SECTION 501
EXCAVATION AND BACKFILL FOR STRUCTURES

501.01. DESCRIPTION.

(a) **General.** Excavation consists of the removal of all material, of whatever nature, necessary for the construction of bridges, retaining walls, and other major structures as specified in the contract documents. This work also includes the disposal of excess excavated material.

If not otherwise provided for in the contract documents, excavation work shall include the furnishing of all necessary equipment and the construction of and subsequent removal of all cofferdams, shoring, and water control systems which may be necessary for the execution of the work. If the contract does not include a separate pay item, or items, for such work, excavation work shall include all necessary clearing and grubbing and the removal of existing structures within the area to be excavated.

Backfill consists of placing of all necessary backfill material including any necessary stockpiling of excavated material which is to be used in the backfill and the disposing of excess excavated material which is not required for use in the project, if not otherwise specified in the contract documents.

Excavation and backfill shall be done in reasonably close conformity with the lines, grades and typical cross sections shown on the contract drawings or established by the Engineer.
Comply with all environmental regulations including the requirements of the United States Army Corp of Engineers 404 Permit when applicable.

(b) **Classification.** Excavation and backfill for structures will be classified as follows:

1. *Unclassified Excavation.* Unclassified Excavation, as provided in Section 202, consists of the removal of all material, of whatever nature, for the construction of box culverts, channels, ditches at culvert inlets and outlets, and any other ditches as shown on the contract drawings or directed by the Engineer.
2. *Structural Excavation, Unclassified.* Structural Excavation, Unclassified consists of the removal of all material, of whatever nature, below the level of Unclassified Excavation for the construction of box culverts, at the specified locations and elevations.
3. *Substructure Excavation, Common.* Substructure Excavation, Common consists of the removal of all materials for the construction of substructures, piers and abutments, except those classified as substructure excavation, rock.
4. *Substructure Excavation, Rock.* Substructure excavation, Rock consists of the removal of solid rock, redbed, shale, slate, or other hard material that cannot be excavated without first being loosened or broken by blasting, sledging or drilling for the construction of substructures, piers and abutments. Rock ledges encountered above the foundation material and, boulders or pieces of concrete having a volume of 0.5 cubic yards (0.5 cubic meter) or more, will be classified under this item.

The amount of substructure excavation, rock will be determined by the Engineer and agreed to by the Contractor while the excavation is open for inspection. Claims for additional

quantities under this classification over the amount determined during the progress of the work will not be recognized.

5. *Unclassified Backfill, Select Backfill, and Granular Backfill.* Unclassified Backfill, Select Backfill, Granular Backfill consists of supplying, placing, and compacting unclassified borrow, select borrow, granular backfill material, respectively, according to the requirements of Section 202, these specifications, and the contract documents.
6. *Controlled Low-Strength Material (CLSM) Backfill.* CLSM Backfill consists of supplying and placing of controlled low strength material in excavations or other confined or formed spaces.

(c) **Obstructions.** The removal and disposal of buried natural or man-made objects are to be included in the class of excavation in which they are located, unless specifically included in other items of work. The removal and disposal of man-made objects will be paid for as extra work and its volume not included in the measured quantity of excavation if:

- the removal of the man-made object requires the use of methods or equipment not used for other excavation on the project, and
- its presence was not indicated in the contract drawings, and
- its presence could not have been ascertained by site investigation, including contact with identified utilities within the area, and
- the Contractor so requests in writing before its removal.

501.02. MATERIALS.

(a) **Backfill - General Requirements.** Materials used for backfill shall be free of frozen lumps or other degradable or hazardous matter, and shall have a gradation such that the required compaction can be consistently obtained using the compaction methods selected.

Unclassified backfill shall comply with the requirements for Unclassified Borrow as specified in Section 202. Select backfill shall comply with the requirements for Select Borrow as specified in Section 705. Granular backfill shall comply with Subsection 703.05. Granular backfill for MSE walls shall comply with Section 510.

(b) **Controlled Low-Strength Material (CLSM).**

1. *General.* Make CLSM from materials conforming to the following sections and subsections.

Portland Cement	701.02
Fly Ash	702
Fine Aggregate	701.05
Water	701.04
Air Entraining Agent (optional)	701.03

2. *Mix Design.* Use the sample mix proportions given in Table 501-1 as a guide to proportioning CLSM. Adjust the mix design to account for differences in specific gravities and bleeding rate, and to comply with the testing requirements. Use the absolute volume method to design the mix.

Table 501-1
Sample CLSM Mix Design

Ingredient	Pounds per Cubic Yard	(Kilograms per Cubic Meter)
Cement	20-50	12-30
Fly Ash	150-250	90-150
Sand (saturated-surface-dry condition)	2800-3000	1700-1800
Water	200-500	120-300

Submit for approval the proposed mix design with trial batch testing data before use. Include the weight, specific gravity, material source and other material requirements for each ingredient, and the results of the flowability, unit weight, and strength tests from the trial batch. Use the methods described in Subsection 501.02(b) 3. Previously used and successful mix designs may be submitted without retesting if the material sources have not changed.

If bleed water does not appear on the surface immediately after the CLSM levels off, replace 50 lb/C.Y. (30 kg/cubic meter) approximately 60 lb/C.Y. (35 kg/cubic meter)t replacement rate depends upon the actual specific gravities of the fly ash and sand.) Continue this process incrementally until the mixture bleeds freely.

3. *Sampling and Testing.* Provide ample CLSM for field testing. The testing methods are as follows:

3.1 *Flow Test.* Flow tests shall be conducted in accordance with ASTM D 6103, "Standard Test Method for Flow Consistency of Controlled Low Strength Material." To be acceptable, the diameter of the CLSM spread must equal or exceed 8 inches (200mm).

3.2 *Unit weight.* Unit weight tests shall be conducted in accordance with ASTM D 6023, "Standard Test Method for Unit Weight, Yield, Cement Content, and Air Content (Gravimetric) of Controlled Low Strength Material." A deviation of 5% in measured unit weight from the approved mix design value will be cause for rejection of a CLSM batch.

3.3 *Strength Test.* Compressive strength tests shall be conducted in accordance with ASTM D 4832, " Standard Test Method for Preparation and Testing of Controlled Low Strength Material." Strength shall be measured at 28 days. The Contractor may test CLSM strength earlier than 28 days to confirm the material placed has reached the minimum required strength. Report all cylinder breaks. To be acceptable, the compressive strength must be more than 100 psi (700kPa) and less than 1200 psi (8000kPa). If 28 day strengths exceed 1200 psi (8000kPa), adjust the mix design to reduce strength.

501.04. CONSTRUCTION METHODS.

(a) **Excavation.**

1. *Depth of Footings.* Consider planned elevations for the bottom of footings to be approximate. The Engineer may order in writing changes in dimensions or elevations of footings as may be necessary to secure a satisfactory foundation. Boring logs shown on the Plans were made

for the purpose of designing the foundation. Interpret and confirm the boring information for construction as needed.

2. *Foundation Preparation and Control of Water.*

2.1 *General.* Construct all substructures, where practical, in open excavation and, where necessary, shore, brace, or protect by cofferdams, the excavation in accordance with the requirements of Subsection 502.04(d).

When footings can be placed in the dry without the use of cofferdams, backforms may be omitted with the approval of the Engineer, and the entire excavation filled with concrete to the required elevation of the top of the footing. The additional concrete required shall be furnished and placed at the expense of the Contractor. Construct temporary water control systems according to Subsection 502.04(e).

Make excavations adjacent to abutments, wings, and retaining walls vertical or broken by "stepping" before backfilling.

Remove existing structures as shown on the contract drawings according to Subsection 619.04(b).

2.2 *Excavation within Channels.* Clear the right-of-way according to Section 201 for the full length of the bridge unless otherwise specified.

Keep creek and river banks in their natural state as much as possible. Do not excavate or cut banks up or downstream except as specified or directed. Submit proposed work road location for approval. Construct work roads in approved locations only. Restore all bank cuts and work roads to their original shape, density and condition in an approved manner.

Obtain approval before excavating or dredging outside of caissons, cribs, cofferdams, steel piling or sheeting, and before disturbing the natural stream bed adjacent to the structure. Backfill and compact excavation outside these structures according to Subsection 501.04(b) to the original ground surface without extra charge. Remove excess excavated material within the stream area, and restore the stream area to its natural condition.

2.3 *Foundations on Rock.* Excavate solid rock or other hard foundation material to the depth shown on the Plans or as directed. Remove all loose and disintegrated material from the excavation. Make the final surface entirely level or in level steps as shown on the contract drawings, or as directed. Do not disturb solid rock outside the neat lines of the footing. Clean out all seams and fill with concrete or CLSM before the footing is placed.

Where blasting is required to reach footing level, remove and replace any loose, fractured rock caused by overbreak below the bearing level with concrete at no additional cost to the Department.

2.4 *Foundations not on Rock.* When a foundation is to rest on an excavated surface other than rock, take special care not to disturb the bottom of the excavation. Do not make the final removal of foundation material to grade until just before the footing is to be placed.

Where the material below the bottom of the footings not supported by piles has been disturbed, remove the disturbed material and fill the entire disturbed volume with concrete or CLSM at no additional cost to the Department. Under footings supported on piles, replace and compact disturbed volumes as directed.

For box culvert excavation, remove poor foundation material below the normal designed elevation as directed. Replace material removed below designed elevation with approved bedding material. Open outlets for the effective width of the structure before constructing footings of box culverts.

2.5 *Approval of Foundation.* After each excavation is completed, notify the Engineer that the excavation is ready for inspection and evaluation, and, after the Engineer has approved the depth of the excavation and the character of the foundation material, place the footing concrete. Do not place concrete through water unless approved by the Engineer.

(b) **Backfilling.**

1. *General.* Place and compact backfill and embankment according to Section 202, except as modified in this subsection. If sufficient material of suitable quality is not available from excavation within the project limits, import such material as directed. Supply the type of backfill materials specified.

Unless otherwise specified in the contract documents, refill all spaces excavated and not occupied by abutments, piers, or other permanent work, with earth up to the surface of the surrounding ground, allowing for settlement. Except as otherwise provided, thoroughly compact all backfill to the density of the surrounding ground, and neatly grade its top surface. Deposit fill around piers on both sides to approximately the same elevation at the same time. Do not place rocks larger than 3 inches (75mm), maximum dimension, against concrete surfaces.

Place fill for retaining walls, abutments, wingwalls, and bridge bents in well-compacted layers not exceeding 6 inches (150 mm) in thickness and bring up uniformly on all sides of the structure or facility. Place fill behind abutments to subgrade elevation. Compact backfill within or beneath embankments, within roadways in excavated areas, or in front of abutments and retaining walls or wingwalls, to the same density required for the embankments. Unless otherwise specified in the Plans or Special Provisions, compact fill in embankments to not less than 95% of Standard Density in accordance with AASHTO T-99.

Allow concrete in structures against which backfill is to be placed, to mature according the requirements of Subsection 509.04(i)2, *"Earth Loads."*

To prevent the possibility of forward movement, place the backfill in front of abutments and wingwall before placing backfill behind these structures. Do not jet the backfill behind abutments or wingwalls. Operate rollers, vibrators, or other approved compactors parallel to the outside lines of barrels and wing walls of cross drains. Compact areas inaccessible to rolling equipment with mechanical tampers.

2. *Placing CLSM.* Discharge CLSM into the work after the completion the required testing and acceptance of the material. Bring up the fill material uniformly to the elevation specified in

the contract documents. Placing of material over CLSM may commence as soon as the surface water is gone or as directed.

3. *Disposal of Surplus.* Clean up areas affected by the construction according to Subsection 104.10. Do not place excess material in the stream bed. Remove obstructions that may collect drift, induce scour, or endanger the work as directed. Dispose of excavated and removed materials not used in the project. (These unused, waste materials will be the property of the Contractor.)

501.05. METHOD OF MEASUREMENT.

(a) **General.** Excavation for structures will be measured by volume in units of cubic yards (cubic meter). The volume will be computed based upon the material actually removed from its original position within the limits specified below, or as shown on the contract drawings. Additional volume caused by slips, slides, cave-ins, silting or filling due to the action of the elements or carelessness will not be measured for payment. Water will not be classified as excavated material. The disposal of excess material will not be measured and paid for separately, but will be considered incidental to the various classes of excavation and removal. Additional concrete required to fill any excavation outside the neat lines shown on the contract drawings will not be measured for payment.

Backfill for structures will be measured as specified in Subsection 501.05(f).

(b) **Excavation for Box Culverts.**

1. *Unclassified Excavation.* For concrete boxes, the difference in elevation between the existing ground surface and the design flow line will be used to measure excavation depth. Unless otherwise specified, the base width of the excavation will be 8 feet (2.4m) wider (4 feet (1.2m) on each side) than the outside limits of the barrel of the structure. Side slopes will be 2:1 from the design flow line to the existing ground line. The length of the channel excavation will be measured along the center line to a point on the imaginary line connecting the outer ends of the wingwalls plus 15 feet (5m), to a similar point at the other end of the box. The volume of excavation as specified will be computed on a theoretical basis and will be paid for as unclassified excavation in accordance with Section 202. Except as otherwise directed, do not excavate the channel below the flow line elevation outside the neat lines of the concrete base.

2. *Structural Excavation, Unclassified.* Excavation for the base slab will be measured for payment as structural excavation, unclassified. The volume will be computed on a theoretical basis with the height and width dimension to the neat lines of the base slab of the box shown on the contract drawings. The length will be measured along the centerline to a point on the imaginary line connecting the outer ends of the wingwalls to a similar point at the other end of the box. Additional measurement and payment outside the theoretical dimensions defined above will not be made for curtain walls, wingwall footings, and aprons. Sheeting and shoring or extra excavation beyond the limits defined above will be considered as Contractor convenience and will not be measured for payment.

Soft and yielding material encountered at the bottom of the footing of boxes shall be removed and replaced with stable bedding material as directed. The materials removed and

replaced will be paid for as structural excavation, unclassified based upon double the volume of soft and yielding material removed.

(c) **Excavation for Substructures Supported on Piling.** Excavation for substructures, piers and abutments, supported on piling will be measured as Substructure Excavation, Common. The excavation volume for each substructure will be bounded by the existing ground surface, the bottom of the footing, and vertical planes 3 feet (1m) outside the neat lines of the footing for the entire depth of the excavation. The existing ground surface will be the bottom of channel excavation when channel excavation is specified in the contract documents or directed by the Engineer.

(d) **Excavation for Substructures Supported on Natural Foundation Materials.** Excavation for substructures, piers and abutments, supported on natural foundation materials will be measured as either Substructure Excavation, Common or Substructure Excavation, Rock. The excavation volumes will be computed as described above in Subsection 501.05(c), except the quantity below the top of the approved foundation material, will be computed within the neat lines of footings as shown on the contract drawings or as directed by the Engineer. Measurement of abutment excavation volumes will be based on contract drawings quantities.

(e) **Excavation for Bracing.** Excavation necessary to place sway bracing, sash bracing and bulkheads on timber substructures will not be paid for as a separate item, but will be included in the price bid for such construction items.

(f) **Backfilling.** Backfill for each type of specified backfill material, will be measured by volume within the neat lines shown on the contract drawings or as directed by the Engineer.

501.06. BASIS OF PAYMENT.

The accepted quantities of excavation measured as provided above, shall be paid for at the contract unit price for:

(A) STRUCTURAL EXCAVATION, UNCLASSIFIED CUBIC YARD (CUBIC METER)
(B) SUBSTRUCTURE EXCAVATION, COMMON ..... CUBIC YARD (CUBIC METER)
(C) SUBSTRUCTURE EXCAVATION, ROCK ..... CUBIC YARD (CUBIC METER)

which will be full compensation for the respective work prescribed in this Section. Backfilling to existing ground line around structures will not be paid for as a separate item, but will be included in the cost of excavation for the various types of structures.

Accepted quantities of backfill, measured as provided above, shall be paid for at the contract unit price for:

(D) UNCLASSIFIED BACKFILL ..... CUBIC YARD (CUBIC METER)
(E) SELECT BACKFILL ..... CUBIC YARD (CUBIC METER)
(F) GRANULAR BACKFILL ..... CUBIC YARD (CUBIC METER)
(G) CLSM BACKFILL ..... CUBIC YARD (CUBIC METER)

which will be full compensation for the respective work prescribed in this Section.