

Hellroaring Creek Fish Passage Project

Bid Schedule and Specifications

for

Bonner Soil Conservation District

in cooperation with

AVISTA Corporation
US Fish and Wildlife Service
Idaho Office of Species Conservation
Bonner County



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Natural Resources Conservation Service
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Hellroaring Creek Fish Passage Project
 Bonner Soil Conservation District

Bid Schedule

Item Number	Item	Specification	Amount	Units	Unit Cost	Total
1	Mobilization and Demobilization	08		1 Job	_____	_____
2	Pollution Control	05		1 Job	_____	_____
3	Removal of Water	11		1 Job	_____	_____
4	Traffic Control	09		1 Job	_____	_____
5	Structure Removal	03		1 Job	_____	_____
6	Culvert Replacement	51, 31, 23		1 Job	_____	_____
7	Channel Excavation	21		480 CY	_____	_____
8	Rock Structures	61		220 CY	_____	_____
Total						=====

Firm Name: _____

Completed By: _____

Date: _____

BONNER SOIL CONSERVATION DISTRICT

Specifications for Hellroaring Creek Fish Passage Project

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Construction Specification 3—Structure Removal

1. Scope

The work shall consist of the removal, salvage, and disposal of structures (including fences) from the designated areas.

2. Marking

Method 1—Each structure or structure part to be removed will be marked with stakes, flags, paint, or other suitable method.

Method 2—The area boundaries from which structures must be removed will be marked using stakes, flags, paint, or other suitable method. Structures to remain undisturbed or to be salvaged will be designated by special markings.

3. Removal

Method 1—All structures designated for removal in the contract shall be removed to the specified extent and depth.

Method 2—Within the areas so marked, all visible and buried structures identified shall be removed to the specified extent and depth.

4. Salvage

Structures or structure parts that are designated to be salvaged shall be carefully removed and neatly placed in the specified or approved storage location. Salvaged structures that are capable of being disassembled shall be dismantled into individual members or sections. Such structures shall be neatly and systematically match marked with paint before disassembly. All connectors and other parts shall be marked to indicate their proper location within the structure and shall be fastened to the appropriate structural member or packed in suitable containers.

Material from fences designated to be salvaged shall be placed outside the work area on the property on which the fence was originally located. Fence wire shall be rolled into uniform rolls of suitable size and neatly piled with other salvaged materials. Posts and rails shall be neatly stacked.

5. Disposal of refuse materials

Refuse materials resulting from structure removal shall be disposed of in a manner and at locations specified in section 7 of this specification or in an acceptable manner and at locations approved by the contracting officer. Disposal by burning shall be in accordance with local rules and regulations.

6. Measurement and payment

Method 1—For items of work for which specific unit prices are established by the contract, payment for the removal of each structure unit, except fences, is made at the contract unit price. Fences removed or removed and salvaged are measured to the nearest linear foot. Payment for fence removal or removal and salvage is made at the contract unit prices for each type and size of fence.

Such payment will constitute full compensation for all labor, equipment, tools, applicable permits and associated fees for burning and disposal of refuse, and all other items necessary and incidental to the completion of the work.

Method 2—For items of work for which specific lump sum prices are established by the contract, payment for structure removal is made at the contract lump sum price.

Such payment will constitute full compensation for all labor, equipment, tools, applicable permits and associated fees for burning and disposal of refuse, and all other items necessary and incidental to the completion of the work.

All Methods—The following provisions apply to all methods of measurement and payment. Compensation for any item of work described in the contract, but not listed as a contract line item number in the bid schedule, is included in the payment for the item of work to which it is made subsidiary. Such items and items to which they are made subsidiary are identified in section 7 of this specification.

7. ITEMS OF WORK AND CONSTRUCTION DETAILS

Items of work to be performed in conformance with this specification and the construction details are:

a. Bid Item #5, Structure Removal

- (1) This item shall consist removing the concrete weir, pieces of concrete in the channel, the existing culvert, and the existing headwalls.
- (2) Under Section 2, Marking, Method 1 will be used.
- (3) Under Section 3, Removal, Method 1 will be used.
- (4) Under Section 5, Disposal, disposal will be at a site of the contractor's selection. No burial onsite will be allowed. Disposal site will meet all applicable local, State and federal laws.
- (5) Under Section 6, Measurement and Payment, Method 2 will be used. Payment will be at a lump sum.

Construction Specification 5—Pollution Control

1. Scope

The work consists of installing measures or performing work to control erosion and minimize the production of sediment and other pollutants to water and air from construction activities.

2. Material

All material furnished shall meet the requirements of the material specifications listed in section 8 of this specification.

3. Erosion and sediment control measures and works

The measures and works shall include, but are not limited to, the following:

Staging of earthwork activities—The excavation and moving of soil materials shall be scheduled to minimize the size of areas disturbed and unprotected from erosion for the shortest reasonable time.

Seeding—Seeding to protect disturbed areas shall occur as soon as reasonably possible following completion of that earthwork activity.

Mulching—Mulching to provide temporary protection of the soil surface from erosion.

Diversions—Diversions to divert water from work areas and to collect water from work areas for treatment and safe disposition. They are temporary and shall be removed and the area restored to its near original condition when the diversions are no longer required or when permanent measures are installed.

Stream crossings—Culverts or bridges where equipment must cross streams. They are temporary and shall be removed and the area restored to its near original condition when the crossings are no longer required or when permanent measures are installed.

Sediment basins—Sediment basins collect, settle, and eliminate sediment from eroding areas from impacting properties and streams below the construction site(s). These basins are temporary and shall be removed and the area restored to its original condition when they are no longer required or when permanent measures are installed.

Sediment filters—Straw bale filters or geotextile sediment fences trap sediment from areas of limited runoff. Sediment filters shall be properly anchored to prevent erosion under or around them. These filters are temporary and shall be removed and the area restored to its original condition when they are no longer required or when permanent measures are installed.

Waterways—Waterways for the safe disposal of runoff from fields, diversions, and other structures or measures. These works are temporary and shall be removed and the area restored to its original condition when they are no longer required or when permanent measures are installed.

Other—Additional protection measures as specified in section 8 of this specification or required by Federal, State, or local government.

4. Chemical pollution

The contractor shall provide watertight tanks or barrels or construct a sump sealed with plastic sheets to dispose of chemical pollutants, such as drained lubricating or transmission fluids, grease, soaps, concrete mixer washwater, or asphalt, produced as a by-product of the construction activities. At the completion of the construction work, sumps shall be removed and the area restored to its original condition as specified in section 8 of this specification. Sump removal shall be conducted without causing pollution.

Sanitary facilities, such as chemical toilets, or septic tanks shall not be located next to live streams, wells, or springs. They shall be located at a distance sufficient to prevent contamination of any water source. At the completion of construction activities, facilities shall be disposed of without causing pollution as specified in section 8 of this specification.

5. Air pollution

The burning of brush or slash and the disposal of other materials shall adhere to state and local regulations.

Fire prevention measures shall be taken to prevent the start or spreading of wildfires that may result from project activities. Firebreaks or guards shall be constructed and maintained at locations shown on the drawings.

All public access or haul roads used by the contractor during construction of the project shall be sprinkled or otherwise treated to fully suppress dust. All dust control methods shall ensure safe construction operations at all times. If chemical dust suppressants are applied, the material shall be a commercially available product specifically designed for dust suppression and the application shall follow manufacturer's requirements and recommendations. A copy of the product data sheet and manufacturer's recommended application procedures shall be provided to the engineer 5 working days before the first application.

6. Maintenance, removal, and restoration

All pollution control measures and temporary works shall be adequately maintained in a functional condition for the duration of the construction period. All temporary measures shall be removed and the site restored to near original condition.

7. Measurement and payment

Method 1—For items of work for which specific unit prices are established in the contract, each item is measured to the nearest unit applicable. Payment for each item is made at the contract unit price for that item. For water or chemical suppressant items used for dust control for which items of work are established in section 8 of this specification, measurement for payment will not include water or chemical suppressants that are used inappropriately or excessive to need. Such payment will constitute full compensation for the completion of the work.

Method 2—For items of work for which lump sum prices are established in the contract, payment is made as the work proceeds and supported by invoices presented by the contractor that reflect actual costs. If the total of all progress payments is less than the lump sum contract price for this item, the balance remaining for this item will be included in the final contract payment. Payment of the lump sum contract price will constitute full compensation for completion of the work.

Method 3—For items of work for which lump sum prices are established in the contract, payment will be prorated and provided in equal amounts on each monthly progress payment estimate. The

number of months used for prorating shall be the number estimated to complete the work as outlined in the contractor's approved construction schedule. The final month's prorate amount will be provided with the final contract payment. Payment as described will constitute full compensation for completion of the work.

All Methods—The following provisions apply to all methods of measurement and payment. Compensation for any item of work described in the contract, but not listed in the bid schedule is included in the payment for the item of work to which it is made subsidiary. Such items, and the items to which they are made subsidiary, are identified in section 8 of this specification.

8. ITEMS OF WORK AND CONSTRUCTION DETAILS

Items of work to be performed in conformance with this specification and the construction details are:

a. Bid Item #2, Pollution Control

- (1) This item shall consist of installing measures or performing work to control erosion, and minimize delivery of sediment and other pollutants to the stream channel. All requirements and stipulations for pollution control indicated on the State and/or Federal fill and removal permit shall be strictly adhered to.
- (2) The contractor shall develop a Stormwater Pollution Prevention plan, and file a notice of intent with EPA at the web site:
http://www.epa.gov/Region8/water/stormwater/downloads/sw_cgp_brochure.pdf The designers do not anticipate any exceptional pollution control measures will be necessary.
- (3) In Section 7, Measurement and Payment, Method 2 will apply. Payment will be in a lump sum.

Construction Specification 8—Mobilization and Demobilization

1. Scope

The work consists of the mobilization and demobilization of the contractor's forces and equipment necessary for performing the work required under the contract. It does not include mobilization and demobilization for specific items of work for which payment is provided elsewhere in the contract. Mobilization will not be considered as work in fulfilling the contract requirements for commencement of work.

2. Equipment and material

Mobilization shall include all activities and associated costs for transportation of contractor's personnel, equipment, and operating supplies to the site; establishment of offices, buildings, and other necessary general facilities for the contractor's operations at the site; premiums paid for performance and payment bonds including coinsurance and reinsurance agreements as applicable; and other items specified in section 4 of this specification.

Demobilization shall include all activities and costs for transportation of personnel, equipment, and supplies not required or included in the contract from the site; including the disassembly, removal, and site cleanup of offices, buildings, and other facilities assembled on the site specifically for this contract.

This work includes mobilization and demobilization required by the contract at the time of award. If additional mobilization and demobilization activities and costs are required during the performance of the contract as a result of changed, deleted, or added items of work for which the contractor is entitled to an adjustment in contract price, compensation for such costs will be included in the price adjustment for the item or items of work changed or added.

3. Payment

Payment will be made as the work proceeds, after presentation of paid invoices or documentation of direct costs by the contractor showing specific mobilization and demobilization costs and supporting evidence of the charges of suppliers, subcontractors, and others. When the total of such payments is less than the lump sum contract price, the balance remaining will be included in the final contract payment. Payment of the lump sum contract price for mobilization and demobilization will constitute full compensation for completion of the work.

Payment will not be made under this item for the purchase costs of materials having a residual value, the purchase costs of materials to be incorporated in the project, or the purchase costs of operating supplies.

4. ITEMS OF WORK AND CONSTRUCTION DETAILS

Items of work to be performed in conformance with the specification and construction details are:

a. Bid Item #1, Mobilization and Demobilization

- (1) This Item shall consist of mobilization and demobilization of the contractor's forces and equipment necessary for performing the work.
- (2) All temporary access roads will be obliterated after construction is complete. All construction debris will be removed.

Construction Specification 9—Traffic Control

1. Scope

The work shall consist of establishing traffic control and maintaining safe, convenient use of public roads and rights-of-way.

2. Traffic and access

The contractor's operations shall cause no unnecessary inconvenience to the public. The public rights-of-way shall be maintained at all times unless interruption is authorized by proper local authority. Contractor's authorized closing or detour plans shall be provided to the engineer for approval.

Safe and adequate access shall be provided and maintained to all public protection devices and to all critical utility control locations. Facility access shall be continuous and unobstructed unless otherwise approved.

3. Storage of equipment and material in public streets

Construction materials and equipment shall not be stored or parked on public streets, roads, or highways. During any material or equipment loading or unloading activities that may temporarily interfere with traffic, an acceptable detour shall be provided for the duration of the activity. Any associated expense for this activity is the responsibility of the contractor.

Excavated material, including suitable material that is intended for adjacent trench backfill or other earth backfill as specified in section 5 of this specification, shall not be stored on public streets, roads, or highways that remain in service for the public. Any waiver of this requirement must be obtained from the proper local authority and approved by the engineer. All excess and unsuitable material shall be removed from the site as soon as possible. Any spillage shall be removed from roadways before they are used by the public.

4. Street closures, detours, and barricades

The contractor shall comply with the requirements of all applicable responsible units of government for closure of any street, road, or highway. The contractor shall provide the required barriers, guards, lights, signs, temporary bridges, and flaggers together with informing the public of any detours and construction hazards by the most suitable means available, such as local newspapers or radio stations. The contractor is also responsible for compliance with additional public safety requirements that may arise during construction. The contractor shall furnish, install, and, upon completion of the work, promptly remove all signs, warning devices, and other materials used in the performance of this work.

Unless otherwise specified, the contractor shall notify, in writing, the fire chief, police chief, county sheriff, state patrol, schools that operate school buses, or any other government official as may be appropriate no less than 7 days before closing, partly closing, or reopening any street, road, or highway.

Unless otherwise specified, the contractor shall furnish to the engineer a written plan showing the proposed method of signing, barricading for traffic control, and safety for street detours and closures.

All temporary detours will be maintained to ensure use of public rights-of-way is provided in a safe manner. This may include dust control, grading, and graveling as required in section 7 of this specification.

5. General and specific references

All signs, signals, barricades, use of flaggers, and other traffic control and public safety devices shall conform to the general requirements set forth in the Manual of Uniform Traffic Control Devices (MUTCD) and the latest edition of *Standard Highway Signs and Standard Alphabets for Highway Signs* and/or OSHA *Construction Industry Standards (29 CFR Part 1926), Subpart G, Signs, Signals, and Barricades* unless otherwise specified in section 7 of this specification.

6. Measurement and payment

For items of work for which specific lump sum prices are established in the contract, payment for the work is made at the contract lump sum price. Progress payments will be made based upon the percentage of estimated total time that traffic control will be required unless otherwise specified in section 7 of this specification. Payment will constitute full compensation for all flaggers, labor, materials, equipment, and all other items necessary and incidental to completion of the work.

Compensation for any item of work described in the contract, but not listed in the bid schedule will be included in the payment for the item of work to which it is made subsidiary. Such items and items to which they are made subsidiary are identified in section 7 of this specification.

7. ITEMS OF WORK AND CONSTRUCTION DETAILS

Items of work to be performed in conformance with this specification and the construction details are:

a. Bid Item #4, Traffic Control

- (1) This item shall consist of maintaining continuous single lane traffic access around the construction site for the entirety of the project. A bypass road will be constructed around the existing culvert while it is replaced.
- (2) Under Section 4 and 5, regarding signage. Bonner County will provide all required signage.

Construction Specification 11—Removal of Water

1. Scope

The work consists of the removal of surface water and ground water as necessary to perform the construction required by the contract in accordance with the specifications. It shall include: (1) constructing, installing, building, and maintaining all necessary temporary water containment facilities, channels, and diversions; (2) furnishing, installing, and operating all necessary pumps, piping, and other facilities and equipment; and (3) removing all such temporary works and equipment after their intended function is no longer required.

2. Diverting surface water

The contractor shall install, maintain, and operate all cofferdams, channels, flumes, sumps, and all other temporary diversion and protective works needed to divert streamflow and other surface water through or around the construction site. Control of surface water shall be continuous during the period that damage to construction work could occur. Unless otherwise specified and/or approved, the diversion outlet shall be into the same drainageway that the water would have reached before being diverted.

The contractor shall furnish the contracting officer, in writing, a proposed plan for diverting surface water before beginning any construction activities for which a diversion is required, unless waived in section 8 of this specification. Acceptance of this plan or the waiving of the plan requirement will not relieve the contractor of the responsibilities related to this activity during the process of completing the work as specified.

3. Dewatering the construction site

Foundations, cutoff trenches, and all other parts of the construction site shall be dewatered and kept free of standing water and muddy conditions as necessary for the proper execution of the work. The contractor shall furnish, install, operate, and maintain all drains, sumps, pumps, casings, well points, and all other equipment required to properly dewater the site as specified. Dewatering systems that cause a loss of soil fines from the foundation areas will not be permitted.

The contractor shall furnish the contracting officer, in writing, a proposed plan for dewatering before commencing with any construction activity for which dewatering may be required, unless waived in section 8 of this specification. Acceptance of this plan or the waiving of the plan requirement will not relieve the contractor of the responsibilities for completing the specified work.

4. Dewatering borrow areas

The contractor shall maintain all borrow areas free of surface water or otherwise provide for timely and effective removal of surface and subsurface water that accumulates within the borrow area, unless waived in section 8 of this specification. Borrow material shall be processed as necessary to achieve proper and uniform moisture content at the time of placement.

If pumping to dewater borrow areas is included as a bid item of work in the bid schedule, each pump discharge pipe shall be equipped with a water meter. The meter shall be such that the measured quantity of water is accurate within 3 percent of the true quantity. The contractor shall provide necessary support to perform accuracy tests of the water meter when requested by the

contracting officer.

5. Erosion and pollution control

Removal of water from the construction site, including the borrow areas, shall be accomplished so that erosion and the transporting of sediment and other pollutants are minimized. Dewatering activities shall be accomplished in a manner that the water table water quality is not altered. Pollution control activities shall not conflict with the requirements of Construction Specification 5, Pollution Control, if it is a part of this contract.

6. Removal of temporary works

When temporary works are no longer needed, the contractor shall remove and return the area to a condition similar to that which existed before construction. Areas where temporary works were located shall be graded for slight appearance with no obstruction to natural surface waterflows or the proper functioning and access to the works of improvement installed. The contractor shall exercise extreme care during the removal stages to minimize the loss of soil sediment and debris that was trapped during construction.

Pipes, casings, and any other material used to dewater the site shall be removed from temporary wells. The wells shall be filled to ground level with clean gravel or other suitable material approved by the contracting officer. The contractor shall exercise extreme care to prevent pollution of the ground water by these actions.

7. Measurement and payment

Method 1—Items of work listed in the bid schedule for removal of water, diverting surface water, and dewatering construction sites and borrow areas are paid for at the contract lump sum prices. Such payment will constitute full compensation for all labor, equipment, tools, and all other items necessary and incidental to the completion of the work.

Method 2—Items of work listed in the bid schedule for removal of water, diverting surface water, dewatering construction sites, and dewatering borrow areas are paid for at the contract lump sum prices. Such payment will constitute full compensation for furnishing, installing, operating, and maintaining the necessary trenches, drains, sumps, pumps, and piping and for all labor, equipment, tools, and all other items necessary and incidental to the completion of the work. The exception is that additional payment for pumping to dewater borrow areas and the removal of water will be made as described in the following paragraph.

If pumping to dewater borrow areas is a contract bid item, payment is made at the contract unit price, which shall be the price per 1,000 gallons shown in the bid schedule. Such payment will constitute full compensation for pumping only. Compensation for equipment and preparation and for other costs associated with pumping is included in the lump sum payment for removal of water or the lump sum payment for dewatering the borrow areas. Payment is made only for pumping that is necessary to dewater borrow areas that cannot be effectively drained by gravity or that must have the water table lowered to be usable as a suitable borrow source. Pumping for other purposes will not be included for payment under this item.

All Methods—The following provisions apply to all methods of measurement and payment. Compensation for any item of work described in the contract, but not listed in the bid schedule is included in the payment for the contract line item to which it is made subsidiary. Such items and the items to which they are made subsidiary are identified in section 8 of this specification.

8. ITEMS OF WORK AND CONSTRUCTION DETAILS

Items of work to be performed in conformance with the specification and construction details are:

a. Bid Item #3, Removal of Water

- (1) This item shall consist of dewatering and diverting surface water from the construction area to the extent that construction operations can be performed under stable conditions and a professional product can be obtained.
- (2) Diversion of surface water shall be accomplished using an 18" pipe and ditch as shown on the plans. Pipe will be property of the contractor at the completion of the contract.
- (3) Diversion of surface water shall be in the sequence prescribed by the engineer in consultation with US Fish and Wildlife Service to minimize impact to fish. Dewatering portions of the stream channel shall be undertaken so as to not strand or trap any fish. Normal, prudent efforts shall be taken to protect fish and aquatic life during water control efforts.
- (4) The 3 foot culvert shown on the drawings will be provided by Bonner County Roads.
- (5) Payment for this item will be by Method 2 shown above in Section 7, Measurement and Payment. Payment will be in a lump sum.

Construction Specification 21—Excavation

1. Scope

The work shall consist of the excavation required by the drawings and specifications and disposal of the excavated materials.

2. Classification

Excavation is classified as common excavation, rock excavation, or unclassified excavation in accordance with the following definitions.

Common excavation is defined as the excavation of all materials that can be excavated, transported, and unloaded using heavy ripping equipment and wheel tractor-scrapers with pusher tractors or that can be excavated and dumped into place or loaded onto hauling equipment by excavators having a rated capacity of one cubic yard or larger and equipped with attachments (shovel, bucket, backhoe, dragline, or clam shell) appropriate to the material type, character, and nature of the materials.

Rock excavation is defined as the excavation of all hard, compacted, or cemented materials that require blasting or the use of ripping and excavating equipment larger than defined for common excavation. The excavation and removal of isolated boulders or rock fragments larger than 1 cubic yard encountered in materials otherwise conforming to the definition of common excavation shall be classified as rock excavation. The presence of isolated boulders or rock fragments larger than 1 cubic yard is not in itself sufficient cause to change the classification of the surrounding material.

For the purpose of these classifications, the following definitions shall apply:

Heavy ripping equipment is a rear-mounted, heavy duty, single-tooth, ripping attachment mounted on a track type tractor having a power rating of at least 250 flywheel horsepower unless otherwise specified in section 10.

Wheel tractor-scraper is a self-loading (not elevating) and unloading scraper having a struck bowl capacity of at least 12 cubic yards.

Pusher tractor is a track type tractor having a power rating of at least 250 flywheel horsepower equipped with appropriate attachments.

Unclassified excavation is defined as the excavation of all materials encountered, including rock materials, regardless of their nature or the manner in which they are removed.

3. Blasting

The transportation, handling, storage, and use of dynamite and other explosives shall be directed and supervised by a person(s) of proven experience and ability who is authorized and qualified to conduct blasting operations.

Blasting shall be done in a manner as to prevent damage to the work or unnecessary fracturing of the underlying rock materials and shall conform to any special requirements in section 10 of this

specification. When specified in section 10, the contractor shall furnish the engineer, in writing, a blasting plan before blasting operations begin.

4. Use of excavated material

Method 1—To the extent they are needed, all suitable material from the specified excavations shall be used in the construction of required permanent earthfill or rockfill. The suitability of material for specific purposes is determined by the engineer. The contractor shall not waste or otherwise dispose of suitable excavated material.

Method 2—Suitable material from the specified excavations may be used in the construction of required earthfill or rockfill. The suitability of material for specific purposes is determined by the engineer.

5. Disposal of waste materials

Method 1—All surplus or unsuitable excavated materials are designated as waste and shall be disposed of at the locations shown on the drawings.

Method 2—All surplus or unsuitable excavated materials are designated as waste and shall be disposed of by the contractor at sites of his own choosing away from the site of the work. The disposal shall be in an environmentally acceptable manner that does not violate local rules and regulations.

6. Excavation limits

Excavations shall comply with OSHA Construction Industry Standards (29CFR Part 1926) Subpart P, Excavations, Trenching, and Shoring. All excavations shall be completed and maintained in a safe and stable condition throughout the total construction phase. Structure and trench excavations shall be completed to the specified elevations and to the length and width required to safely install, adjust, and remove any forms, bracing, or supports necessary for the installation of the work. Excavations outside the lines and limits shown on the drawings or specified herein required to meet safety requirements shall be the responsibility of the contractor in constructing and maintaining a safe and stable excavation.

7. Borrow excavation

When the quantities of suitable material obtained from specified excavations are insufficient to construct the specified earthfills and earth backfills, additional material shall be obtained from the designated borrow areas. The extent and depth of borrow pits within the limits of the designated borrow areas shall be as specified in section 10 or as approved by the engineer.

Borrow pits shall be excavated and finally dressed to blend with the existing topography and sloped to prevent ponding and to provide drainage.

8. Overexcavation

Excavation in rock beyond the specified lines and grades shall be corrected by filling the resulting voids with portland cement concrete made of materials and mix proportions approved by the engineer. Concrete that will be exposed to the atmosphere when construction is completed shall meet the requirements of concrete selected for use under Construction Specification 31, Concrete for Major Structures, or 32, Structure Concrete, as appropriate.

Concrete that will be permanently covered shall contain not less than five bags of cement per

cubic yard. The concrete shall be placed and cured as specified by the engineer.

Excavation in earth beyond the specified lines and grades shall be corrected by filling the resulting voids with approved, compacted earthfill. The exception to this is that if the earth is to become the subgrade for riprap, rockfill, sand or gravel bedding, or drainfill, the voids may be filled with material conforming to the specifications for the riprap, rockfill, bedding, or drainfill. Before correcting an overexcavation condition, the contractor shall review the planned corrective action with the engineer and obtain approval of the corrective measures.

9. Measurement and payment

For items of work for which specific unit prices are established in the contract, the volume of each type and class of excavation within the specified pay limits is measured and computed to the nearest cubic yard by the method of average cross-sectional end areas or by methods outlined in section 10 of this specification. Regardless of quantities excavated, the measurement for payment is made to the specified pay limits except that excavation outside the specified lines and grades directed by the engineer to remove unsuitable material is included. Excavation required because unsuitable conditions result from the contractor's improper construction operations, as determined by the engineer, is not included for measurement and payment.

Method 1—The pay limits shall be as designated on the drawings.

Method 2—The pay limits shall be defined as follows:

- a. The upper limit shall be the original ground surface as it existed before the start of construction operations except that where excavation is performed within areas designated for previous excavation or earthfill, the upper limit shall be the modified ground surface resulting from the specified previous excavation or earthfill.
- b. The lower and lateral limits shall be the neat lines and grades shown on the drawings.

Method 3—The pay limits shall be defined as follows:

- a. The upper limit shall be the original ground surface as it existed before the start of construction operations except that where excavation is performed within areas designated for previous excavation or earthfill, the upper limit shall be the modified ground surface resulting from the specified previous excavation or earthfill.
- b. The lower and lateral limits shall be the true surface of the completed excavation as directed by the engineer.

Method 4—The pay limits shall be defined as follows:

- a. The upper limit shall be the original ground surface as it existed before the start of construction operations except that where excavation is performed within areas designated for previous excavation or earthfill, the upper limit shall be the modified ground surface resulting from the specified previous excavation or earthfill.
- b. The lower limit shall be at the bottom surface of the proposed structure.
- c. The lateral limits shall be 18 inches outside of the outside surface of the proposed structure or shall be vertical planes 18 inches outside of and parallel to the footings, whichever gives the larger pay quantity, except as provided in d below.
- d. For trapezoidal channel linings or similar structures that are to be supported upon the sides of the excavation without intervening forms, the lateral limits shall be at the underside of

the proposed lining or structure.

- e. For the purposes of the definitions in b, c, and d, above, any specified bedding or drainfill directly beneath or beside the structure will be considered to be a part of the structure.

All methods—The following provisions apply to all methods of measurement and payment.

Payment for each type and class of excavation is made at the contract unit price for that type and class of excavation. Such payment will constitute full compensation for all labor, materials, equipment, and all other items necessary and incidental to the performance of the work except that extra payment for backfilling overexcavation will be made in accordance with the following provisions.

Payment for backfilling overexcavation, as specified in section 8 of this specification, is made only if the excavation outside specified lines and grades is directed by the engineer to remove unsuitable material and if the unsuitable condition is not a result of the contractor's improper construction operations as determined by the engineer.

Compensation for any item of work described in the contract, but not listed in the bid schedule is included in the payment for the item of work to which it is made subsidiary. Such items and the items to which they are made subsidiary are identified in section 10 of this specification.

10. ITEMS OF WORK AND CONSTRUCTION DETAILS

Items of work to be performed in conformance with the specification and construction details are:

- a. Bid Item #7, Channel Excavation
 - (1) This item shall consist of all common excavation required to construct the channel profile as shown on the drawings. Some sorting of the material will be required to segregate large cobble suitable for construction of bid item #8, Rock Structures
 - (2) In Section 4, Use of Excavated Materials, Method 2 shall apply.
 - (3) In Section 5, Disposal of Waste Materials, spoil and debris shall be disposed of at locations designated by the Engineer.
 - (4) In Section 9, Measurement and Payment, Method 2 shall be used. Onsite surveys by the Engineer and/or the contractor will be used to verify yardage.
 - (5) Excavation required for installation of the culvert, and installation of the rock structures is not included in this item, but rather is subsidiary to Bid Item #6 and Bid Item #8, respectively.

Construction Specification 23—Earthfill

1. Scope

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

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

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

2. Material

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

Fill materials shall contain no frozen soil, sod, brush, roots, or other perishable material. Rock particles larger than the maximum size specified for each type of fill shall be removed prior to compaction of the fill.

The types of material used in the various fills shall be as listed and described in the specifications and drawings.

3. Foundation preparation

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

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

Earth abutment surfaces shall be free of loose, uncompacted earth in excess of 2 inches in depth normal to the slope and shall be at such a moisture content that the earthfill can be compacted against them to produce a good bond between the fill and the abutments.

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

Foundation and abutment surfaces shall be no steeper than one horizontal to one vertical unless otherwise specified. Test pits or other cavities shall be filled with compacted earthfill conforming to the specifications for the earthfill to be placed upon the foundation.

4. Placement

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

Earthfill shall be placed in approximately horizontal layers. The thickness of each layer before compaction shall not exceed the maximum thickness specified in section 10 or shown on the drawings. Materials placed by dumping in piles or windrows shall be spread uniformly to not more than the specified thickness before being compacted.

Hand compacted earth backfill shall be placed in layers whose thickness before compaction does not exceed the maximum thickness specified for layers of earth backfill compacted by manually directed power tampers.

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

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

- (a) The distribution of materials throughout each zone shall be essentially uniform, and the earthfill shall be free from lenses, pockets, streaks, or layers of material differing substantially in texture, moisture content, or gradation from the surrounding material. Zone earthfills shall be constructed concurrently unless otherwise specified.
- (b) If the surface of any layer becomes too hard and smooth for proper bond with the succeeding layer, it shall be scarified parallel to the axis of the fill to a depth of not less than 2 inches before the next layer is placed.
- (c) The top surface of embankments shall be maintained approximately level during construction with two exceptions: A crown or cross-slope of about 2 percent shall be maintained to ensure effective drainage, or as otherwise specified for drainfill or sectional zones.
- (d) Dam embankments shall be constructed in continuous layers from abutment to abutment except where openings to facilitate construction or to allow the passage of streamflow during construction are specifically authorized in the contract.
- (e) Embankments built at different levels as described under (c) or (d) above shall be constructed so that the slope of the bonding surfaces between embankment in place and embankment to be placed is not steeper than 3 feet horizontal to 1 foot vertical. The bonding surface of the embankment in place shall be stripped of all material not meeting the requirements of this specification and shall be scarified, moistened, and recompactd when the new earthfill is placed against it. This ensures a good bond with the new earthfill and obtains the specified moisture content and density at the contact of the inplace and new earthfills.

5. Control of moisture content

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

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

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

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

6. Compaction

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

Class A compaction—Each layer of earthfill shall be compacted as necessary to provide the density of the earthfill matrix not less than the minimum density specified in Section 10 or identified on the drawings. The earthfill matrix is defined as the portion of the earthfill material finer than the maximum particle size used in the compaction test method specified.

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

Class C compaction—Each layer of earthfill shall be compacted by the specified number of passes of the type and weight of roller or other equipment specified or by an approved equivalent method. Each pass shall consist of at least one passage of the roller wheel or drum over the entire surface of the layer.

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

The passage of heavy equipment will not be allowed:

- Over cast-in-place conduits within 14-days after placement of the concrete
- Over cradled or bedded precast conduits within 7 days after placement of the concrete cradle or bedding
- Over any type of conduit until the backfill has been placed above the top surface of the structure to a height equal to one-half the clear span width of the structure or pipe or 2 feet, whichever is greater, except as may be specified in section 10.

Compacting of earth backfill adjacent to structures shall not be started until the concrete has attained the strength specified in section 10 for this purpose. The strength is determined by compression testing of test cylinders cast by the contractor's quality control personnel for this purpose and cured at the work site in the manner specified in ASTM C 31 for determining when a structure may be put into service.

When the required strength of the concrete is not specified as described above, compaction of earth backfill adjacent to structures shall not be started until the following time intervals have elapsed after placement of the concrete.

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

7. Reworking or removal and replacement of defective earthfill

Earthfill placed at densities lower than the specified minimum density or at moisture contents outside the specified acceptable range of moisture content or otherwise not conforming to the requirements of the specifications shall be reworked to meet the requirements or removed and replaced by acceptable earthfill. The replacement earthfill and the foundation, abutment, and earthfill surfaces upon which it is placed shall conform to all requirements of this specification for foundation preparation, approval, placement, moisture control, and compaction.

8. Testing

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

Densities of earthfill requiring Class A compaction will be determined in accordance with ASTM D 1556, D 2167, D 2922, or D 2937 except that the volume and moist weight of included rock particles larger than those used in the compaction test method specified for the type of fill will be determined and deducted from the volume and moist weight of the total sample before computation of density or, if using the nuclear gauge, added to the specified density to bring it to the measure of equivalent composition for comparison (See ASTM D 4718). The density so computed is used to determine the percent compaction of the earthfill matrix. Unless otherwise specified, moisture content is determined by one of the following methods: ASTM D 2216, D 3017, D 4643, D 4944, or D 4959.

9. Measurement and payment

For items of work for which specific unit prices are established in the contract, the volume of each type and compaction class of earthfill and earth backfill within the specified zone boundaries and pay limits is measured and computed to the nearest cubic yard by the method of average cross-sectional end areas. Unless otherwise specified in section 10, no deduction in volume is made for embedded items, such as, but not limited to, conduits, inlet structures, outlet structures, embankment drains, sand diaphragm and outlet, and their appurtenances.

The pay limits shall be as defined below, with the further provision that earthfill required to fill voids resulting from overexcavation of the foundation, outside the specified lines and grades, will be included in the measurement for payment only under the following conditions:

- Where such overexcavation is directed by the engineer to remove unsuitable material, and
- Where the unsuitable condition is not a result of the contractor's improper construction operations as determined by the engineer.

Earthfill beyond the specified lines and grades to backfill excavation required for compliance with OSHA requirements will be considered subsidiary to the earthfill bid item(s).

Method 1—The pay limits shall be as designated on the drawings.

Method 2—The pay limits shall be the measured surface of the foundation when approved for placement of the earthfill and the specified neat lines of the earthfill surface.

Method 3—The pay limits shall be the measured surface of the foundation when approved for placement of the earthfill and the measured surface of the completed earthfill.

Method 4—The pay limits shall be the specified pay limits for excavation and the specified neat lines of the earthfill surface.

Method 5—The pay limits shall be the specified pay limits for excavation and the measured surface of the completed earthfill.

Method 6—Payment for each type and compaction class of earthfill and earth backfill is made at the contract unit price for that type and compaction class of earthfill. Such payment will constitute full compensation for all labor, material, equipment, and all other items necessary and incidental to the performance of the work.

Method 7—Payment for each type and compaction class of earthfill and earth backfill is made at the contract unit price for that type and compaction class of earthfill. Such payment will constitute full compensation for all labor, material, equipment, and all other items necessary and incidental to the performance of the work except furnishing, transporting, and applying water to the foundation and earthfill material. Water applied to the foundation and earthfill material is measured and payment made as specified in Construction Specification 10.

All methods—The following provisions apply to all methods of measurement and payment. Compensation for any item of work described in the contract, but not listed in the bid schedule is included in the payment for the item of work to which it is made subsidiary. Such items and the items to which they are made subsidiary are identified in section 10 of this specification.

10. ITEMS OF AND CONSTRUCTION DETAILS

Items of work to be performed in conformance with the specification and construction details are:

a. Subsidiary Item, Earthfill

(1) This item shall consist of all earthfill required to construct the temporary access road (Bid Item #4), the replaced culvert (Bid Item #6) and the rock structures (Bid Item #8).

(2) Total earthfill is estimated to be:

<u>Structure</u>	<u>Fill (CY)</u>
Access Road	415
Replace Culvert	150
Rock Structures	225

(3) Fill for the access road and culvert backfill shall contain no rocks larger than 6 inches. Fill for the rock structures shall be 6 to 18 inch rocks

(4) The thickness of each uncompacted lift around the culvert shall not exceed 6 inches prior to compaction. (Section 4, Placement).

(6) Soil moisture content for fill around the culvert will be between 10% and 14% during fill placement. (Section 5, Control of Moisture Content).

(7) In Section 6, Compaction will be Class C. Each layer shall be compacted by 3 passes over the entire surface of the lift with vibratory machinery. Either hand directed whackers or vibratory rollers are acceptable.

(8) In Section 10, Measurement and Payment, no method shall apply. Earthfill is subsidiary to Bid Item #4, Traffic Control, Bid Item #6, Culvert Replacement, and Bid Item #8 Rock Structures.

Construction Specification 31—Concrete for Major Structures

1. Scope

The work consists of furnishing, forming, placing, finishing, and curing Portland cement concrete as required to build the structures designated in section 25 of this specification.

2. Material

Aggregates shall conform to the requirements of section 25 and Material Specification 522, Aggregates for Portland Cement Concrete, unless otherwise specified.

Portland cement shall conform to the requirements of Material Specification 531, Portland cement, for the specified type. One brand only of any type of cement shall be used in any single structure as defined in section 25.

Fly ash shall conform to the requirements of Material Specification 532, Mineral Admixtures for Concrete.

Blast-furnace slag used as a partial substitution of Portland cement in concrete shall conform to the requirements of Material Specification 532, Mineral Admixtures for Concrete.

Air-entraining admixtures shall conform to the requirements of Material Specification 533, Chemical Admixtures for Concrete. If air-entraining cement is used, any additional air-entraining admixture shall be of the same type as that in the cement.

Plasticizing admixtures shall conform to the requirements of Material Specification 533, Chemical Admixtures for Concrete.

Water-reducing and/or retarding admixtures shall conform to the requirements of Material Specification 533, Chemical Admixtures for Concrete.

Accelerating and water-reducing and accelerating admixtures, if specified in section 25, shall conform to the requirements of Material Specification 533, Chemical Admixtures for Concrete.

Curing compound shall conform to the requirements of Material Specification 534, Concrete Curing Compound.

Preformed expansion joint filler shall conform to the requirements of Material Specification 535, Preformed Expansion Joint Filler.

Sealing compound for joints shall conform to the requirements of Material Specification 536, Sealing Compound for Joints in Concrete and Concrete Pipe.

Waterstops shall conform to the requirements of Material Specifications 537, Nonmetallic Waterstops, and 538, Metal Waterstops, for the specified kinds.

Dowels shall be a plain, round steel bar conforming to the requirements of Material Specification 539, Steel Reinforcement (for concrete).

Metal plates shall conform to the requirements of Material Specification 581, Metal, for structural quality or commercial or merchant quality steel. Structural quality shall be used only if specifically designated in the drawings or specifications.

Water used in mixing and curing concrete shall be clean and free from injurious amounts of oil, salt, acid, alkali, organic matter, or other deleterious substances.

3. Concrete mix design

Method 1

Responsibilities—The contractor is responsible for the design and proportioning of the concrete. Job mixes shall be prepared to meet the quality, consistency, and strength of concrete specified.

Submittals—At least 15 calendar days before the placement of any concrete, the contractor shall provide the engineer with full documentation to support each job mix and any admixtures to be used in the work. The contractor shall furnish test results to the engineer for each admixture showing that it meets the requirements of Material Specification 533, Chemical Admixtures for Concrete. Job mixes are reviewed and accepted or rejected by the engineer within 8 calendar days following the date of submittal. After a job mix has been accepted, neither the source, character, or gradation of the aggregates nor the type or brand of cement or admixtures shall be changed without prior notice to the engineer. Revisions or changes in a job mix that are determined to be significant by the engineer shall follow the same submittal and acceptance process as that for the initial job mix.

Design criteria—The class of concrete shall be as specified in Section 25 and in accordance with the following specified compressive strength.

Class of concrete	Specified compressive strength (f'_c) at 28 days (lb/in ²)
5000	5,000
4000	4,000
3000	3,000
2500	2,500

Maximum water-cement ratio shall be 0.50, unless otherwise specified.

Unless otherwise specified the air content (by volume) of the concrete at the time of placement shall be:

Maximum size aggregate	Air content (%)
3/8 inch to 1 inch	5 to 7
Over 1 inch	4 to 6

The consistency of all concrete shall allow it to be placed without segregation or excessive laitance. Unless otherwise specified, the slump shall be:

Type of structural section	Slump (inches)
Massive sections, pavements, footings	2 ± 1
Heavy beams, thick slabs, thick walls (>12 inches)	3 ± 1
Columns, light beams, thin slabs, thin walls (12 inches or less)	4 ± 1

Superplasticized concrete shall be a concrete mix containing either a water-reducing, high range admixture (ASTM C 494, Type F or G) at a dosage rate that reduces the quantity of water required to produce a concrete mix within the above slump range by 12 percent or more, or a plasticizing admixture (ASTM C 1017) at a dosage rate required to produce an increase in the slump of at least 2 inches more than that specified above.

A water-reducing admixture (ASTM C 494, Type F or G) and/or a plasticizing admixture (ASTM C 1017) may be added to an approved job mix without resubmittal and reapproval of the job mix if the following requirements are met:

- a. The admixture shall be introduced into the concrete mix as specified by the manufacturer and be compatible with other admixtures in the job mix.
- b. The water content shall be equal to or less than that required in the job mix without the admixture.
- c. The cement content shall be the same as that required in the job mix without the admixture.
- d. The air content shall be within the specified range.
- e. The slump shall not exceed 7.5 inches unless the contractor can demonstrate before placement that the job mix can be placed without segregation or excessive laitance at a slump greater than 7.5 inches. The concrete shall retain the increased slump for not less than 30 minutes.
- f. If the admixture is added at the job site, the slump of the concrete before the addition of the admixture shall not exceed the slump specified above for concrete that does not contain the admixture.

Calcium chloride or other corrosive accelerators shall not be used unless otherwise specified.

Fly ash may be used as a partial substitution for Portland cement in an amount not greater than 25 percent (by weight) of cement in the concrete mix unless otherwise specified.

Ground granulated blast-furnace slag may be used as a partial substitution for Portland cement in amounts between 25 to 70 percent (by weight) of cement in the concrete mix unless otherwise specified.

Job mix criteria—Proportioning of concrete for job mixes shall be based on the standard deviation computed from compressive strength tests of previous batch records or established by laboratory trial mixes. Unless otherwise specified a compressive strength test is the average of the compressive strengths of two standard cured cylinders prepared and tested in accordance with section 4.

For a job mix based upon the standard deviation computed from compressive strength tests of previous batch records, the previous batches shall represent similar material and conditions to those expected for the job mix and have a strength within 1,000 pounds per square inch of the specified compressive strength (f'_c) at 28 days for the class of concrete specified. The contractor shall provide to the engineer copies of the facility's previous batching records that show the compressive strength results and the batch mix design used.

For a job mix based upon a laboratory trial mix, the trial mix shall contain the actual material to be used in the final job mix, have a slump within 0.75 inches of the maximum allowable slump, and have an air content within 0.5 percent of the maximum allowable air content. The contractor shall provide the engineer with copies of the actual compressive strength test records for the trial mix from the testing facility performing the test.

The trial job mix or previous batch records shall include the water reducing admixture when a water reducing admixture is used in a concrete mix specifically to improve the physical properties of the hardened concrete or change portions of the mix components.

In meeting strength requirements, the selected job mix proportions must produce an average strength, f_{cr} , exceeding the specified compressive strength, f'_c , by the amount specified below.

n	s_{30}	f_{cr}
>30	1.00 s	The larger of these
25	1.03 s	two equations:
20	1.08 s	$f'_c + 1.34 s_{30}$
15	1.16 s	$f'_c + 2.33 s_{30} - 500$
<15		$f'_c + 1,000$ for $f'_c < 3,000$ $f'_c + 1,200$ for $f'_c - 5,000$ $f'_c + 1,400$ for $f'_c > 5,000$

where:

n = number of consecutive compressive strength tests

s_{30} = standard deviation adjusted to 30 tests, lb/in²

f_{cr} = required average compressive strength, lb/in²

f'_c = specified compressive strength of concrete, lb/in²

s = standard deviation (lb/in²) computed as $\{[\sum(X_i - X_a)^2]/[n-1]\}^{1/2}$

where:

X_i = individual strength test result, lb/in²

X_a = average of n strength test results, lb/in²

Method 2

Responsibilities—The engineer is responsible for the design and proportioning of the job mix. The initial job mix will be as specified in section 25. The engineer may adjust the initial job mix proportions to establish the designated job mix. The engineer will provide the contractor with a copy of each job mix as soon as the material and proportions have been determined. After the job mix has been designated, neither the source, character, or gradation of the aggregates nor the type or brand of cement or admixtures shall be changed without prior approval of the engineer. During the course of the work, the engineer may adjust the job mix proportions and batch weights whenever necessary to meet special job conditions.

The contractor, for each class of concrete, shall be responsible for:

- a. Taking the following actions and furnishing the engineer with the following information at least 35 calendar days before any placement of concrete, unless otherwise designated:
 - (1) Select the source of aggregates and sample and test the gradations of aggregates available.
 - (2) Select the brand and type of cement.
 - (3) Select the brand of admixtures and obtain manufacturer's test data and recommendation of use.
 - (4) Identify the concrete production facility, the type of mixer, and the mixing methods that will be used.
 - (5) Provide from the concrete production facility consecutive compressive strength test records and batching records for concrete mixes that have material, proportions, and compressive strengths within 1 000 pounds per square inch of the proposed design mix.
- b. Batching at least 3 cubic yards of the initial job mix, in the presence of the engineer, for testing and evaluation not less than 30 calendar days before any placement of concrete.

4. Inspecting and testing

During the course of the work, the engineer performs quality assurance testing as required to assure the concrete meets the contract requirements. The engineer shall have free entry to the plant and equipment furnishing concrete under the contract. Proper facilities shall be provided for the engineer to inspect material, equipment, and processes, and to obtain samples of the concrete. All tests and inspections are conducted so as not to interfere unnecessarily with the manufacture, delivery, and placement of the concrete.

Any portion of a batch may be tested by the engineer for any of the purposes shown below. Samples taken for testing shall be representative of that part of the batch.

- a. Determining uniformity of the batch.
- b. Checking compliance with requirements for slump and air content when the batch is discharged over an extended period.
- c. Checking compliance of the concrete with the specifications when the whole amount being placed in a small structure, or a distinct part of a larger structure, is less than full batch.

If concrete is conveyed to the placement location by pumping or conveyor belts, the samples shall be collected at the discharge end.

When a plasticizing admixture is added to the concrete mix at the job site, slump tests are made both before the addition of the admixture to the concrete mix and after the admixture has been incorporated into the concrete mix.

The tests on concrete are performed by the following methods unless otherwise specified:

Type of test	Test method (ASTM designation)
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Sampling	C 172
Slump test	C 143
Air content	C 231 or C 173
Compression test specimens	C 31 or C 42
Compressive strength testing	C 39
Unit weight	C 138
Temperature	C 1064

A strength test for concrete is the average of two standard cured concrete cylinders prepared in accordance with ASTM C 31 from the same sample of concrete and tested in accordance with ASTM C 39 at 28 days, unless otherwise specified. If one cylinder shows manifest evidence of improper sampling, molding, curing, or testing, it shall be discarded and the strength of the remaining cylinder shall then be considered the compressive strength of the concrete. Should both cylinders show such defects, the entire test shall be discarded.

If both cylinders are discarded or in-place concrete that was not sampled is in question, the in-place concrete may be sampled by coring in accordance with ASTM C 42. For core tests, these requirements shall be followed:

- a. At least three representative cores shall be taken from each area of concrete in question. If one or more of the cores shows signs of being damaged before testing, it shall be replaced by a new one.
- b. Test cores shall be prepared for testing in accordance with moisture conditioning in ASTM C 42 unless the engineer determines that the concrete in the structure will be dry under service conditions. If the concrete is determined to be dry under service conditions, the cores shall be air dried (temperature 60 °F to 80 °F and relative humidity less than 60%) for 7 days before testing and shall be tested dry.

5. Handling and measurement of material

Aggregates shall be stored or stockpiled in such a manner that separation of coarse and fine particles of each size is avoided and that various sizes do not become intermixed before proportioning. Methods of handling and transporting aggregates shall avoid contamination, excessive breakage, segregation, degradation, or intermingling of various sizes.

Unless otherwise specified, scales shall be beam type or springless dial type. They shall be accurate when static load tested to plus 0.4 percent of the total capacity of the scales. All exposed fulcrums, clevises, and similar working parts of scales shall be kept clean.

Measuring tanks for mixing water shall be of adequate capacity to furnish the maximum amount of mixing water required per batch. Tanks shall be equipped with outside taps and valves to verify their calibration unless other means are provided for readily and accurately determining the amount of water in the tank.

The quantities of each component of the concrete mix shall be measured by the following methods and to the accuracy indicated below:

Cement, fly ash, slag—Cement, except as otherwise specifically permitted, shall be measured by weight or in bags on which the weight is plainly marked. When cement, fly ash, and slag are supplied in bulk and are measured by weight, they shall be weighed on a scale separate from that used for other material and in a hopper entirely free and independent of the hopper used for weighing the aggregate. When fly ash or slag is used in the job mix, the cement and the fly ash or slag may be weighed separately or cumulatively by weighing the cement first and then adding the fly ash or slag to arrive at the composite weight. The weight of the cement and the combined weight of the cement and fly ash or slag shall be within plus or minus 1 percent of the required weight of the cementitious material. When cement is measured in bags, no fraction of a bag shall be used unless weighed.

Aggregates—Aggregates shall be measured by weight unless otherwise specifically permitted. Mix proportions shall be based on saturated, surface-dry weights. The batch weight of each aggregate shall be the required saturated, surface-dry weight corrected by the weight of surface moisture it contains. The weight of each of the specified aggregates shall be within plus or minus 2 percent of the required weight.

Mixing water—Mixing water shall consist of water added to the batch, ice added to the batch, water occurring as surface moisture on the aggregates, and water introduced in the form of admixtures. The added water shall be measured by weight or volume to an accuracy of 1 percent of the required total mixing water. Added ice shall be measured by weight. Wash water shall not be used as part of the mixing water for succeeding batches.

Admixtures—Dry admixtures shall be measured by weight. Paste or liquid admixtures shall be measured by weight or volume. The admixtures shall be within plus or minus 3 percent of the required weight or volume for each specific admixture.

6. Mixers and mixing

Mixers are either stationary parts of a central mixing plant or portable equipment, such as revolving drum truck mixers and volumetric batching/continuous mixing truck mixers. Mixers shall be capable of thoroughly mixing the concrete ingredients into a uniform mass within the specified mixing time and of discharging the mix without segregation. Each mixer or agitator shall bear a manufacturer's rating plate indicating the gross volume of the drum, the capacity of the drum or container in terms of the volume of mixed concrete, and the minimum and maximum mixing speeds of rotation of the drum, blades, or paddles. When the truck mixer is used for truck mixed concrete as described in section 6a(2) or for shrink mixed concrete as described in section 6a(3), the capacity of the drum or container in terms of the volume of mixed concrete shall not exceed 63 percent of the gross volume of the drum. When the truck mixer is used to transport central-mixed concrete as described in section 6a(1), the capacity of the drum or container in terms of the volume of mixed concrete shall not exceed 80 percent of the gross volume of the drum. The mixer shall be operated in accordance with these recommendations.

Concrete shall be uniform and thoroughly mixed when delivered to the forms in a freshly mixed and unhardened state. Variations in slump of more than 1 inch within a batch is considered evidence of inadequate mixing and shall be corrected by changing batching procedures, increasing mixing time, changing mixers, or other means. Mixing time shall be within the limits specified below unless the contractor demonstrates by mixer performance tests that adequate uniformity is obtained by different times of mixing.

No mixing water in excess of the amount called for by the job mix shall be added to the concrete during mixing or hauling or after arrival at the delivery point. Water to compensate for up to a 1-inch loss in slump may be added, not to exceed the design maximum water cement ratio. Withholding some of the mixing water until the concrete arrives on the job, then adding the remaining water and turning the mixer 30 revolutions at mixing speed is allowed to overcome transporting conditions. When loss of slump or workability cannot be offset by these measures, complete mixing shall be performed by onsite batching and mixing or by using a combination of centrally batching and transporting material to the site and adding remainder of material onsite.

Concrete may be furnished by ready-mix methods, by volumetric batching and continuous mixing at the site, or by batch mixing at the site.

a. Ready-mixed concrete

Ready-mixed concrete shall be mixed, transported, and placed in a freshly mixed and unhardened state. The contractor shall furnish the engineer a batch ticket showing amount of concrete in cubic yards, the time of loading, the time the load was discharged, the revolution counter reading at the time of loading and discharge, and the type and actual quantity of each material including all admixtures used in each batch of concrete.

Truck mixers and truck agitators shall be equipped with revolution counters by which the number of revolutions of the drum or blades may be readily verified. Ready-mixed concrete shall be mixed and delivered by one of the following methods:

- (1) Central-mixed concrete—Central-mixed concrete is mixed completely in a stationary mixer and transported to the point of delivery either in a truck agitator, a truck mixer operating at agitating speed, or nonagitating equipment.

When a truck agitator or a truck mixer is used as an agitator and transports concrete that has been completely mixed in a stationary mixer, mixing during transportation shall be at the speed designated by the manufacturer of the equipment as agitating speed. When concrete is transported in a truck mixer or truck agitator, the volume of the mixed concrete shall not exceed 80 percent of the gross volume of the drum. The total number of revolutions of the truck mixer or truck agitator shall not exceed 200 before discharge of the concrete, unless otherwise specified.

The use of nonagitating equipment to transport concrete to the site of the work is permitted only if the consistency and uniformity of the concrete as discharged at the point of delivery meet the requirements of this specification. Bodies of nonagitating hauling equipment shall be constructed so that leakage of the concrete mix, or any part thereof, does not occur. Concrete hauled in opentop vehicles shall be protected from rain and from more than 20 minutes exposure to the sun and wind when the air temperature is above 75 degrees Fahrenheit.

- (2) Truck-mixed concrete—Truck-mixed concrete is completely mixed in a truck mixer. The total volume of all ingredients to be mixed in a revolving drum truck mixer shall not exceed 63 percent of the gross volume of the drum. The concrete ingredients shall be mixed between 70 and 100 revolutions of the drum or blades at the speed designated by the manufacturer as mixing speed. Mixing in excess of 100 revolutions shall be at the speed designated by the manufacturer of the equipment as agitating speed. The total number of revolutions shall not exceed 300 before discharge of the concrete unless otherwise specified.

- (3) **Shrink-mixed concrete**—Shrink-mixed concrete is partly mixed at a central plant and the mixing is completed in a truck mixer. The mixing time in the central plant mixer is the minimum required to intermingle the ingredients. The volume of the mixed concrete in a truck mixer shall not exceed 63 percent of the gross volume of the truck drum. The mixing shall be completed in a truck mixer. The number of revolutions of the truck mixer drum or blades shall be between 50 and 100 revolutions at the speed designated by the manufacturer as mixing speed. Mixing in excess of 100 revolutions shall be at the speed designated by the manufacturer of the equipment as agitating speed. The total number of revolutions shall not exceed 300 before discharge of the concrete unless otherwise specified.

b. Volumetric batching and continuous mixing at the site

Volumetric batching and continuous mixing at the site is commonly referred to as mobile concrete mixers. Unless otherwise specified volumetric batching and continuous mixing at the construction site is permitted. The batching and mixing equipment shall conform to the requirements of ASTM C 685 and shall be demonstrated before placement of concrete by tests with the job mix to produce concrete meeting the specified proportioning and uniformity requirements. Concrete made by this method shall be produced, inspected, and documented in conformance with sections 6, 7, 8, 13, and 14 of ASTM C 685.

c. Batch mixing at the site

This method of batching and mixing concrete is either by batching and mixing all material onsite using paving mixers or stationary construction mixers or by using a combination of centrally batching part of the mix, transporting it to the site, and adding the rest of the material and mixing onsite.

Paving mixers or stationary construction mixers and associated transport vehicles shall be in accordance with recommended practices described in method 1 for central mixed concrete. The time for mixing a batch of concrete in the mixer drum shall be according to manufacturer's recommendations, but not less than 1 minute plus 0.25 minute for each cubic yard of concrete being mixed (8 yd³ batch = 3 minutes).

When a combination of centrally batching and transporting material to the site and adding rest of material onsite is used, the contractor shall prepare a written plan detailing how the batching and mixing of the concrete material will be accomplished and controlled. This written batching and mixing plan shall be submitted to the engineer for review and approval not less than 10 working days before the placement of concrete. The volume of the mixed concrete in a truck mixer shall not exceed 63 percent of the gross volume of the drum.

The contractor shall furnish the engineer a batching ticket for each batch of fresh concrete. The ticket shows the type, brand, and amount of cement; the type, name, and amount of each admixture; total water added to the batch, which includes free water on the aggregate; maximum size of aggregate; the type and dry weight of fine aggregate; the type and dry weight of coarse aggregate; the time of loading (the time that water was introduced to the cement); and the time the load was discharged.

7. Forms

Forms shall be of good quality wood, plywood, steel, or other approved material and shall be mortar tight. The forms and associated falsework shall be substantial and unyielding and shall be constructed so that the finished concrete conforms to the specified dimensions and contours. Form surfaces shall be smooth and free from holes, dents, sags, or other irregularities and shall be maintained in this condition throughout the work. Forms shall be coated with a nonstaining form release agent before being set into place. Acceptable tolerances for formed structure members are specified in section 23.

When a superplasticized concrete mix is used, forms shall be coated according to the manufacturer's recommendations with a form release agent that is specifically formulated for plasticized concrete. Forms shall be designed to withstand the increased pressures of the superplasticized concrete and the increased impact forces resulting from larger drop heights used in placing the superplasticized concrete.

Metal ties or anchorages that will be embedded in the concrete shall be equipped with cones, she-bolts, or other devices that permit their removal to a depth of at least 1 inch without injury to the concrete. Ties designed to break off below the surface of the concrete shall not be used without cones. If approved fiberglass or plastic form ties are used, the tie ends shall be cut flush with the finished concrete and ground smooth.

All edges that will be exposed shall be chamfered unless finished with molding tools as specified in section 18.

8. Preparation of forms and subgrade

Before placement of concrete, the forms, embedments, and subgrade shall be free of chips, sawdust, debris, water, ice, snow, extraneous oil, mortar, or other harmful substances or coatings. Any form release agent on the reinforcing steel or other surfaces required to be bonded to the concrete shall be removed.

Rock surfaces shall be cleaned by high pressure air-water cutting, sandblasting, or wire brush scrubbing, as necessary, and shall be wetted immediately before placement of concrete. The earth surface shall be firm and damp. Placement of concrete on mud, dried earth, noncompacted fill, or frozen subgrade is not permitted. All ice, snow, and frost shall be removed, and the temperature of all surfaces, including the reinforcing steel and other steel inclusions, to be in contact with the new concrete shall be no colder than 40 degrees Fahrenheit.

Items to be embedded in the concrete shall be positioned accurately and anchored firmly.

Weepholes in walls or slabs shall be formed with nonferrous material.

9. Conveying

Concrete shall be delivered to the site and discharged completely into the forms within 1.5 hours or before the drum of truck has revolved a total of 300 revolutions, whichever comes first, after the introduction of the mixing water to the cement and aggregates or the introduction of the cement to the aggregates. In hot weather or under conditions contributing to quick stiffening of the concrete, or when the temperature of the concrete is 85 degrees Fahrenheit or above, the time between the introduction of the cement to the aggregates and discharge shall not exceed 45 minutes.

Superplasticized concrete can be conveyed and placed when the temperature of the concrete is below 95 degrees Fahrenheit and the slump of the concrete remains within the allowable slump range.

The engineer can allow an appropriate extension of time when the setting time of the concrete is increased a corresponding amount by the addition of an approved admixture. In any case concrete shall be conveyed from the mixer to the forms as rapidly as practicable by methods that prevent segregation of the aggregates or loss of mortar.

10. Placing

Concrete shall not be placed until the subgrade, forms, steel reinforcement, and other embedments are inspected and approved by the engineer. For walls and columns, subsequent higher placements of concrete shall not be placed until the concrete below the new placement has gained sufficient strength to support the concrete dead load and any superimposed loads without distress. Placement sequences and timing shall consider form removal timing covered in section 16.

If a placement plan is required in section 25, concrete shall not be placed until the placement plan has been reviewed and approved by the engineer. The contractor shall have all equipment and material required for curing available at the site ready for use before placement of concrete begins.

Concrete shall be placed only in the presence of the engineer. The contractor shall give reasonable notice to the engineer before each placement. Such notice shall be far enough in advance to give the engineer adequate time to assure that the subgrade, forms, steel reinforcement, and other preparations comply with specifications. Other preparations include, but are not limited to, the concrete batching plant, mixing and delivery equipment and system, placing and finishing equipment and system, schedule of work, workforce, and heating or cooling facilities, as applicable. All deficiencies are to be corrected before concrete is delivered for placing.

Concrete shall be placed and consolidated to prevent segregation of the mix components. The concrete shall be deposited as closely as possible to its final position in the forms. It shall be worked into the corners and angles of the forms and around all reinforcement and embedded items to prevent segregation of aggregates or excessive laitance. The depositing of concrete shall be regulated so that the concrete can be consolidated with a minimum of lateral movement. Concrete placed against a sloping surface shall start at the lowest elevation and work upwards to the highest elevation.

Concrete other than architectural concrete shall not be dropped more than 5 feet vertically unless suitable equipment is used to prevent segregation. Architectural concrete shall not be dropped more than 3 feet vertically unless suitable equipment is used to prevent segregation. When a superplasticized concrete mix is used, concrete other than architectural concrete shall not be dropped more than 12 feet vertically and architectural concrete shall not be dropped more than 10 feet vertically unless suitable equipment is used to prevent segregation.

11. Layers

Slab concrete shall be placed to design thickness in one continuous layer unless otherwise specified. Formed concrete shall be placed in horizontal layers not more than 20 inches deep. Where a superplasticized concrete mix is used, formed concrete may be placed in horizontal layers not more than 5 feet deep.

Successive layers of fresh concrete between construction joints shall be placed at a rate fast enough that the preceding layer is still plastic and can be easily mixed with the fresh concrete such that seams (cold joints) or plane of weakness do not occur. If the surface of a previously placed layer of concrete has taken a set to the degree that it will not flow and mix with the succeeding layer when vibrated, the contractor shall discontinue placing concrete and shall make a construction joint according to the procedure specified in section 13. If placing is discontinued when a layer is incomplete, the ends of the incomplete layer shall be formed by a vertical bulkhead.

12. Consolidating

All concrete shall be consolidated with internal type mechanical vibrators capable of transmitting vibration to the concrete at frequencies not less than 8,000 impulses per minute, unless otherwise specified or approved before placement. Vibration shall be supplemented by spading, rodding, and hand tamping as necessary to ensure smooth and dense concrete along the form surface, in corners, and around embedded items. The contractor shall provide a sufficient number of vibrators to properly consolidate the concrete immediately after it is placed. A sufficient number of standby vibrators shall be kept onsite during the placement of concrete.

Vibration shall compact the concrete and bring it into intimate contact with the forms, reinforcing steel, and other embedded items while removing voids and pockets of entrapped air. The location, insertion, duration, and removal of the vibrators shall be such that maximum consolidation of the concrete is achieved without causing segregation of the mortar and coarse aggregate or causing water or cement paste to flush to the surface. Vibration shall be applied to the freshly deposited concrete by rapidly inserting the vibrator and slowly, in an up and down motion, removing the vibrator at points uniformly spaced at not more than 1.5 times the radius of the area visibly effected by vibration. Generally, this is at 5 to 10 seconds per foot on 14-inch spacings or less. The area visibly effected by the vibrator shall overlap the adjacent, just vibrated area. The vibrator shall extend vertically into the previously placed layer of fresh concrete by at least 6 inches at all points. This ensures effective bond between layers. In thin slabs the vibrator(s) should be sloped toward the horizontal to allow operations in a fully embedded position.

Vibration shall not be applied directly to the reinforcement steel, the forms, or other embedded items unless otherwise specified. Vibration shall not be applied to concrete that has hardened to the degree that it does not become plastic when vibrated. If surface vibrators are used, they may contact forms when consolidating thin slabs.

The use of vibrators to transport concrete in the forms or conveying equipment is not permitted.

Surface vibrators may be used to consolidate slabs 8 inches and less in thickness. Slabs more than 8 inches thick shall be consolidated with internal vibration and may be augmented through use of surface vibrator, such as vibrating screeds, plate or grid vibratory tampers, or vibratory roller screeds. If concrete is to be consolidated using surface vibration methods, the contractor shall detail how this work is to be performed in writing to the engineer for review and approval. This report must be submitted no less than 30 calendar days before placing concrete by this method. It includes equipment selection and specifications.

13. Construction joints

Construction joints shall be made at the locations shown on the drawings unless otherwise specified or approved by the engineer. If construction joints are needed that are not shown on the drawings, they shall be placed in locations approved by the engineer.

Where a feather edge would be produced at a construction joint, as in the top surface of a sloping wall, an insert form shall be used so that the resulting edge thickness on either side of the joint is not less than twice the maximum aggregate diameter used in the concrete mix.

Nonvertical construction joints in structural elements, such as walls and columns, shall be consolidated and screeded to grade unless otherwise specified. Construction joints shall be covered and wet cured for 7 days or until concrete placement resumes unless otherwise specified.

Steel tying and form construction next to concrete in place shall not be started until the concrete has cured at least 12 hours. Before new concrete is deposited on or against concrete that has hardened, the forms shall be retightened. New concrete shall not be placed until the hardened concrete has cured at least 12 hours.

Method 1—The surface of construction joints shall be cleaned of all unsatisfactory concrete, laitance, coatings, stains, or debris by sandblasting or high-pressure air-water cutting, or both. Sandblasting can be used after the concrete has gained sufficient strength to resist excessive cutting, and high-pressure air-water cutting can be used as soon as the concrete has hardened sufficiently to prevent the jet from displacing the coarse aggregates. The surface of the concrete in place shall be cut to expose clean, sound aggregate, but not so deep as to undercut the edges of larger particles of the aggregate. After cutting, the surface shall be thoroughly washed to remove all loose material. If the surface is congested by reinforcing steel, is relatively inaccessible, has cured beyond the ability to cut with air-water blasting, or disturbing the concrete before it is hardened is considered undesirable, cleaning of the joint by air or water jets is not permitted. The sandblasting method is required after the concrete has hardened.

Immediately before new concrete is placed, all construction joints shall be wetted and standing water removed.

Method 2—The surface of construction joints shall be cleaned of all unsatisfactory concrete, laitance, coatings, stains, or debris by washing and scrubbing with a wire brush or wire broom, or by other means approved by the engineer. Immediately before new concrete is placed, all construction joints shall be wetted and standing water removed.

14. Expansion and contraction joints

Expansion and contraction joints shall be made only at locations shown on the drawings. Exposed concrete edges at expansion and contraction joints shall be carefully tooled or chamfered, and the joints shall be free of mortar and concrete. Joint filler shall be fully exposed for its entire length with clean and true edges.

Where open joints or weakened plane "dummy" joints are specified, joints formed in fresh concrete shall be constructed by the insertion and subsequent removal of a wood strip, metal plate, or other suitable template. This will be done so that the corners of the concrete do not chip or break. The edges of the fresh concrete at the joints shall be finished with an edging tool before the joint strips are removed. Open joints or weakened plane dummy joints may also be sawcut joints conforming to the depth and extent specified.

Preformed expansion joint filler shall be held firmly in the correct position as the concrete is placed.

15. Waterstops

Waterstops shall be held firmly in the correct position as the concrete is placed. Joints in metal waterstops shall be brazed or welded. Joints in rubber or plastic waterstops shall be cemented, welded, or vulcanized as recommended by the manufacturer. Joints shall be watertight and of a strength equivalent to that specified in Material Specification 537. Intersecting waterstop joints shall be prefabricated and supplied by the same manufacturer providing the waterstop.

16. Removal of forms, supports, and protective coverings

Forms, supports, and protective coverings shall be removed as soon as practical after the concrete has gained sufficient strength to support its own weight and superimposed loads. Removal shall be done so that the concrete surface is not damaged and sudden or excessive stresses are not induced. The minimum period from completion of the concrete placement to the removal of the forms shall be based on either strength tests or cumulative times.

Strength tests—The strength of the in-place concrete is determined by testing concrete cylinders specifically cast for this purpose and cured adjacent to the member in accordance with the ASTM C 31 method for determining removal time. Unless otherwise specified, forms supporting the weight of the concrete member may be removed after the concrete strength is 70 percent of that specified for the class of concrete. Forms not supporting the weight of the concrete member or other superimposed loads may be removed after the concrete strength has reached the strength specified in section 25.

Cumulative time—The total accumulated time, not necessarily continuous, that the air adjacent to the concrete is above 50 degrees Fahrenheit and the specified concrete curing has occurred concurrently will be determined. Forms may be removed after the total accumulated time shown:

Accumulated form removal times

Forms	Time ^{1/}	
Sides of slabs or beams	12 hours	
Undersides of slabs or beams	Clear span ^{2/}	
	< 10 ft	4 days
	10 - 20 ft	7 days
	> 20 ft	14 days
Sides of walls or columns	Height above form ^{3/ 4/}	
	< 10 ft	12 hours
	< 20 ft	24 hours
	> 20 ft	72 hours

1/ Table values apply to normal concrete. Values for concrete that contains cements or admixtures that significantly retard or accelerate strength gain will be determined by the engineer and based on actual design mix data.

2/ Values apply to members designed to support significant superimposed loads. Values for members designed for only self weight when placed in service shall be 50 percent greater.

3/ Values apply to members not subject to significant horizontal loads. Additional time or rebracing is needed for members subject to significant wind or other horizontal loads.

4/ Subsequent higher lifts may be placed after 12 hours.

17. Finishing formed surfaces

All formed concrete surfaces shall be true and even, and shall be free from overtolerance depressions, holes, projections, bulges, or other defects in the specified surface finish or alignment, unless otherwise specified in section 25. Depressions are measured as the distance from the bottom of a 5-foot-long template or straight edge.

A surface to be backfilled or otherwise concealed when construction is completed shall have the following surface treatment unless otherwise specified:

- Repair defective concrete.
- Fill all form tie holes.

- Correct surface depressions deeper than 1 inch.
- Remove or smooth fins and abrupt projections that exceed 0.75 inch.

A surface to be permanently exposed, where other finishes are not specified, shall have the following treatment:

- Repair defective concrete.
- Fill all form tie holes.
- Remove or smooth all abrupt irregularities greater than 0.25 inch in depth or projection.
- Treat all depressions and irregularities so that they do not exceed 0.5 inch in depth.

Form bolt and tie holes and other holes of similar size and depth shall be repaired and filled as specified in section 20.

18. Finishing unformed surfaces

All exposed surfaces of the concrete shall be accurately screeded to grade and then float finished unless otherwise specified. The float finish shall result in a surface that has no irregularities of more than 0.25 inch when checked with a template or straight edge that is 10 feet long.

All exposed surfaces of concrete shall be accurately struck off to grade after placement and consolidation are completed. Following strike off, the surface shall be immediately smoothed by darbying or bull floating before any free water has bled to the surface. The concrete shall then be allowed to rest until the bleed water and water sheen have left the surface and the concrete has stiffened to where it will sustain foot pressure with only about 0.25-inch indentation. At this time all joints and edges that are exposed to view and are not chamfered shall be finished with edging tools. After edging and hand jointing is complete, all exposed surfaces shall be floated with wood or magnesium floats. The floating should work the concrete no more than necessary to remove screed, edger, and jointer marks and to produce a compact surface uniform in texture.

Water shall not be sprinkled or added to the surface of the concrete during the darbying, bull floating, floating, or other finishing operations to facilitate finishing.

19. Curing

Freshly placed concrete shall be cured a minimum of 7 days in accordance with the recommended practices set forth in this section. A curing process shall be started as soon as the concrete has hardened sufficiently to prevent surface damage. Curing concrete, including exposed surfaces of formed concrete and concrete in forms, shall be maintained at a satisfactory moisture content for at least 7 days following placement. If forms are removed before the end of the 7-day curing period, the interrupted curing process shall be reestablished and maintained until a full 7-day curing period is achieved. A satisfactory moisture condition is:

- Continuous or frequent application of water or use of a saturated cover material, such as canvas, cloth, burlap, earth, or sand.
- Prevention of excessive water loss from the concrete by use of an impermeable coating (curing compound) or covering (plastic, paper).

The application of water or covering shall not erode, mar, or otherwise damage the concrete. Plastic film or paper shall meet the requirements of ASTM C 171. Black covering shall not be used when concreting in hot weather.

Except as otherwise specified in section 25, curing compound may be used for exposed surfaces or formed surfaces after patching and repair are completed. Unless otherwise specified, the curing compound shall be white pigmented and conform to ASTM C 309, Type 2, Class A or B. Clear curing compound (Type 1) or clear with fugitive dye (Type 1-D) may be used only when specified in section 25. Curing compounds shall not be used on a surface that is to receive additional concrete, paint, tile, or other coatings unless the contractor demonstrates that the membrane can be satisfactorily removed or can serve as a base for the later application.

Curing compound shall be thoroughly mixed before applying and be agitated during application. Except as otherwise specified in section 25, the compound shall be applied at a pressure of 75 to 100 pounds per square inch. A continuously agitating pressure sprayer is used for application at a uniform rate of not less than 1 gallon per 175 square feet of surface. Manual hand pump sprayers shall not be used unless otherwise specified. For individual concrete placements or repairs having a surface area of 400 square feet or less, curing compound may be applied with a soft-bristled brush, paint roller, or hand sprayer. The compound shall form a uniform, continuous, adherent film that shall not check, crack, or peel and shall be free from pinholes or other imperfections.

All surfaces covered with curing compound shall be continuously protected from damage to the protective film during the required curing period.

A surface subjected to heavy rainfall or running water within 3 hours after the compound has been applied or that is damaged by subsequent construction operations during the curing period shall be resprayed in the same manner as for the original application.

Water for curing shall be clean and free from any substances that cause discoloration of the concrete.

20. Concrete patching, repair or replacement

Patching—All form bolts, metal ties, and similar forming restraints shall be removed to a depth of 1 inch below the surface of the concrete and their cavities repaired unless otherwise specifically permitted or specified. Small cavities, large air holes, minor honeycombed areas, and other superficial imperfections that require patching to meet the specified finish requirements shall be thoroughly cleaned and filled. Holes left by bolts or straps that pass through the concrete section shall be filled solid with a dense, well-bonded, nonshrink patching material. Dry-pack mortar and replacement concrete shall follow the appropriate procedure detailed in the Repair and Maintenance chapter of the Concrete Manual, Bureau of Reclamation, U.S. Department of the Interior. Proprietary patching material shall be appropriate for the type of repair, used within the manufacturer's recommended limits, and applied according to the manufacturer's recommendations.

Repair or replacement—The contractor shall repair or replace concrete that does not meet the requirements of this specification. Before starting any repair or replacement work, the contractor shall prepare a written plan for the repair or replacement. The primary reference for material and repair methods for the plan shall be the appropriate sections of the Repair and Maintenance chapter of the Concrete Manual, Bureau of Reclamation, U.S. Department of the Interior. The repair plan shall be submitted to the engineer for review at least 10 days before any repair or replacement work. Approval of the plan will be authorized in writing by the contracting officer.

When proprietary patching material is proposed in the plan, the manufacturer's data sheets and written recommendations shall be included in the plan.

Repair material or replacement concrete shall have properties, color, and texture similar to and compatible with the concrete being repaired or replaced. Repair or replacement concrete work shall be performed only when the engineer is present.

Curing of repaired or replaced concrete shall be started immediately after finish work is completed and as specified in section 19 or as specified by the manufacturer of proprietary compounds.

21. Concreting in cold weather

Methods for concreting in cold weather shall be performed when, for more than 3 consecutive days, the following conditions exist:

- The average daily air temperature at the job site is less than 40 degrees Fahrenheit. (The average daily air temperature is the average of the highest and lowest temperatures occurring during the period from midnight to midnight.)
- The air temperature at the job site is not more than 50 degrees Fahrenheit for more than half of any 24-hour period.

Concrete shall be protected against freezing during the first 24 hours after placement whether or not the average weather conditions specified above for cold weather concreting exist. The following provisions also shall apply unless otherwise specified:

- a. When the cement is added to the mix, the temperature of the mixing water shall not exceed 140 degrees Fahrenheit nor shall the temperature of the aggregate exceed 150 F.
- b. The temperature of the concrete at the time of placing shall be within the placement temperature range shown below, unless otherwise specified.

Least dimension of section, inches	Placement temperature, °F
Less than 12	55 – 75
12 to 36	50 – 70
36 to 72	45 – 65
Greater than 72	40 – 60

- c. The minimum temperature of the concrete for the first 72 hours after placement shall not be less than the minimum temperature shown above. Concrete structures shall be immediately protected after concrete placement by covering, housing, insulating, or heating concrete structures sufficiently to maintain the minimum temperature adjacent to the concrete surface. If the minimum temperature requirements are not met and the concrete did not freeze, the protection time will be extended a period equal to twice the number of hours the temperature was below the minimum temperature.
- d. Exhaust flue gases from combustion heaters shall be vented to the outside of the enclosure. The heat from heaters and ducts shall be directed in such a manner as to not overheat or dry the concrete in localized areas or to dry the exposed concrete surface.
- e. At the end of the protection period, the concrete shall be allowed to cool gradually. The maximum decrease at the concrete surface in a 24-hour period shall not exceed 40 degrees Fahrenheit.

22. Concreting in hot weather

Methods for concreting in hot weather shall be in accordance with the requirements set forth below.

For the purpose of this specification, hot weather is defined as any combination of the following conditions that impair the quality of freshly mixed or hardened concrete by accelerating the rate of moisture loss and rate of cement hydration, or otherwise resulting in detrimental results:

- High ambient temperature
- High concrete temperature
- Low relative humidity
- Wind velocity
- Solar radiation

Whenever the above conditions exist or when climatic conditions are such that the temperature of the concrete may reasonably be expected to exceed 90 degrees Fahrenheit at the time of delivery to the worksite or during the placement operations, the following provisions shall apply:

- a. The contractor shall maintain the temperature of the concrete below 90 degrees Fahrenheit during mixing, conveying, and placing.
- b. Exposed concrete surfaces that tend to dry or set too rapidly shall be continuously moistened using fog sprays or other means to maintain adequate moisture during the time between placement and finishing. Water shall not be sprinkled or added directly to the surface of the concrete before finishing.
- c. Finishing of slabs and other exposed surfaces shall be started as soon as the condition of the concrete allows and shall be completed without delay. Water shall not be sprinkled or added to the surface of the concrete during the darbying, bull floating, floating, or other finishing operations to facilitate finishing.
- d. Formed surfaces shall be kept completely and continuously wet from the time the concrete takes initial set to when the forms are removed. After the forms are removed, the concrete surfaces shall be kept completely and continuously wet for the duration of the curing period or until curing compound is applied in accordance to section 21.
- e. Exposed and unformed concrete surfaces, especially flat work placed with large areas of surface, shall be kept completely and continuously wet for the duration of the curing period or until curing compound is applied in accordance to section 19. The concrete shall be protected against thermal shock from rapid cooling (5 °F per hour or more than 40 °F per 24-hour period) of the concrete by application of curing water or temperature changes during the first 24 hours of the curing period.
- f. When any single or combination of conditions may result in very rapid setting or drying of the concrete, extreme conditions exist. For flat work and slab construction, extreme conditions exist when the evaporation rate exceeds 0.2 pound per square foot per hour. The engineer may:
 - (1) Restrict placement to the most favorable time of the day.
 - (2) Restrict the depth of layers to assure coverage of the previous layer while it will still respond readily to vibration.
 - (3) Suspend placement until conditions improve.
 - (4) Restrict the removal of forms, repair, and patching to small areas that can be protected with curing compound immediately.

The evaporation rate for flat work and slab construction may be determined by calculating the evaporation rate from a shallow cake pan having a surface area of at least 1 square foot or by other methods approved by the engineer or designated in section 25.

23. Acceptance of the concrete work

Acceptance of the concrete work will be a cumulative acceptance process based upon progressively meeting the requirements of the specifications and drawings for:

- Fresh concrete
- Concrete strength and durability
- Structure dimensions
- Structure appearance

Fresh concrete—Fresh concrete conforming to the mix proportions and quality requirements of the approved job mix and the handling and placement requirements of previous sections will be satisfactory.

Concrete strength—A strength test is the average of the compressive strengths of two standard cured cylinders prepared and tested in accordance with section 4, unless otherwise specified. The strength of the hardened concrete is satisfactory if the following requirements are met:

- a. If method 1 from section 3 is specified and the concrete work is less than 75 total cubic yards for the class of concrete specified, the compressive strength of the concrete is satisfactory if no individual strength test falls more than 500 pounds per square inch below the specified compressive strength ($f'c$) for the respective class of concrete.
- b. If method 1 from section 3 is specified and the concrete work is 75 total cubic yards or more for the class of concrete specified, the compressive strength of the concrete is satisfactory if both of the following requirements are met:
 - (1) No individual strength test falls more than 500 pounds per square inch below the specified compressive strength ($f'c$) for the class of concrete specified.
 - (2) The average of any three consecutive strength tests is not less than the specified compressive strength ($f'c$) two or more consecutive times for the class of concrete specified.The contractor shall take steps to increase the average of subsequent strength tests when the average of any three consecutive strength tests falls below the specified concrete strength ($f'c$).
- c. The engineer determines the structural adequacy and evaluates the durability of the in-place concrete when the concrete strength based on the standard cured concrete cylinders is unsatisfactory. The engineer determines the need for additional quality assurance testing.
- d. The contractor may core the concrete, have the cores tested by a certified testing laboratory at the contractor's expense, and submit test results to the engineer for consideration and evaluation of concrete strength adequacy when the concrete strength based on the standard cured concrete cylinders is unsatisfactory.
- e. Sampling and testing concrete by coring shall conform to section 4. The strength of the concrete based upon concrete cores is satisfactory if both of the following requirements are met:
 - (1) The average compressive strength of the three cores equal or exceed 85 percent of the specified compressive strength ($f'c$).
 - (2) The compressive strength of any individual core does not fall below 75 percent of the specified compressive strength ($f'c$).
- f. If method 2 from section 3 is specified, the engineer is responsible for the concrete job mix design and the quality concrete that results from the job mix.

The hardened concrete is satisfactory if the required batch tickets or other documentation acceptable to the engineer clearly show that the batch ingredients and weights of each ingredient including all admixtures conforms to the job mix provided by the engineer. Random periodic inspection of the batching operations may be made by the engineer to verify that ingredients and ingredient

proportions conform to the batching documentation.

If the concrete ingredients, proportions, or admixtures varies from the job mix provided by the engineer, the concrete may be rejected if, in the judgment of the engineer, the variance will significantly affect the strength or durability of the concrete or will adversely affect the life expectancy or other components of the structure.

Structure dimensions and appearance

The appearance of the concrete shall meet the requirements of sections 17 and 18.

The dimensions of formed members, unless otherwise specified, are satisfactory if they conform to the requirements of the specifications, the locations shown on the drawings, and are within acceptable tolerances:

- a. Variation from plumb for walls and column shall be not more than 0.2 percent of the wall or column height.
- b. Variation from specified elevations for slabs, floors, or other horizontal members shall be not more than 0.2 percent of the length of the member in the direction of grade.
- c. Variations in the cross-sectional dimensions of columns and beams and in the thickness of walls and above-grade slabs shall not be more than minus 0.25 inch or plus 0.5 inch from the shown dimensions.

24. Measurement and payment

For items of work for which specific unit prices are established in the contract, concrete is measured to the neat lines or pay limits shown on the drawings, and the volume of concrete is computed to the nearest 0.1 cubic yard. No deduction in volume is made for chamfers, rounded or beveled edges, or for any void or embedded item that is less than 5 cubic feet in volume. Where concrete is placed against the sides or bottom of an excavation without intervening forms, drainfill, or bedding, the volume of concrete required to fill voids resulting from overexcavation outside the neat lines or pay limits is included in the measurement for payment where such overexcavation is directed by the engineer to remove unsuitable foundation material. However, this payment is only to the extent that the unsuitable condition is not a result of the contractor's improper construction operations, as determined by the engineer.

Method 1—Payment for each item of concrete is made at the contract unit price for that item. The payment for concrete will constitute full compensation for completion of the concrete work, including joint fillers, waterstops, dowels or dowel assemblies, and metal plates, but not including reinforcing steel or other items listed for payment elsewhere in the contract.

Method 2—Payment for each item of concrete is made at the contract unit price for that item. The payment for concrete constitutes full compensation for completion of the concrete work, including joint fillers, waterstops, metal plates, dowels, and other assemblies. It does not include furnishing and placing reinforcing steel or furnishing and handling cement or other items listed for payment elsewhere in the contract.

Cement is measured by dividing the volume of concrete accepted for payment by the yield of the applicable job mix. The yield is determined by the procedure specified in ASTM C 138. If the amount of cement actually used per batch exceeds the amount in the job mix specified by the engineer, the measurement is based on the amount of cement specified by the engineer for the job mix. Unless otherwise stated in section 25, a bag of cement is considered 94 pounds. Payment for each type of cement will be made at the contract unit price for furnishing and handling that type of cement and such payment will constitute full compensation for furnishing and handling the cement.

All methods—The following provisions apply to all methods of measurement and payment. Compensation for any item of work described in the contract, but not listed in the bid schedule, will be included in the payment for the item of work to which it is made subsidiary. Such items and the items to which they are made subsidiary are identified in section 25 of this specification.

25. ITEMS OF AND CONSTRUCTION DETAILS

Items of work to be performed in conformance with the specification and construction details are:

- a. Subsidiary Item, Concrete
 - (1) This item shall consist of placing cast-in-place or precast footings for the replacement culvert. At the contractors choosing, cast-in-place wingwalls may be used on the culvert.
 - (2) Under Section 3, Concrete Mix Design, Method 1 will apply. Concrete shall be Class 4000.
 - (3) Under Section 13, Construction Joints, no construction joints will be allowed.
 - (4) Under Section 24, Measurement and Payment, no method will apply. Concrete is subsidiary to Bid Item #6, Culvert Replacement.

Construction Specification 51—Corrugated Metal Pipe

1. Scope

The work consists of furnishing and placing circular, arched, or elliptical corrugated metal pipe and the necessary fittings.

2. Material

Pipe and fittings shall conform to the requirements of Material Specification 551, Coated Corrugated Steel Pipe, or Material Specification 552, Aluminum Corrugated Pipe, whichever is specified.

Unless otherwise specified in section 11 of this specification, perforated pipe furnished shall conform to the requirements for Class I perforations as described in ASTM A 760 or A 762.

3. Coupling bands and hardware

Pipe joint coupling bands shall be provided meeting the requirements specified in section 11 of this specification.

Hardware consisting of coupling bands and band fastening devices, such as connecting bolts, rods, lugs, and angles used in conjunction with zinc-coated iron or steel pipe, shall be galvanized by the hot-dip method. Hardware used in conjunction with aluminum pipe and aluminum or aluminum-zinc alloy-coated iron and steel pipe shall be of the same material as the pipe except that hot-dip galvanized or cadmium-plated fasteners may be used. The surface of all band-fastening devices for pipe specified with bituminous or polymer coating shall be coated with asphalt-mastic material meeting the requirements of ASTM A 849. The coupling band shall be coated similar to that specified for the pipe unless otherwise specified in section 11 of this specification.

Coupling bands shall be installed to provide straight alignment of the connecting pipe ends. Unless otherwise specified in section 11 of this specification, the bandwidth shall be as specified in ASTM A 760 and A 762. The bands shall be positioned to overlap adjacent pipe ends equally. The coupling bands shall be corrugated to match the corrugations of the pipe section ends being connected.

4. Fabrication

Fabrication of appurtenant sections shall be performed as shown on the drawings and described in section 11 of this specification. The items may consist of inlet sections, outlet sections, end sections, elbows, skew or beveled sections, rod reinforced ends, cut-off collars, or headwalls. Fabrication of these appurtenant sections shall be made from metallic-coated material identical to that from which the attached pipe is fabricated. Fabrication shall be of a quality and finished workmanship equal to that required for the pipe.

5. Handling the pipe

The contractor shall furnish equipment as necessary to install the pipe without damaging the pipe or coating. The pipe shall be transported and handled in a manner to prevent damage to the pipe and coating.

6. Laying and bedding the pipe

Unless otherwise specified, the pipe shall be installed in accordance with the manufacturer's recommendations. Pipe shall be installed so no reversal of grade between joints results unless otherwise shown on the drawings. The pipe shall be installed with the outside laps of circumferential joints pointing upstream and with longitudinal laps at the sides near the vertical mid-height of the pipe.

Field welding of corrugated galvanized iron or steel pipe is not permitted. The pipe sections shall be joined with fabricator-supplied coupling bands meeting the specified joint requirements. The coupling shall be installed as recommended by the fabricator.

The pipe shall be firmly and uniformly bedded throughout its full length to the depth and in the manner specified on the drawings.

Perforated pipe shall be installed with the perforations down and oriented symmetrically about a vertical centerline. Perforations shall be clear of any obstructions at the time the pipe is installed in its final position.

The pipe shall be loaded sufficiently during backfilling to prevent displacement from line and grade and to maintain full contact with the bedding during the placement operations.

7. Strutting

When required, struts or horizontal ties shall be installed in the manner specified on the drawings. Struts and ties shall remain in position until the backfill has been placed above the top of the pipe to a height of 5 feet or the pipe diameter, whichever is greater, or to the surface of the completed earth backfill when the fill height is less than 5 feet above the top of the pipe. The contractor shall remove the struts or ties following completion of the earth backfill requirements that apply.

8. Embedment in concrete

Special treatment shall be provided to the pipe surface when embedded or attached to concrete and the pipe material is aluminum or aluminum-coated and aluminum-zinc alloy-coated. Potential contact surfaces in contact with concrete and masonry surfaces shall be coated with two coats of a bituminous paint of the cutback type. Placement of the pipe shall be such that direct metal-to-metal contact with other metallic material, such as embedded steel reinforcement or water control gates, is prevented.

9. Repair of damaged coating

Any damage to the metallic coating shall be repaired by cleaning the damaged surface area by sand blasting, power disk sanding, or wire brushing. All loose and cracked coating, dirt, and any products of corrosion shall be removed before application of paint. Oil and grease material shall be removed by use of a solvent. The surface shall be clean and dry during the painting period and until the coating has completely dried.

Painting shall be accomplished by one of the following options based upon installed exposure conditions of the pipe as determined by the engineer.

Normal exterior or interior atmospheric exposure:

- a. Zinc dust - zinc oxide primer, ASTM D 79 and D 520
- b. Single package, moisture cured urethane prime in silver metallic color, or

- c. Zinc-rich cold galvanized compound, brush, or aerosol application

Submergence in water exposure:

- a. Zinc dust - zinc oxide primer, ASTM D 79 and D 520
- b. Zinc dust paint, ASTM D 4146

When the metallic coating is damaged in any individual area larger than 12 square inches or if more than 0.2 percent of the total surface area of a single pipe section is damaged, that section of pipe will be rejected.

Breaks or scuffs in bituminous coatings that are less than 36 square inches in area shall be repaired by applying two coats of hot-asphaltic paint or a coating of cold-applied bituminous mastic. The repair coating shall be a minimum of 0.05 inch thick after hardening and shall bond securely and permanently to the pipe and coating. The material shall meet the minimum physical requirements for bituminous coating in ASTM A 849 and A 885. Whenever individual breaks exceed 36 square inches in area or when the total area of breaks exceeds 0.5 percent of the total surface area of an individual pipe section, that section of pipe will be rejected.

Bituminous coating damaged by welding of coated pipe or pipefittings shall be repaired as specified in this section for breaks or scuffs in bituminous coatings.

Breaks or scuffs in polymer coatings that are less than 36 square inches in area shall be repaired by the application of a polymer material similar to and compatible with the durability, adhesion, and appearance of the original polymer coating, as described in ASTM A 849, paragraph 6.8. The repair coating shall be a minimum thickness of 0.010 inch (10 mils) after drying. Whenever individual breaks exceed 36 square inches in area or when the total area of breaks exceeds 0.5 percent of the total surface area of the individual pipe section, that section of pipe will be rejected.

10. Measurement and payment

Method 1—For items of work for which specific unit prices are established in the contract, the quantity of each type, class, size, and gauge of pipe is determined to the nearest 0.1 foot by measurement of the laid length of the pipe along the centerline of the pipe. Payment for each type, class, size, and gauge of pipe is made at the contract unit price for that type, class, size and gauge of pipe. Such payment constitutes full compensation for furnishing, transporting, and installing the pipe and fittings and all other items necessary and incidental to the completion of the work except items designated as *special fittings*. Special fittings are those sections of pipe requiring special fabrication to meet layout requirements. Payment for special fittings is made at the contract unit price for special fittings (CMP).

Method 2—For items of work for which specific unit prices are established in the contract, the quantity of each type, class, size, and gauge of pipe is determined as the sum of the nominal laying lengths of the pipe sections installed. Payment for each type, class, size, and gauge of pipe is made at the contract unit price for that type, class, size, and gauge of pipe. Such payment constitutes full compensation for furnishing, transporting, and installing the pipe and fittings and all other items necessary and incidental to the completion of the work except items designated as *special fittings*. Special fittings are those sections of pipe requiring special fabrication to meet layout requirements. Payment for special fittings is made at the contract unit price for special fittings (CMP).

Method 3—For items of work for which specific lump sum prices are established in the contract, payment for corrugated metal pipe structures is made at the contract lump sum price. Such payment constitutes full compensation for furnishing, fabricating, transporting, and installing the pipe structure complete with metal pipe, fittings, and appurtenances, and all other items necessary and incidental to completion of the work, which includes, except as otherwise specified, required excavation, dewatering, and earth backfill.

All Methods—The following provisions apply to all methods of measurement and payment. Compensation for any item of work described in the contract, but not listed in the bid schedule, is included in the payment for the item of work to which it is made subsidiary. Such items and items to which they are made subsidiary are identified in section 11 of this specification.

11. ITEMS OF AND CONSTRUCTION DETAILS

Items of work to be performed in conformance with the specification and construction details are:

- a. Bid Item #6, Culvert Replacement
 - (1) This item shall consist of supplying and installing a new bottomless arch culvert, including culvert plate, concrete footings, channel substrate, compacted backfill. The contractor has the choice to install prefabricated head and wingwalls, or reinforced concrete head and wingwalls.
 - (2) The bottomless arch will be nominally 21 feet wide at the bottom and 6.5 feet tall. It will be designed for H25 loading.
 - (3) In Section 10, Measurement and Payment, Method #3 shall apply. Payment will be in a lump sum. Subsidiary to this item are concrete footings, headwalls and wingwalls and compacted backfill.

Construction Specification 61—Rock Riprap

1. Scope

The work shall consist of the construction of rock riprap revetments and blankets, including filter or bedding where specified.

2. Material

Rock riprap shall conform to the requirements of Material Specification 523, Rock for Riprap, or if so specified, shall be obtained from designated sources. It shall be free from dirt, clay, sand, rock fines, and other material not meeting the required gradation limits.

At least 30 days before rock is delivered from other than designated sources, the contractor shall designate in writing the source from which rock material will be obtained and provide information satisfactory to the contracting officer that the material meets contract requirements. The contractor shall provide the contracting officer's technical representative (COTR) free access to the source for the purpose of obtaining samples for testing. The size and grading of the rock shall be as specified in section 8.

Rock from approved sources shall be excavated, selected, and processed to meet the specified quality and grading requirements at the time the rock is installed.

Based on a specific gravity of 2.65 (typical of limestone and dolomite) and assuming the individual rock is shaped midway between a sphere and a cube, typical size/weight relationships are:

Sieve size of rock	Approx. weight of rock	Weight of test pile
16 inches	300 pounds	6,000 pounds
11 inches	100 pounds	2,000 pounds
6 inches	15 pounds	300 pounds

The results of the test shall be compared to the gradation required for the project. Test pile results that do not meet the construction specifications shall be cause for the rock to be rejected. The test pile that meets contract requirements shall be left on the job site as a sample for visual comparison. The test pile shall be used as part of the last rock riprap to be placed.

Filter or bedding aggregates when required shall conform to Material Specification 521, Aggregates for Drainfill and Filters, unless otherwise specified. Geotextiles shall conform to Material Specification 592, Geotextile.

3. Subgrade preparation

The subgrade surface on which the rock riprap, filter, bedding, or geotextile is to be placed shall be cut or filled and graded to the lines and grades shown on the drawings. When fill to subgrade lines is required, it shall consist of approved material and shall conform to the requirements of the specified class of earthfill.

Rock riprap, filter, bedding, or geotextile shall not be placed until the foundation preparation is completed and the subgrade surface has been inspected and approved.

4. Equipment-placed rock riprap

The rock riprap shall be placed by equipment on the surface and to the depth specified. It shall be installed to the full course thickness in one operation and in such a manner as to avoid serious displacement of the underlying material. The rock for riprap shall be delivered and placed in a manner that ensures the riprap in place is reasonably homogeneous with the larger rocks uniformly distributed and firmly in contact one to another with the smaller rocks and spalls filling the voids between the larger rocks. Some hand placing may be required to provide a neat and uniform surface.

Rock riprap shall be placed in a manner to prevent damage to structures. Hand placing is required as necessary to prevent damage to any new and existing structures.

5. Hand placed rock riprap

The rock riprap shall be placed by hand on the surface and to the depth specified. It shall be securely bedded with the larger rocks firmly in contact one to another without bridging. Spaces between the larger rocks shall be filled with smaller rocks and spalls. Smaller rocks shall not be grouped as a substitute for larger rock. Flat slab rock shall be laid on its vertical edge except where it is laid like paving stone and the thickness of the rock equals the specified depth of the riprap course.

6. Filter or bedding

When the contract specifies filter, bedding, or geotextile beneath the rock riprap, the designated material shall be placed on the prepared subgrade surface as specified. Compaction of filter or bedding aggregate is not required, but the surface of such material shall be finished reasonably smooth and free of mounds, dips, or windrows.

7. Measurement and payment

Method 1—For items of work for which specific unit prices are established in the contract, the quantity of each type of rock riprap placed within the specified limits is computed to the nearest ton by actual weight. The volume of each type of filter or bedding aggregate is measured within the specified limits and computed to the nearest cubic yard by the method of average cross-sectional end areas. For each load of rock riprap placed as specified, the contractor shall furnish to the COTR a statement-of-delivery ticket showing the weight to the nearest 0.1 ton.

Payment is made at the contract unit price for each type of rock riprap, filter, or bedding. Such payment is considered full compensation for completion of the work.

Method 2—For items of work for which specific unit prices are established in the contract, the quantity of each type of rock riprap placed within the specified limits is computed to the nearest 0.1 ton by actual weight. The quantity of each type of filter or bedding aggregate delivered and placed within the specified limits is computed to the nearest 0.1 ton. For each load of rock riprap placed as specified, the contractor shall furnish to the engineer a statement-of-delivery ticket showing the weight to the nearest 0.1 ton. For each load of filter or bedding aggregate, the contractor shall furnish to the COTR a statement-of-delivery ticket showing the weight to the nearest 0.1 ton.

Payment is made at the contract unit price for each type of rock riprap, filter, or bedding. Such payment is considered full compensation for completion of the work.

Method 3—For items of work for which specific unit prices are established by the contract, the volume of each type of rock riprap and filter or bedding aggregate is measured within the specified limits and computed to the nearest cubic yard by the method of average cross-sectional end areas.

Payment is made at the contract unit price for each type of rock riprap, filter, or bedding. Such payment is

considered full compensation for completion of the work.

Method 4—For items of work for which specific unit prices are established by the contract, the volume of each type of rock riprap, including filter and bedding aggregate, is measured within the specified limits and computed to the nearest cubic yard by the method of average cross-sectional end areas.

Payment is made at the contract unit price for each type of rock riprap, including filter and bedding. Such payment is considered full compensation for completion of the work.

Method 5—For items of work for which specific unit prices are established by the contract, the quantity of each type of rock riprap placed within the specified limits is computed to the nearest ton by actual weight. For each load of rock for riprap placed as specified, the contractor shall furnish to the COTR a statement-of-delivery ticket showing the weight to the nearest 0.1 ton.

Payment is made at the contract unit price for each type of rock riprap, including geotextile used for filter or bedding. Such payment is considered full compensation for completion of the work.

Method 6—For items of work for which specific unit prices are established by the contract, the volume of each type of rock riprap is measured within the specified limits and computed to the nearest cubic yard by the method of average cross-sectional end areas.

Payment is made at the contract unit price for each type of rock riprap, including geotextile used for filter or bedding. Such payment is considered full compensation for completion of the work.

All methods—The following provision applies to all methods of measurement and payment. Compensation for any item of work described in the contract, but not listed in the bid schedule, is included in the payment for the item of work to which it is made subsidiary. Such items and the items to which they are made subsidiary are identified in section 8.

No separate payment is made for testing the gradation of the test pile. Compensation for testing is included in the appropriate bid item for riprap.

8. ITEMS OF WORK AND CONSTRUCTION DETAILS

Items of work to be performed in conformance with the specification and construction details are:

a. Bid Item #8, Rock Structures

- (1) This item shall consist of furnishing and placing rock riprap. Rock riprap will be installed to form rock drop structures as shown on the drawings and staked in the field. Rock for the primary weirs will be imported. Rock for the secondary weirs may be available on site from Bid Item #7. The material to be pressure washed into the structures will have to be provided.
- (2) In Section 2, Materials.

- a. Rock gradation for the primary weirs and secondary weirs will be as shown on the drawings. Gradation for the channel material (which will come from on-site) is expected to be as follows:

<u>Size Opening</u> <u>(inches)</u>	<u>% Passing</u> <u>Dry Weight Basis</u>
18	100
12	75-100
9	40-60
6	20-40
<6	0-10

- (3) Rock amounts are estimated to be, in cubic yards (tons):

Primary weirs	220 (350)
Secondary weirs	180 (290)
Structure infill	100 (160)
Pressure washed sealing material	100 (160)

- (4) In Section 7, Measurement and Payment, Method 2 will apply. The contractor will provide the engineer with a weight ticket for that truck. Tons will be converted to CY using a factor of 1.6 T/CY.