cross section.

c. Compact granular shoulder material with six complete coverages with a pneumatic tired roller or a steel vibratory roller, followed by at least one complete finish coverage with a steel tired roller. The Engineer may reduce the rolling when unstable subgrade is encountered, and may require additional finish rolling if needed to ensure a satisfactory surface finish. Shape concurrently with compaction. The tolerance for width of the completed shoulder is ± 0.2 foot (60 mm).

d. Maintain the required moisture content in the granular shoulder material until it has been satisfactorily spread, compacted, and finished to the required dimensions.

e. The Engineer will check the shoulder cross slope with a template furnished and used by the Contractor. Shoulder cross slope is not to be less than specified or more than 1% greater than specified.

4. Limitations.

a. When traffic is maintained on adjacent pavement, construct shoulders on one side of the pavement at a time. Conduct operations resulting in a minimum inconvenience to traffic. Fill the portion of the shoulder excavated with granular material and compact prior to opening to traffic. The Engineer may modify this requirement for unusual and justifiable conditions.

b. When construction of the pavement is staged, stage construction of the shoulder as well, according to Article 2121.03, C, 4. Place, and moisten if necessary, granular material for temporary fillets and compact according to Article 2121.03, C, 3.

c. Bring granular shoulder material up to the pavement edge for the full width of the shoulder, at the design cross slope, prior to winter shutdown.

C. Type B Granular Shoulders.

1. Proportioning and Mixing.

Use an aggregate in a moist condition so that it will readily compact. Do not apply Article 2001.08.

2. Surface Preparation.

a. Minimum surface preparation work is anticipated. Existing shoulders damaged by the Contractor’s operations shall be restored. Remove existing vegetation and deposit on the foreslope. Salvage bituminous edge rut material and existing aggregate from the fillet area and deposit on the outer shoulder area. The work shall assure a nearly vertical pavement edge.

b. If earth fill is expected, it will be designated in the contract documents along with provisions for payment.

3. Shoulder Construction.

a. Deposit, without dumping on the pavement, granular shoulder material directly on the shoulder for the width designated.
b. Thoroughly compact the moist aggregate with a minimum of four complete coverages of the entire exposed surface using a pneumatic tired roller or a steel vibratory roller. Follow this with at least one complete finish coverage using a steel tired roller. Moisten the aggregate if, in the opinion of the Engineer, it is so dry that it will not readily compact.

c. Shape the aggregate to produce a smooth surface flush with the pavement edge and tapered to meet the shoulders at the width shown in the contract documents.

4. **Limitations.**
   a. When a drop-off is caused by the Contractor’s operations and is adjacent to a lane open to public traffic, placement of granular shoulders shall be coordinated so they are brought up to the pavement operation before the adjacent lane is opened to traffic.
   b. Use a fillet of granular material to temporarily correct a drop-off created by the resurfacing. If a fillet is placed, the minimum width of the fillet is to be 6 times the thickness of HMA resurfacing completed. Blade this material across the shoulder prior to placing the final layer of granular surfacing. The Engineer may modify this requirement for narrow shoulders and other justifiable conditions.
   c. Bring granular shoulder material up to the pavement edge for the full width of the shoulder, at the design cross slope, prior to winter shutdown.

D. **Paved Shoulder Fillet.**
   Place and compact aggregate for a fillet at the edge of a paved shoulder as provided in Article 1107.08.

2121.04 **METHOD OF MEASUREMENT.**

A. Measurement for Type A and Type B Granular Shoulders satisfactorily placed will be computed from the weights (mass) of individual truck loads, including moisture in the aggregate at time of delivery. Moisture added after delivery will not be measured for payment.

B. Trenching and Reshaping, in stations (meters), will be the quantity shown on the contract documents. The quantity of Trenching and Reshaping will be determined for each side of the pavement or base.

2121.05 **BASIS OF PAYMENT.**

A. Payment will be the contract unit price as follows:

1. **Type A Granular Shoulders.**
   a. Per ton (megagrams) for the tons (megagrams) placed on the shoulder.
   b. Payment is full compensation for the following:
      - Furnishing materials, including aggregate and water.
      - Furnishing equipment, tools, and labor to place the material in accordance with the contract documents.
c. The earth shoulder fill required in the shoulder area under the granular shoulder will be paid for separately.

d. When traffic has not been routed through the work during paving or base construction, but all or a portion of the work must be done under traffic as provided in Article 2121.03, B, 4, no payment will be made for additional flagging, barricading, decreased production, or other items directly related to this traffic.

2. Type B Granular Shoulders.
   a. Per ton (megagram) for the tons (megagrams) placed on the shoulder.
   b. Payment is full compensation for the following:
      - Furnishing materials, including aggregate and water.
      - Furnishing equipment, tools, and labor to place the material in accordance with the contract documents.
      - The minimum surface preparation work described in Article 2121.03, C, 2.
   c. The earth shoulder fill required in the shoulder area under the granular shoulder will be paid for separately.
   d. Furnishing and placing the paved shoulder fillet adjacent to paved shoulders is incidental and will not be paid for separately.

3. Trenching and Reshaping
   a. Trenching and reshaping will be paid for at the contract unit price for per station (meter). Payment is full compensation for trenching, reshaping, and removing excess excavated material from the project.

B. The contract will have a separate item for Granular Shoulders, Place Only, of the type specified in tons (Mg), when the Contracting Authority is providing the material or if the material is available from mandatory crushing on the contract. The cost of crushing should be included in the Contractor’s price for granular shoulders if recycling is not required but the Contractor chooses to crush the pavement removal for granular shoulder material.

Section 2122. Paved Shoulders

2122.01 DESCRIPTION.
A. Prepare the area adjacent to a pavement, as necessary, and furnish and place shoulder material on the prepared area. This work may include construction of an earth fill and a special backfill material layer for new construction or surface preparation for resurfacing or overlay construction.

B. The type of shoulder material may be specified, or it may be an alternate on the proposal, and only one type will be bid and awarded.

2122.02 MATERIALS.
A. Hot Mix Asphalt Mixture (1,000,000 ESAL Base Mixture).
   Use materials specified in Section 2303.
B. **Portland Cement Concrete Base.**
   Use materials specified in Section 2201.

C. **Special Backfill.**
   Use materials specified in Section 4132.

2122.03 **CONSTRUCTION.**

A. **Equipment.**
   Use the type of equipment required or allowed for the type of paved shoulder to be placed. Adapt equipment to shoulder construction in a manner approved by the Engineer.

B. **Preparation of Shoulder Area.**

1. This work may involve construction of an earth fill and a special backfill material to allow placement of paved shoulders. Spread and compact earth fill according to the requirements of Section 2109.

2. Use select materials of Article 2102.02, D, 1, if available and coordinated with the Engineer, or suitable soils of Article 2102.02, D, 2. Do not use unsuitable soils of Article 2102.02, D, 3, or topsoil.

3. For shoulder construction in which PCC is placed over HMA, thoroughly clean the surface by brooming prior to placing concrete. When HMA is to be placed over HMA, prepare the surface according to Article 2303.03, C, 4.

C. **Paved Shoulder Construction.**
   Construct paved shoulders as follows:

1. **Hot Mix Asphalt Mixture.**
   a. Prior to placement, tack coat the pavement edge.
   b. Proportion, mix, place, and compact HMA mixture to the width, thickness, grade, and slope shown in the contract documents, according to the requirements of Section 2303.
   c. After finish rolling, visually inspect the paved shoulders to ensure:
      - Roller distortions have been smoothed.
      - Longitudinal and transverse joints have been smoothly constructed.
      - The general grade profile is satisfactory.

2. **Portland Cement Concrete Base.**
   a. Proportion, mix, place, finish, and cure PCC base to the width and thickness shown in the contract documents. Except as modified herein, perform the work according to the requirements of Section 2201.
   b. The shoulder may be placed separately, using either fixed forms or slip forms, after placement of the main line pavement. Place tie bars according to the contract documents, or use a method the Engineer approves, prior to the start of paving operations.
c. Finish and edge the concrete. Obtain the Engineer’s approval for construction of surface corrugations.

d. Saw the transverse joints as shown in the contract documents. In addition, place expansion and contraction joints to coincide with similar joints in the abutting pavement. Seal transverse sawed joints according to Article 2301.03, P. Fill expansion joints in the same manner as for the main line.

Place special backfill material according to Article 2102.03, D, 3, c.

D. Finishing.
After completion of the paved shoulder, place the granular fillet as shown in the contract documents and according to Section 2121. Finish the foreslope according to Article 2123.03, D.

2122.04 METHOD OF MEASUREMENT.
Measurement will be as follows:

A. Paved Shoulders.

1. Hot Mix Asphalt Paved Shoulder.
   Article 2303.04, A, 2, applies.

2. Portland Cement Concrete Paved Shoulder.
   Article 2301.04, A, applies.

B. Special Backfill.
Contract quantity.

C. Resurfacing or Overlay of Existing Paved Shoulders.
Article 2303.04 applies.

2122.05 BASIS OF PAYMENT.
Payment for all work performed and measured as prescribed will be according to the following provisions:

A. Paved Shoulders.

1. Hot Mix Asphalt Paved Shoulder.
   Article 2303.05 applies.

2. Portland Cement Concrete Paved Shoulder.
   a. Article 2301.05, A, applies.
   b. Payment for paved shoulders constructed is full compensation for:
      • Preparing the area, including the earth fill, furnishing and placing the paved shoulder, finishing the shoulder edge and foreslope
      • Furnishing all the material, equipment, tools, and labor to complete the work according the contract documents and this specification.
   c. Separate payment will not be made for:
- Construction of the earth fill.
- Asphalt binder.
- Tack coat bitumen.
- Placement, construction, or sawing and filling of joints for the PCC base.
- Finishing of the shoulder edge and foreslope and furnishing granular material.

3. Furnish samples as specified in Section 2303 or 2301, with payment to be made as specified.

B. Special Backfill.
   Article 2102.05, A, 4, applies.

C. Resurfacing or Overlay of Existing Paved Shoulders.
   For HMA of the type, width, and thickness specified and satisfactorily constructed, payment will be according to Article 2303.05.

Section 2123. Earth Shoulders for Pavements and Bases

2123.01 DESCRIPTION.

A. Construct or finish earth shoulders. In general, earth shoulder construction for pavements and bases relates to the earthwork above subgrade elevation, adjacent to the sides of pavement or base. It may involve minor or major reshaping and replacement of embankment material.

B. This specification will not apply to Rebuilding Shoulders specified in Article 2213.03, J, or to Shoulders specified in Article 2302.03, F.

2123.02 MATERIALS.

A. For material deposited above an elevation 6 inches (150 mm) below subgrade elevation, use select treatment materials of Article 2102.02, D, 1, if available and coordinated with the Engineer, or suitable soils of Article 2102.02, D, 2. Do not use unsuitable soils of Article 2102.02, D, 3, or topsoils.

B. Select earth for use that is reasonably free of roots, granular material, rocks with dimensions greater than approximately 2 inches (50 mm) in the top 3 inches (75 mm), or other materials which will not form a good seedbed.

2123.03 CONSTRUCTION.

A. General.

1. At elevations more than 6 inches (150 mm) below subgrade elevation, treat material placed during shoulder operations as embankment construction, unless specified otherwise.
2. Never deposit shoulder material on pavement or base.

**B. Constructing Earth Shoulders.**

1. Construct and finish earth shoulders by:
   a. Placing and consolidating suitable materials adjacent to a previously constructed pavement or base, as shown in the contract documents.
   b. Placing, in an acceptable condition, other sections of right-of-way disturbed by operations of the Contractor.

2. Spread the material more than 3 inches (80 mm) below the upper edge of the pavement or base in uniform layers no more than 6 inches (150 mm) in loose thickness. Roll at least three times. The final 3 inch (80 mm) layer need not be rolled except for 1 foot (0.3 m) adjacent to the pavement or base.

3. Where the width of shoulder will permit, use a roller meeting the requirements of Article 2001.05, C, or D. The Engineer may permit use of other rollers or other compactive methods that will produce equivalent results. Where the width of shoulder is less than 6 feet (1.8 m), wheels of pneumatic tired equipment may be used in lieu of the roller. Ensure thorough compaction against and adjacent to the edge of the base or pavement. Wheels of pneumatic tired equipment may be used for this purpose.

4. Where unpaved side roads, drives, or entrances extend through the shoulder area, excavate them, or fill them with earth, to the extent necessary to provide a suitable approach with the design shoulder slope, as directed by the Engineer. When the contract item for shoulders is Earth Shoulder Construction, carry the operations beyond the outside shoulder line for a distance of 1 foot (250 mm) for each 1/2 inch (10 mm) of the depth of pavement plus base (where base is used).

5. If the tool or machine used in finishing the shoulder produces a groove in the earth at the edge of the pavement or base, carefully fill the groove and thoroughly compact.

6. Refer to Articles 1105.12 and 2102.03, L, for restrictions on use of heavy equipment.

7. Commence shouldering operations when the pavement or base has attained the age requirements for opening to the Contractor, unless the Engineer specifically advises to delay starting, pending strength requirements or satisfactory surface conditions. Assign adequate equipment and organization so that the major portion of shouldering work may be completed within 6 working days after the Engineer releases the pavement for shoulder work.

8. The time for opening pavements and bases to the Contractor will be no less than that provided in Division 23. In addition to age requirements, Class A, C, or M Portland cement concrete must show a flexural
strength of 500 psi (3.5 MPa) or more and Class B Portland cement concrete placed after September 15 must show a flexural strength of 400 psi (2.8 MPa) or more.

C. Finishing.

1. After earth shoulders have been compacted, shape to the specified cross section and smooth to a condition acceptable to the Engineer.

2. Smooth and finish earth surfaces which have been constructed under the contract.

3. Restore to an acceptable condition sections of right-of-way that have been disturbed by the operations.

2123.04 METHOD OF MEASUREMENT.

A. Contracts involving shoulder work will contain either items for both excavated material in cubic yards (cubic meters) and earth shoulder finishing, or a single item for earth shoulder construction. Measurement will be as follows:

1. Earth Shoulder Finishing.
   a. Stations (meters) shown in the contract documents along each edge of the pavement.
   b. The Engineer will measure material excavated involved with earthwork finishing and shoulders according to Article 2102.04.
   c. Unless provided otherwise in the contract documents, overhaul will be measured according to Article 2108.04.

2. Earth Shoulder Construction.
   Stations (meters) shown in the contract documents along each edge of the pavement.

B. For shoulders built adjacent to paved, intersecting highways, measurement along the edge of pavement or base will terminate at the point where the intersecting highway shoulder merges with the shoulder of the road under construction. Measurement will then be continued from this merging point along the shoulder line of the intersecting highway and continued to a point where shoulder work under the current contract is terminated. There will be no overlapping or duplication in these measurements.

C. Shoulder work in connection with raised, unpaved medians will be measured and computed on the basis of a single measurement for the length of the median.

D. For work done in conjunction with shoulders adjacent to farm drives, approaches, and unpaved, intersecting roads, additional measurement will not be made for shoulders along the drive, approach, or intersecting road, nor will any deduction be made in the measurement along the edge of pavement or base.
2125.03 Reshaping Ditches

E. Shoulder work in connection with unpaved islands will be considered incidental to island construction and will not be measured for payment.

F. For shoulder work completed in conjunction with paved driveways and entrances, additional measurements will not be made for shoulders built along the drive or entrance unless it is more than 25 feet (8 m) in length. If more than 25 feet (8 m) in length, measurements will be made from edge of pavement to the point of shoulder work termination. The width of drives or entrances along the pavement edge will not be measured for payment. Deductions or additional measurements will not be made for unpaved driveways or entrances.

G. When all or a portion of the work is done under general traffic, measurements or payment will not be made for traffic control, decreased production, or other items directly related to this traffic.

2123.05 BASIS OF PAYMENT.

A. Payment will be as follows:

1. **Earth Shoulder Finishing.**
   a. Payment will be the contract unit price for the following:
      1) Earth Shoulder Finishing: per station (meter).
      2) Excavation: per cubic yard (cubic meter), as provided in Article 2102.05, A, 1.
      3) Overhaul: per station yard (cubic meter per metric station), unless the contract provides otherwise.
   b. Payments are full compensation for all work of building shoulders.

2. **Earth Shoulder Construction.**
   a. Payment will be the contract unit price per station (meter).
   b. Payment is full compensation for all costs including the cost of excavating, hauling, placing, compacting, rebuilding approaches, and finishing work.

B. Payment includes costs associated with work done under traffic.

Section 2125. Reshaping Ditches

2125.01 DESCRIPTION.
Remove excess earth material from side ditches according to the contract documents.

2125.02 MATERIALS.
See Article 2125.03.

2125.03 CONSTRUCTION.

A. Shape side ditches to produce smooth surfaces of the ditch and backslope which will conform to the typical section shown in the contract documents.
B. Use excavated materials to build shoulders or widen embankments, or remove excavated materials from the project as the Engineer directs. Do not deposit shoulder material on finished base or surface courses.

C. Place and compact material used for widening embankments according to Article 2107.03, L. Place, compact, and shape material used for earth shoulders as provided in Section 2123.

2125.04 METHOD OF MEASUREMENT.
Reshaping Ditches, in stations (meters), will be the quantity shown on the contract documents as determined along the bottom of the ditch.

2125.05 BASIS OF PAYMENT.
A. Payment for Reshaping Ditches will be the contract unit price per station (meter).

B. Payment is full compensation for the reshaping ditches, and for removal or placement of the excavated material.

Section 2126. Reclaiming Present Surfacing Material

2126.01 DESCRIPTION.
Scarify, windrow, load, stockpile, rehaul, and deposit granular material found on the present road surface.

2126.02 MATERIALS.
None.

2126.03 CONSTRUCTION.
A. Blade loose surfacing material from the shoulders to the central area of the roadway.

B. Scarify the old road surface to be reclaimed to a width and depth that will yield suitable surfacing material. The Engineer will determine what material is suitable for reclaiming. Pulverize the loosened material to the extent that 100% of the particles will pass a 3 inch (75 mm) sieve.

C. Haul and deposit reclaimed material in stockpiles and spread uniformly over the length of the project, or haul and spread the reclaimed material on specified sections of the project after grading is completed.

D. At the Contractor's option and without extra payment, the Contractor may substitute special backfill material, meeting requirements of Section 4132, for reclaimed surfacing in treatment areas. Obtain the Engineer's approval for scarification and disposition of the surfacing material.

E. Reclaim surfacing material prior to installation of crossroad culvert pipe or grading operations. After surfacing material has been removed, satisfactorily blade and shape the roadway for local traffic.
2126.04 METHOD OF MEASUREMENT.
Measurement for Reclaiming Present Surfacing Material will be in cubic yards (cubic meters) in the transporting vehicle, and according to Article 2312.04, A. If such measurement is impractical, measurement may be made by the Engineer of the stockpile by the cross section method or by other feasible methods.

2126.05 BASIS OF PAYMENT.

A. Payment for Reclaiming Present Surface Material will be the contract unit price per cubic yard (cubic meter).

B. Payment is full compensation for reclaiming present surfacing material, scarifying, blading, loading, hauling, stockpiling, and spreading the reclaimed material as directed by the Engineer. No overhaul will be paid on this material.

Section 2127. Reconstruction of Roadbed

2127.01 DESCRIPTION.

A. Remove the upper portion of an existing roadbed to the depth specified in the contract documents.

B. Store removed material.

C. Recover stored material for reconstruction of roadbed.

2127.02 MATERIALS.
None.

2127.03 CONSTRUCTION.

A. Blading.

1. When indicated in the contract documents, blade road surfacing material into a windrow and reclaim according to the provisions of Section 2126. Store this reclaimed material at locations selected or designated for use as required for later construction. Remove and store the upper portion of existing roadbed (either in excavation or embankment) on the foreslope or at convenient locations adjacent to the work.

2. Lower the roadbed over the entire width from outside edge of shoulder to outside edge of shoulder to the elevation indicated in the contract documents. To the extent possible, place the material removed in this operation in its final location below subgrade elevation and compact as required. Excess material required for later building of shoulders may be stored on the foreslopes or in selected stockpile locations until construction of subgrade, subbase, base, or pavement is completed.
B. **Widening.**

1. Prior to the placement of material for the widening of embankments, remove all vegetation from the existing foreslope, and roughen or step the foreslope. Vegetation removal and foreslope roughening or stepping may be performed:
   - As a complete operation on a given slope, or
   - Just prior to placement of the material for a particular lift as the embankment is brought up.

2. **Widening Less than 4 Feet (1.2 m).**
   If the width of the embankment widening at an attained elevation (measured horizontally between the existing foreslope and the proposed foreslope) is less than 4 feet (1.2 m), the widening material may be placed and shaped without specified compaction.

3. **Widening 4 Feet (1.2 m) or More.**
   a. If the width of the embankment widening is 4 feet (1.2 m) or more, step or bench the existing foreslope:
      - To the extent that the widening material can be placed in lifts of 8 inch (200 mm) loose thickness, and
      - To a width sufficient to permit the operation of placing, leveling, and compaction equipment.
   b. Depending the variance between the rate of slope of existing foreslope and the proposed foreslope, this may require compaction of widening material in the bottom nine or ten lifts of an embankment and not require a specified compaction in the top three or four lifts. Compact the materials used in embankment widening where the width is 4 feet (1.2 m) or more as provided in Article 2107.03, L.

C. When required by the contract documents, return reclaimed road surfacing material to the central portion of the roadbed. Spread the material uniformly over the area to be covered with a base or pavement, plus 1 foot (0.3 m) on each side.

D. When the base course or pavement has been completed, recover the material which has not already been used in required embankment. Use this material to build shoulders, flatten foreslopes, or to place otherwise as directed by the Engineer. If not utilized, remove the material from the project. This material becomes the property of the Contractor.

E. Build and finish earth shoulders as provided in Section 2123. When granular surface shoulder construction is a required part of the work, finish and compact the shoulders to the elevation of the granular surfacing bottom.

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**2127.04 METHOD OF MEASUREMENT.**

A. **Reconstruction of Roadbed.**
   The quantity, in stations (meters), will be shown in the contract documents as determined along the centerline.
B. **Earth Shoulder Construction.**
   Article 2123.04, A, 2, applies.

C. **Reclaiming Present Surfacing Material.**
   Article 2126.04 applies.

### 2127.05 BASIS OF PAYMENT.

A. **Reconstruction of Roadbed.**
   1. Payment will be the contract unit price per station (meter).
   2. Payment is full compensation for excavating, hauling, compacting, and recovering excavated material. This work will not include the cost of reclaimed surfacing material or earth shoulder construction in the area of Reconstruction of Roadbed.

B. **Earth Shoulder Construction.**
   Article 2123.05, B, applies.

C. **Reclaiming Present Surfacing Material.**
   Article 2126.05 applies.

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**Section 2128. Furnish and Apply Granular Shoulder Material**

### 2128.01 DESCRIPTION.

Furnish and apply granular material on the shoulder of an existing road for the purpose of shoulder repair. The quantity and rate will be specified for each site in the contract documents. Furnish the material to the locations shown in the contract documents. The Contracting Authority will prepare the surface, shape the material to the desired cross-section, and compact materials.

### 2128.02 MATERIAL AND EQUIPMENT.

A. Furnish material meeting the requirements of Section 2121 for Type B Granular Shoulders.

B. Use weighing equipment meeting the requirements of Article 2001.07.

C. The contract documents may require the Contractor to use an edge rut spreader that will be furnished by the Contracting Authority. The contract documents may require the Contractor to deposit the material directly into a shouldering machine furnished and operated by the Contracting Authority.

### 2128.03 CONSTRUCTION.

A. **Traffic Control**
   The Contracting Authority will furnish traffic control. All material to be deposited onto a shoulder will be accessible from a closed lane.
B. **Staging of Work**  
Provide the Engineer a minimum of one week notice prior to commencing delivery of materials at a particular site. The hours of delivery, delivery days of the week, delivery requirements, and contact person will be identified in the contract documents. The Contractor will be restricted to a single work site unless otherwise specified in the contract documents.

C. **Placement**  
Spread the material to the width and depth specified in the contract documents. Place granular shoulder material on the subgrade in such manner that no material is deposited on the adjacent pavement surface. If material is inadvertently spilled on the pavement, immediately remove it.

D. **Spreading**  
The Contracting Authority will perform the final spreading of the placed material to the final cross section.

E. **Compaction**  
The Contracting Authority will compact the placed material.

2128.04 **METHOD OF MEASUREMENT.**

A. Measurement for Furnish and Apply Granular Shoulder Material satisfactorily placed will be computed from the weights (mass) of individual truckloads, including moisture in the aggregate at time of delivery.

B. Measurement may be converted from tons to cubic yards (megagrams to cubic meters) or cubic yards to tons (cubic meters to megagrams) with approval of the Engineer. The Engineer will determine the conversion factor.

C. When measurement is by the cubic yard (cubic meter), all loads shall be leveled and corners filled at the loading point. Measurement will be checked at the point of delivery. Deductions will not be made for natural settlement in transit. The tops of end gates on transporting vehicles shall not be lower than the adjacent sides. Weight (mass) measurements shall be taken on the Contractor's weighing equipment according to Article 2001.07. Load vehicles to ensure against loss of material between the scales and the point of delivery. Deduction will not be made for the weight (mass) of moisture naturally occurring in the material.

2128.05 **BASIS OF PAYMENT.**

A. Payment for Furnish and Apply Granular Shoulder Material will be the contract unit price per cubic yard or ton (cubic meter or megagram).

B. Payment is full compensation for:
   - Furnishing, transporting, and depositing the material on the shoulder according to the contract documents,
   - Furnishing all equipment, labor, and materials, and
   - Performance of all work necessary to complete the work.