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DIVISION 02 - SITE WORK

SECTION 02100

CLEAR SITE AND REMOVE OBSTRUCTIONS

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SECTION 02100

CLEAR SITE AND REMOVE OBSTRUCTIONS

PART 1 GENERAL

1.1 PROTECTION

1.1.1 Protection of Existing Work

Before beginning any cutting or demolition work for removals, the Contractor shall carefully survey the existing work and examine the drawings and specifications to determine the extent of the work. The Contractor shall take all necessary precautions to insure against damage to existing work to remain in place or to be reused, and any damage to such work shall be repaired or replaced as approved by the Contracting Officer at no additional cost to the Government. The Contractor shall carefully coordinate the work of this section with all other work and construct and maintain shoring, bracing and supports, as required. The Contractor shall insure that structural elements are not overloaded and be responsible for increasing structural supports or adding new supports as may be required as a result of any cutting, removal, or demolition work performed under any part of this contract.

1.1.2 Environmental Protection

All work and Contractor operations shall comply with the requirements of SECTION 01410: ENVIRONMENTAL PROTECTION.

1.2 BURNING

The use of burning at the project site for the disposal of refuse and debris will not be permitted.

PART 2 PRODUCTS

Not used.

PART 3 EXECUTION

3.1 REQUIREMENTS

3.1.1 General

Except as hereinafter specified, and/or indicated, areas to be cleared and grubbed will be limited to actual excavation areas and areas on which fills and/or structures are to be placed. The removal of trees, shrubs, turf, and other vegetation outside of these areas shall be held to a minimum and care shall be exercised not to damage any trees, shrubs, turf, or vegetation which can be left in place.

3.1.2 Existing Structures and Obstructions

The Contractor shall clear the site, including all fill, borrow, and excavation areas, and remove and dispose of all existing structures and obstructions for project construction, except as otherwise noted on the drawings. Obstructions which are designated or specified to be removed but which are not designated or specified to be removed by others shall be removed by the Contractor. Except as otherwise specified, obstructions designated to be removed by others will be removed in sufficient time to preclude interference with the Contractor's operations. Utility relocations are not considered to be obstructions.

3.1.3 Clearing

Clearing shall consist of the removal of all trees, brush, rubbish, fences and other objectionable material. Trees shall be cut a maximum of one foot above ground surface. Other vegetation shall be cut off flush or slightly below the original ground surface. Clearing operations shall be conducted so as to prevent damage to trees, structures, and installations under construction, or to remain in place, and to provide for the safety of employees and others. All rubbish, waste dumps, and debris areas shall be cleared.

3.1.4 Grubbing

Grubbing shall consist of removing all stumps, roots, logs, and other objectionable vegetable matter in the required fills, borrow, foundation areas, and all excavation areas. In grubbing out stumps and roots, all roots or other timber shall be removed to the extent specified hereinafter. Stumps shall be pulled, not cut off.

3.1.5 Utilities

Prior to removing an obstruction, all applicable utility relocations shall have been coordinated as required per SECTION 01200: GENERAL REQUIREMENTS.

3.2 AREAS TO BE CLEARED AND GRUBBED

3.2.1 Existing Embankment

All features not otherwise specified in Section 02200: EXCAVATION, shall be removed and disposed of.

3.2.2 Outlet Works, Approach Channel and Abutments

The area to be excavated for the outlet works, approach channel and abutments shall be cleared and grubbed by the Contractor. In areas where soil or overburden will be excavated for direct use in embankment or for stockpiling, roots 1-1/2 inches or more in diameter will be removed to a depth of 18 inches below natural ground surface. In areas where soil and overburden is to be excavated and wasted, grubbing shall be required only to the extent needed to prepare for excavation. Clearing and grubbing includes the removal of all interfering items including existing asphalt structures fences, wells and all other items identified on plans or interfering with the work, but not identified on the plans.

3.2.3 Borrow Areas

Clearing and grubbing in the borrow areas shall be done only in the areas where material is to be excavated and removed. Roots 1-1/2 inches or more in diameter, shall be removed to a depth of 18 inches below the original

ground surface.

3.2.4 Disposal Areas and Stockpile Areas

Disposal areas shall be cleared to the extent needed for disposal of waste material. Stockpile areas shall be cleared to the extent needed for stockpiling, blending, and recovery of material. Stockpile areas may be developed within the workments identified on the plans for this project. Disposal and stockpile areas shall not be grubbed. Permanent disposal areas as identified on the plans shall be used only for the disposal of non-degradable materials (i.e. concrete and earth). Organic material and vegetation striped from the dam site shall be hauled and stockpiled adjacent to the borrow sites. The organic material and vegetation stockpiled shall be spread uniformly throughout the borrow site upon completion of the excavation from the selected borrow site.

3.2.5 Demolition of Existing Intake Structure and Access Bridge

Existing intake structure and access bridge shall be removed to the extent and limits shown on the plans. Concrete removal shall be performed without damage to any structure that is to remain in place.

Blasting or similar methods of fracturing concrete by explosive release of energy or impact of a projectile on the surface of the concrete will be permitted.

3.2.6 Abandon Existing Intake Structure and Access Bridge

Existing outlet conduit and transition structure, where shown on the plans to be abandoned, shall be abandoned in place. All resulting openings into the existing intake structure shall be plugged with shotcrete barrier, and the existing bypass inlet and outlet pipes shall be sealed. The entrance to the existing gate well shall also be covered with a reinforced concrete slab.

The structures to be abandoned shall be backfilled with sand to the extent and limits shown on the plans, by any method acceptable to the Contracting Officer which completely fills the conduits and transition structure. Sand backfill material shall be clean, free draining, and free from roots and other deleterious substances.

The openings into the existing intake structure shall be securely closed by a reinforced shotcrete plug which is epoxy doweled all around into the existing structure. A pair of peripheral metallic waterstop epoxied in grooves shall be added to provide a watertight barrier.

The existing bypass inlet pipe with sand backfill shall be plugged with a steel plate welded to the pipe. The existing bypass outlet pipe shall also be sealed with a steel plate. The existing gate well entrance shall be covered with a reinforced concrete slab per detail shown on the plans.

The demolition and/or abandonment of the existing intake structure and access bridge may not commence without prior approval of the Contracting Officer. The existing outlet conduit and transition structure shall not be abandoned until the new intake structure is completely operational and has been accepted.

3.2.7 Removal of Existing Railroad Piers

The existing piers in the vicinity of the outlet channel shall be removed to one foot below the subgrade for the channel.

3.2.8 Other Areas

Any area where embankment fill will be placed or where facilities will be excavated, such as road and dike fill or the approach channel excavation, shall be cleared and grubbed. Roots 1-1/2 inches or more in diameter shall be removed to a depth of 18 inches below existing ground surface.

3.3 DISPOSAL OF CLEARED, GRUBBED, AND REMOVED MATERIAL

All material removed, except material specified and/or indicated to be stockpiled, is designated as scrap, shall become the property of the Contractor, and shall be removed from the site. All rubble, trash, debris that is degradable shall be disposed of in an approved landfill. The Contractor may dispose of approved materials to the permanent disposal site to the greatest extent possible. Excess material shall be disposed of offsite. Unsuitable materials from clearing operations may be temporarily used for diversion and control of water. Disposal of unsuitable materials shall be in accordance with the requirements of SECTION 02200: EXCAVATION.

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DIVISION 02 - SITE WORK

SECTION 02130

DIVERSION AND CONTROL OF WATER

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SECTION 02130

DIVERSION AND CONTROL OF WATER

PART 1 GENERAL

1.1 GENERAL

It is anticipated that storm, surface, ground and or other waters will be encountered at various times and locations during the work as a result of groundwater, rainfall and/or the Santa Ana River and the operation of the dam. Such waters may interfere with Contractor's operation and may cause damage to the construction by flooding, lateral erosion, sedimentation or pollution if not properly controlled by the Contractor. The Contractor, by submitting a bid assumes all of said risk and the Contractor acknowledges that a bid was prepared accordingly. The responsibility of the Contractor for protection of work is specified in paragraph: Damage to Work.

Prado Dam will be operated during the construction period to provide flood control and water conservation benefits. Operation of the dam during the construction period will be outlined in a Corps document entitled "Prado Dam Interim Water Control During Construction". The Contractor shall plan his activities so as they do not interfere with the operation of the dam, as described in the said document. Should a conflict between construction and the operation of the dam arise, the dam will be operated with priority given to public safety, flood control and water conservation.

The Contractor shall conduct its operations in such a manner that storm or other waters may proceed without diversion or obstruction along existing drainage courses. Diversion of water for short reaches in order to protect construction in progress will be permitted.

During the course of water control, the Contractor shall conduct construction operations to protect water from being polluted with fuels, oils, bitumens or other harmful materials, and shall be responsible for removing said materials in the event protective measures are not protective.

1.2 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Cofferdam System; G

Water Control Plan; G

1.3 MAINTENANCE OF DAM OPERATION

The Contractor is responsible for following the sequence and stages of construction as outlined in the paragraph: Sequence of Construction, in order to maintain the operation and integrity of Prado Dam. The existing outlet works must remain in operation until the new outlet works and runout channel are complete. The new outlet works must be operational and accepted prior to any demolition of the existing outlet works. The Contractor shall maintain access to the existing outlet works and control tower via the SR-71 at all times until the new outlet works is accepted. Specifically, the Contractor shall not hinder the dam tender's access to any part of the dam, existing outlet channel and downstream gage station at any time. The Contractor shall not compromise the integrity or functionality of the existing dam embankment nor take any action that lowers the maximum elevation at which water can be stored at any time, other than what is stated hereinbelow.

The embankment of Prado Dam shall be constructed in stages to maintain the integrity of the Dam. Specific requirements include

a. Construct the outlet works in the stages identified in the plan documents,

b. Excavate the existing Dam crest and reconstruct only between May 1 and August 1.

c. Plan the work cycle with consideration for the flood seasons and water conservation operations.

The contractor shall not plan or rely on any special operation of the dam to protect his work or work area.

1.3.1 Sequence of Construction

The order of work established in this section is for the purpose of maintaining the operation and integrity of the existing dam. The Contractor is responsible for the development of his own construction schedule, but shall incorporate and comply with the sequence of construction as defined in this section. Adjustments in the sequence require the approval of the Contracting Officer and must be coordinated with the District's Reservoir Regulation Section (Brian Tracy, phone: (213) 452-3527, fax: (213) 452-4202.

Phase 1

1. Coordinate the relocation of SCE and SCG electric and gas line facilities by the utility agencies.

2. Clear the Dam and borrow sites. Commence development of borrow sites and borrow haul roads.

3. Construct the cofferdam as part of the Stage 1 grading including the Contractor’s designed seepage control system.

4. Construct the Stage 1 portion of the outlet works intake facility, transition structure, conduit and stilling basin;

5. Concurrent with the Stage 1 construction, remove and stockpile the gravel blanket on the south side of the embankment. Commence construction of south embankment to elevation 558.

Phase 2

1. Construct over the completed portions of the conduit, the specified materials to the lines and grades identified in the Stage 2 a and Stage 2 b grading. Prior to commencement of the Stage 2 c grading, install gates in the intake structure in a closed position. The integrity of the dam shall be secured prior to proceeding with Stage 2 c construction.

2. Construct Stage 2 c grading and conduit, remove cofferdam and relocate SARI line.

3. Construct runout channel leaving an opening for the existing runout channel in order to maintain operation of existing dam.

Phase 3

1. Construct Stage 3 grading which includes the completion of the dam embankment over the conduit constructed during Stage 2 c, approach and plot channel grading.

2. Excavate existing dam crest between May 1 and August 1 and proceed with raising embankment to final grade between Sta. 8+00 and E.O.P.

3. Complete interior of outlet works. Install access bridge, electrical systems, well and waterline, sewer facilities, complete and transfer operations of dam from existing outlet works to new outlet works, complete paving of all access road and embankment except for SR-71 access road and beginning of embankment.

Phase 4

1. Remove existing access bridge and demobilize outlet works.

2. Excavate existing dam crest between Sta. B.O.P. and Sta. 8+00 between May 1 and August 1 complete embankment.

3. Plug existing outlet works, complete runout channel, fill existing runoff channel to final grade.

4. Final projects: close borrow sites, hydroseed and demobilize equipment.

The Contractor shall not implement any haul road for Stage 1 grading that will breach the integrity of the existing dam. Any Contractor developed haul roads that deviate from the Stage 1 grading design shall require the approval of the Contracting Officer.

1.4 COFFERDAM SYSTEM

The cofferdam and seepage control system are a required part of the diversion and control of the water plan. The Constructed cofferdam system will have a minimum crest elevation at 525. The cofferdam system shall be constructed as specified in Section 02200: EXCAVATION. Alternate designs may be submitted for approval by the Contracting Officer for the configuration of the cofferdam and the seepage control features.

1.4.1 Water Conservation Storage

To the extent that flood protection is not compromised and environmental constraints are met, Prado Dam is utilized to store flood runoff and release water at a rate that can be recharged to groundwater downstream by the Orange County Water District (OCWD). Pool regulation differs slightly during the winter flood season and the non-flood season.

Winter Flood Season. (1 October to 28 February) Pool elevation for water conservation will not exceed 494 feet.

Non-Flood Season. (1 March to 30 September) The allowable maximum reservoir elevation for water conservation is increased from 494 feet to 505 feet. An outflow of 200-600 cubic-feet per second is maintained as requested by the OCWD until the pool is exhausted. The pool may be maintained until 31 August. The month of September is designed for maintenance purposes. Maintenance activities that require a dry reservoir will be performed at this time.

1.5 BORROW AREAS

Surface drainage from the borrow areas shall be controlled by dikes, ditches, sump pumps, drainage pipes, etc. Suitable drainage facilities shall be provided to protect existing facilities which are to remain in place. The Contractor shall submit a borrow site drainage plan for the Contracting Officer's review and approval.

1.6 DRAINAGE DITCHES AND SUMPS

The location and depth of any bypass drainage ditch or sump shall be subject to Government approval. Special precautions shall be taken to avoid impairing the permanent subgrade or embankment foundation. Any excavation below the foundation subgrade shall be refilled with compacted fill in accordance with the SECTION 02200: EXCAVATION and Section 02212: EMBANKMENT by and at the expense of the Contractor.

1.7 WATER CONTROL PLAN

Thirty (30) calendar days prior to construction of the diversion facilities specified in paragraph: Sequence of Construction, the Contractor shall submit plans showing the proposed methods to dewater each working area and control the water from rain, sheet flow, streamflows, and other surface water. The plans shall show the scheme of operations and a complete layout of drainage pipes, pumps, diversion channels, cofferdams, etc. The Contractor shall assume full responsibility for the adequacy of his dewatering and control methods. Prior knowledge by the Contracting Officer of the Contractor's method of dewatering will in no way release the Contractor from the fulfillment of his obligations or place the Government, in any manner, responsible for any losses due to failure or inadequacy of the dewatering and control method used.

1.7.1 Damage to Work

Except as herein provided, damage to all work (including temporary construction), utilities, materials, equipment and plant shall be repaired to the satisfaction of the Contracting Officer at the Contractor's expense, regardless of the cause of such damage. As specified in the CONTRACT CLAUSE: PERMITS AND RESPONSIBILITIES "The Contractor shall be responsible for all materials-delivered and work performed until completion and

acceptance of the entire work, except for any completed unit of work which may have been accepted under the contract." However, if any part of the accepted permanent work performed by the Contractor is damaged by surface flows in excess of a 25 year storm, the Contractor will make the repairs as ordered by the Contracting Officer and full compensation for such repairs will be made at the applicable contract unit or lump sum prices as fixed and established in the contract. If, in the opinion of the Contracting Officer, there are no contract unit or lump sum prices applicable to any part of such work an equitable adjustment pursuant to CONTRACT CLAUSE: CHANGES, will be made as full compensation for the repairs of that part of the accepted permanent work for which there are no applicable contract unit or lumps prices.

PART 2 PRODUCTS

Not used.

PART 3 EXECUTION

Not used.`

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DIVISION 02 - SITE WORK

SECTION 02200

EXCAVATION

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SECTION 02200

EXCAVATION

PART 1 GENERAL

1.1 GENERAL INFORMATION

Excavation shall consist of the removal and appropriate disposal of every type of material encountered except materials covered by the provisions of the SECTION 02100: CLEAR SITE AND REMOVE OBSTRUCTIONS, or from other areas as directed, to the lines, grades and elevations indicated. The material to be removed may include but is not limited to earth, silt, clay, sand, gravel, cobbles, conglomerate, alluvium, and rock. "Rock" is defined as either fresh, decomposed, or weathered in-place bedrock. Excavation for permanent cuts shall be made to the slope lines indicated. Excavation shall be performed in a manner which will not impair the subgrade. Except as otherwise directed or specified, the finished surface of subgrade which will form the foundation for concrete structures (except for excavation in rock) shall be not more than plus or minus 1.0 inch from the indicated grade at any point when tested with a 10-foot straight edge. Any excavation or overcut made outside the payment lines indicated on the drawings or staked in the field shall be refilled with suitable earth or concrete in an approved manner by and at the expense of the Contractor, except where such overcut is directed or specified, in which case payment for such overcut and fill will be made at the applicable contract unit prices for the type of excavation and fill made. Excavation in rock within the limits of the Zone II material contact area shall be done in such a manner that abrupt changes in slope are avoided. The Zone II material contact area refers to the area of contact of the bedrock against which the Zone II material is placed. Methods used to achieve these slopes shall conform to the requirements specified in paragraph: EXCAVATION, ROCK.

1.2 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM D 2487	(1998) Classification of Soils for Engineering Purposes (Unified Soil Classification System)

1.3 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Excavation Plan; G

An excavation plan will be required. See PARAGRAPH, EXCAVATION PLAN.

SD-03 Product Data

Survey data; G

Survey data, including location numbers, date of survey, Lambert coordinates, elevation, and other pertinent data.

SD-05 Design Data

Rock reinforcement system

Design and backup calculations of rock reinforcement system for vertical excavation of bedrock discussed in PARAGRAPH, VERTICAL EXCAVATION OF ROCK WITHIN THE OUTLET CONDUIT EXCAVATION.

Cofferdam

Design and construction procedures for cofferdam and cutoff.

SD-06 Test Reports

Testing of Gravel Blanket

Downstream gravel gradation and thickness test results.

1.4 AVAILABILITY OF ADDITIONAL INFORMATION

Additional design information and data are available through the Contracting Officer. Information relevant to this specification is included in the Phase II General Design Memorandum on the Santa Ana River (Prado Dam), the Draft Feature Design Memorandum No. 12 Prado Dam Outlet Works, pump test data, and groundwater data. It is emphasized that significant changes have been incorporated into the Plans and Specifications from the designs proposed in the design memorandums. The design memorandums and other data are available for information purposes only and are not a part of the contract documents since they have been superseded by the Plans and Specifications.

1.5 EQUIPMENT

All plant, equipment, tools, and machines used in the performance of the work covered by this section shall be subject to the approval of the Contracting Officer, and shall be maintained in satisfactory working condition at all times. Excavating equipment used in the areas from which fill and borrow materials are obtained shall be capable of excavating to varying depths and of producing the necessary blending required to consistently meet the specified gradation requirements.

1.6 EXCAVATION LIMITS

Limits of excavation for the various structures and parts of the work are as indicated on the drawings, but the right is reserved to increase or

decrease the depth or areal extent of excavation if, in the opinion of the Contracting Officer, the conditions encountered warrant such modifications. Except as otherwise directed, the Contractor shall make all excavations to the profiles and sections indicated.

1.7 DISPOSAL OF EXCAVATED MATERIAL

Excavated material meeting the requirements of SECTION 02250, FILLS AND SUBGRADE PREPARATION or SECTION 02212, EMBANKMENT, for embankment or fill shall be placed in the embankment, stockpile or fill areas as approved by the Contracting Officer. The Contractor shall stockpile approved excavation materials as delineated in PARAGRAPH, EXCAVATION, BORROW AREAS, as well as materials that cannot be feasibly sequenced into immediate placement as backfill or embankment fill in areas approved by the Contracting Officer; no additional payment will be made for stockpiling or rehandling from stockpile to place of final disposition. Materials not meeting the requirements defined in SECTION 02212, EMBANKMENT, PART 2, PRODUCTS, or SECTION 02250, FILLS AND SUBGRADE PREPARATION, PART 2, PRODUCTS from the borrow areas and required excavations, and unsatisfactory material, as defined in PARAGRAPH, REMOVAL OF UNSATISFACTORY SOILS, shall become the Contractor's property and shall either be removed from the site or wasted in the on site permanent disposal areas to the extent that they can be accommodated, at the Contractor's option.

1.8 PRESERVATION OF PROPERTY

All excavation operations shall be conducted in such a manner that improvements which are to remain in place permanently will not be damaged or subjected to settlement or horizontal embankment movement.

1.9 Excavation Plan

An excavation plan, including methods and equipment to be used in excavating each area or feature, location of existing structures to be removed or remain, methods of blending and stockpiling excavated material, locations of stockpile and temporary disposal areas, proposed methods for transporting material from the borrow area to the embankment or stockpiles, precautions to be taken to protect the existing spillway and to ensure that excavation operations do not go beyond the limits shown, methods to be used for protecting the rock foundation of the outlet works, measures to be taken to minimize or preclude affects of slaking of bedrock, procedures for providing a uniform surface in which cobbles and boulders would not project more than 9 inches from the specified plane of excavatioin, haul roads into and out of excavations (including haul roads for material excavated from below the top of the conduit elevation), and location of proposed structures, including fences, signs, trailers, conveyor systems, stationary processing equipment, staging areas and designated parking areas, shall be submitted to the Contracting Officer for approval thirty (30) calendar days prior to commencing excavation. The excavation plan shall include the Contractor's proposal for removing material meeting the requirements for Zone II to expose the surface of materials meeting the requirements of Zone I.

PART 2 PRODUCTS (Not Applicable)

PART 3 EXECUTION

3.1 COFFERDAM AND DEWATERING

3.1.1 Cofferdam

Prior to the Stage I excavation, a cofferdam shall be constructed as shown in the plans. Zone II material shall be used. The cofferdam shall be constructed in accordance with all specifications pertinent to Zone II fill delineated in Section 02212. Prior to placement of fill, weaker surface materials and organics shall be removed and the surface proof-rolled by 4 passes of a 10 ton vibratory steel wheeled roller. A contractor-designed impervious cutoff shall be provided between the top of the existing ground surface and the bedrock. It should be noted that the depth to bedrock in this area is variable and not well defined. The cofferdam and impervious cutoff shall be designed and stamped by a licensed professional engineer authorized to use the title "Geotechnical Engineer" in the State of California. The engineer's analysis shall show that the system has a factor of safety of three or greater against failure by seepage and piping when analyzed for pool elevation at the top of the cofferdam and assuming steady state seepage. The analysis, plans and supporting design documentation shall be submitted to the Contracting Officer a minimum of 10 days prior to commencing excavation for the conduit.

3.1.2 Dewatering

Field investigations indicate that both the bedrock and soil will be saturated along much of the required excavation. Temporary cut slopes will probably destabilize if not dewatered. The general design assumption for the groundwater level between Stations 10+00 and approximately Station 15+50 was that the groundwater is at the top of bedrock, unless the top of bedrock is below elevation 500 feet, in which case the groundwater elevation was assumed to be at elevation 500 feet. Laboratory test data indicates the coefficient of permeability of the bedrock to be between 0.005 and 0.1 feet per day. In the vicinity of the stilling basin, field data indicates that the groundwater may be within 20 feet of the ground surface. Pump tests of the alluvium downstream of the embankment indicate a permeability of approximately 280 feet per day.

3.2 EXCAVATION, SOIL, OUTLET WORKS STATION 0+00 TO 18+13.50

The native soil consists of three units. The most extensive and thickest consists of sand and gravel, with occasional cobbles and boulders (generally increasing in number with depth) up to about 18 inches. The sand and gravel unit is overlain by a thin and discontinuous silt and fine-grained sand deposit, which in turn is partially overlain by a wedge of reddish, gravelly fan deposits and poorly bedded clayey and gravelly silt and sand. In addition to the native soil, artificial fill will be encountered. Soil excavation consists of the removal and disposal to the indicated lines and grades of any and all alluvial and artificial fill materials between the existing ground surface and the top of bedrock. (In general, that work which occurs under the trace of the modified embankment or embankment extension is treated in SECTION 02212, while that which is outside of the trace of the embankment is treated in SECTION 02250.)

3.2.1 Blending of Excavated Soil

Soil from required excavation which meet the requirements for fill as specified in SECTION, 02212, EMBANKMENT, or SECTION, 02250, FILLS AND SUBGRADE PREPARATION, may be used in the embankment or fill areas as approved by the Contracting Officer. Soil shall be excavated so as to produce maximum blending.

3.3 EXCAVATION, ROCK

3.3.1 General

Rock excavation consists of the removal and disposal of any and all bedrock. Rock excavation shall be to the lines and grades shown on the contract drawings. Because of the weakly cemented nature of the sedimentary bedrock, the low measured P-wave velocities, and previous construction history, it is anticipated that the bedrock can be mechanically excavated and shaped to the specified tolerances. The bedrock along the outlet works alignment is the Sycamore Canyon member of the Tertiary-age, sedimentary, Puente Formation. Investigations indicate that the bedrock surface is an old erosional surface exhibiting known local relief of up to 40 feet. The bedrock at the left abutment outcrop shows signs of subaerial weathering at the overburden contact and the overlying basal conglomerate occasionally contains fragments of weathered sandstone and siltstone. In general, the bedrock grades between silty sandstone and sandy siltstone with occasional shale or mudstone intervals. The rock has the following general characteristics: gradational contacts; massive; indistinct bedding surfaces; weak cementation; and moderate density. Bedding is nearly perpendicular to the outlet works alignment, dipping steeply upstream. Groundwater will be encountered during excavation. Dewatering will be required. Within the Outlet Works excavation, between Outlet Works Stations 10+00 and 14+00, the slope in the bedrock shall be no steeper than 1V:1H in any direction measured between the bench and the top of bedrock as shown on the drawings. The rock excavation shall be done in such a manner as to protect the integrity of the underlying rock. This may require specialized equipment and techniques. Ripping of the rock will not be permitted within 3 feet of the finished surface of the subgrade. Blasting will not be allowed.

3.3.2 Tolerances for Rock Excavation

Deviations from the lines and grades shown on the drawings or established by the Contracting Officer for excavation in rock shall be within tolerance limits of plus or minus 1.5-inches, except for those excavations against which concrete structures are to be constructed.

3.3.3 Excavation, Existing Concrete Cutoff Wall Within Outlet Conduit Trench

As shown on the drawings, an existing concrete cutoff wall will be encountered during excavation of the outlet works conduit trench. Within the excavation, the wall shall be removed in a manner which minimizes disturbance to the surrounding, non-excavated material. The final cut edge of the wall shall parallel the slope. The remaining portion of the cutoff wall shall not protrude from the trench slope by more than 3 inches. All loose and fractured material surrounding the wall shall be removed by hand excavation and disposed of. The combined total volume of loose and fractured material removed by hand from both slopes around the cutoff wall shall not exceed four cubic yards. The hand excavation shall leave the rock surface in a condition satisfactory for the placement of concrete fill. Following approval of the Contracting Officer, the void between the rock and the wall shall be backfilled with concrete. Prior to placement of the concrete, the designated areas for placement shall be thoroughly cleaned using approved methods. The designated areas shall be moistened such that absorption of water from the concrete will be minimized, however, no standing water will be allowed. Where the wall protrudes from the slope, concrete shall be applied in a manner to create a smooth transition from the outer edge of the wall to the slope. Concrete materials,

properties, and procedures shall conform to the applicable requirements of SECTION 03305, CONCRETE.

3.3.4 Disposition of Excavated Rock

Material from rock excavation which meet the requirements for embankment or fill as specified in SECTION, 02212, EMBANKMENT, or SECTION, 02250, FILLS AND SUBGRADE PREPARATION, may be used in the embankment or fill areas as approved by the Contracting Officer.

3.3.5 Prevention of Slaking or Spalling of Rock

In general, the bedrock grades between silty sandstone and sandy siltstone with occasional shale or mudstone intervals. At his discretion, the Contractor may apply shotcrete, asphalt emulsion, or another product approved by the Contracting Officer to the siltstone, shale, and mudstone, to prevent air slaking or spalling of rock.

3.3.6 Abutments

All vegetation, loose soil, and weathered rock should be removed down to a material having physical properties equal to or better than the overlying embankment fill. Abutment slopes should be as smooth and flat as feasible at the embankment contact to improve compaction of fill against the abutment. At the right abutment, the minimum depth of excavation at the contact with the existing embankment shall be to the top of the cutoff wall.

3.4 VERTICAL EXCAVATION OF ROCK WITHIN THE OUTLET CONDUIT EXCAVATION

3.4.1 General

The Contractor shall excavate the rock below the top of the conduit between Stations 10+00 and 16+50.50 to vertical slopes. The tower area (between Stations 9+00 and 10+00) shall be excavated as shown in the drawings.

3.4.2 Tolerances

Excavations for concrete structures have certain reference lines designated as "A" line and "B" line. The "A" line is located 6 inches inside the "B" line. The "A" line represents the outer edge of the conduit walls shown in the plans and thus is the inner tolerance limit inside which no rock will be permitted to project. Any projections inside the "A" line shall be removed. The "B" line is the line to which measurement for payment of excavation will be made, and is considered to be the final excavation line indicated on the drawings. Measurement for payment will be made to this line regardless of whether the limit of the actual excavation falls inside or outside of it, but sufficient excavation inside this line shall be performed to provide for the proper installation of slope reinforcement and placement of concrete. Any excavation beyond the "B" line shall be replaced with concrete complying with applicable portions of these specifications without additional cost to the Government.

3.4.3 Reinforcement System

The Contractor shall design a rock reinforcement system to ensure the integrity of the vertical cut. The design shall be developed and stamped by a qualified Engineer licensed in the State of California having at least five years design experience with similar support systems. The plans and

supporting design documentation shall be submitted to the Contracting Officer. No element of the rock reinforcement system shall project beyond the "A" line.

3.5 EXCAVATION, SOIL, OUTLET WORKS STATION 18+13.50 TO 54+00

The excavation for the access roads and channels shall consist of the removal and disposal of all materials to the lines and grades indicated on the drawings. Suitable excavated materials shall be placed within the fill portions of the roads, channel levees, or wasted as necessary. All access and haul roads shall be maintained as specified in SECTION 01200: GENERAL REQUIREMENTS, paragraph: Roads and Culverts in PRADO DAM EMBANKMENT, OUTLET WORKS AND APPURTENANCES. Open work gravel lenses, nested cobbles and boulders, debris, and unsatisfactory material shall be removed from the sides and bottom of the excavation to the extent directed by the Contracting Officer, and refilled in accordance with SECTION 02250, FILLS AND SUBGRADE PREPARATION.

3.6 EXCAVATION, BORROW AREAS

3.6.1 General

Borrow shall be taken from the indicated borrow areas. In all borrow areas except for Borrow Area B, varying thicknesses of Zone II materials overlie the Zone I materials. The eastern two-thirds of Borrow Area B has been disturbed by recent construction activity and the existence and extent of a Zone II layer is uncertain. The transition from Zone II to Zone I materials may be gradual or indistinct and the Contractor is responsible for obtaining materials that meet the requirements specified in SECTION 02212, EMBANKMENT. As discussed above, the excavation plan shall include the Contractor's plan for removing material meeting the requirements for Zone II to expose the surface of materials meeting the requirements of Zone I. In all borrow areas, the Zone II materials to be placed in the embankment at elevation 566 or below shall be removed and placed in stockpiles of sufficient depth to permit reloading with a Holland loader, or any other suitable type of loader capable of making a vertical cut that will result in complete blending of the full depth of the stockpile. Zone II materials to be placed above elevation 566 shall be excavated in a manner which will produce maximum blending of materials from top to bottom of the excavation. In order to obtain uniform moisture content, prewetting of the Zone II materials at the borrow areas or stockpile areas shall be required. The underlying Zone I material shall be excavated in a manner which will produce maximum blending of materials from top to bottom of the excavation. The depth of excavation will vary and shall at all times be controlled to produce the specified gradations. The excavation shall be conducted in such a manner that the excavated area will not pond water. The Contractor is responsible for all construction haul roads. The Contractor shall construct and maintain such roads throughout their required use as specified in SECTION 01200: GENERAL REQUIREMENTS, paragraph: Roads and Culverts in PRADO DAM EMBANKMENT, OUTLET WORKS AND APPURTENANCES. Permanent excavated slopes shall not be steeper than 2H:1V, except as approved by the Contracting Officer. The borrow areas shall be left in a neat condition, graded to drain and in accordance with the requirements specified in SECTION 01410: ENVIRONMENTAL PROTECTION.

3.6.2 Location Change

Whenever, in the opinion of the Contracting Officer, it is necessary to change the location of the excavating equipment working in the borrow areas

in order to obtain specified material, or to avoid areas of unsuitable materials, the Contractor shall move his equipment to a new location at no additional cost to the Government. The Contractor shall provide sufficient personnel in the borrow areas to monitor the excavation and direct the disposition of all excavated materials.

3.6.3 Protection of Area Underlying Future Dike

As shown in the drawings, a dike will be built adjacent to Borrow Areas B and C under future contracts. This area shall be left in an undisturbed state except as approved in writing by the Contracting Officer.

3.6.4 Excavation of Zone II Materials

Erosion due to wind or flowing water shall be controlled during borrow operations. Areas of surface water concentration shall be drained into silt ponds to remove sediment prior to water being discharged from the borrow site into existing drainages. Reclamation shall occur concurrently with excavation to the extent possible given operational constraints of the ongoing excavation. See SECTION 02130, DIVERSION AND CONTROL OF WATER, for reclamation requirements.

3.6.5 Excavation of Zone I Materials

In general, Zone I materials underlie the Zone II materials at all borrow sites. Unsuitable materials shall be disposed. Excavation shall be performed in a manner and sequence that will provide drainage at all times. Excavations shall be kept free from water while construction therein is in progress. Upon completion of excavation from borrow areas, stockpiled growth media from stripping operations shall be spread over the excavated surface and the area revegetated according to the requirements of SECTION 02900: HYDROSEEDING.

3.6.6 Excavation of Zone I Select Materials

Zone I Select materials are to be excavated from the Zone I Select Sub-Borrow Area within Borrow Area A. Select Zone I materials are to be used as structural backfill. The intent is to utilize those materials with the lowest percentage passing the number 200 sieve available. Following removal of the upper materials, the Zone I Select materials shall be excavated to an approximately vertical cut face of not less than 10 feet. The excavation shall be performed in a manner which will produce maximum blending of materials from top to bottom of the excavation. The depth of excavation will vary and shall at all times be controlled to produce the specified gradations. The excavation shall be conducted in such a manner that the excavated area will not pond water. The Zone I Select borrow area shall not be used for regular Zone I material until such excavation is approved by the Contracting Officer.

3.7 EXCAVATION FOR STRUCTURES

Excavation for all structures shall be made accurately to the lines, grade, and elevations shown. Trenches and foundation pits shall be of sufficient size to permit the placement and removal of forms for the full length and width of structure, footings, and foundations as shown. Foundation material shall be cleaned of loose debris and cut to a firm level surface. Loose disintegrated rock and thin strata shall be removed. When concrete is to be placed in an excavated area, special care shall be taken not to disturb the bottom of the excavation. Where the top of bedrock is below

the elevation required for the bottom of the tower, outlet conduit or stilling basin, the soil shall be over-excavated two feet, or to the top of bedrock, and backfilled with lean mixture concrete, as directed by the Contracting Officer. The quantity of lean mix backfill required as a result of this overexcavation shall not exceed 100 cubic yards.

3.8 EXCAVATION OF EXISTING EMBANKMENT

The crest of the existing embankment shall be excavated as shown in the drawings to allow for the creation of a continuous impervious core. Reasonable measures shall be taken during excavation of the crest to separate the existing impervious core material from the existing pervious upstream and downstream shell materials. The existing road, riprap, bedding, and other surface materials are to be removed in a timely manner prior to the excavation so as to minimize damage or loss of material.

3.8.1 Removal of Gravel Blanket, Stone Protection

The existing gravel blanket on the downstream slope is to be removed as late as feasible prior to placement of the embankment material to minimize erosion or other damage to the existing embankment surface. The gravel shall be stockpiled for reuse. Existing documentation describes the upstream stone protection as 12-inch stone over 6-inch spalls. Both the stone and spalls shall be removed from the embankment. The stone shall be stockpiled for later use as grouted stone. The spalls may be reused where the gradation permits. Care shall be taken with the stone and gravel so as to minimize breakdown and preclude contamination. Stone protection which is disturbed due to the construction process shall be replaced without cost to the Government by the Contractor. The replacement stone and bedding shall conform to that specified for new stone protection.

3.8.2 Testing of Gravel Blanket

Prior to removing the gravel blanket, the contractor shall verify the thickness and gradation of the gravel blanket. The thickness and gradation results shall be submitted to the Contracting Officer 10 days prior to removal of the gravel blanket.

3.8.3 Excavation of Existing Embankment Crest

The crest of the existing embankment shall be lowered as shown on the drawings. The crest excavation shall occur in the months of May, June, or July. Excavation of the crest shall not commence until the modified embankment has been raised to elevation 558.0 or greater and the Contractor has received approval to proceed from the Contracting Officer. In addition to the lowering of the embankment crest, a key trench will be required as shown in the drawings. The length of trench allowed to remain open prior to backfilling shall not exceed 150 feet.

3.8.4 Disposition of the Excavated Crest Material

Materials meeting the gradation requirements specified in SECTION 02212, EMBANKMENT, shall be reused in the modified embankment. Materials from the existing pervious upstream shell and existing pervious downstream shell shall be used as Zone I or Transition Zone fill, depending on the gradation. Additional blending of the excavated embankment material may be necessary to satisfy the requirements of Zone I or Transition Zone fill. Material from the existing Select Impervious Zone shall be placed in the Zone II stockpile.

3.8.5 Protection of Existing Impervious Material Moisture Content

After the crest has been lowered as shown on the plans, care shall be taken to maintain the pre-excavation moisture content of the existing core material. Any materials in which the moisture content changes by plus or minus 2 percent prior to placement of the impervious material shall be removed and replaced. Note that this is a general rule that will be applied wherever the existing impervious material is exposed, whether in the embankment or abutments.

3.8.6 Left Abutment

In addition to the key trench shown in the plans in the left abutment between the existing embankment and the new outlet works, additional excavation will be required between the new outlet works and the spillway. In this area a six-foot deep key trench shall be shall be excavated underlying the trace of the Zone II fill. Slopes of the trench shall be no steeper than 1H:1V.

3.9 REMOVAL OF UNSATISFACTORY SOILS

The removal of in-situ soils which are unsatisfactory for foundations of the embankment, structures, and roads may be required in certain areas. The Contractor will be required to excavate any such areas to the depth directed and backfill the areas with compacted fill conforming to the requirements of SECTION 02250: FILLS AND SUBGRADE PREPARATION and SECTION 02212EMBANKMENT. Unsatisfactory soils include those which contain sod, roots, brush, debris, trash or other objectionable material, and those classified in ASTM D 2487 as MH, CH, OH, and OL.

3.10 RECORDS

The Contractor shall keep and furnish to the Contracting Officer accurate logs and records of all operations pertaining to the preparation and excavation procedures. The records shall be submitted daily with the Quality Control Report and shall include the following: The number, size, type, and make of all equipment used in the excavation process.

3.11 SURVEY CONTROL FOR GEOLOGICAL MAPPING

3.11.1 Survey Locations

The Contractor shall provide survey control for geological mapping or other requirements within the footprint of the modified embankment, embankment extension, and foundation for the outlet structure elements. The Contractor shall provide coordinates and vertical control to within 0.10 foot accuracy for each location identified by the Government's field inspectors or geologists. The Contractor shall perform the requested survey within 24 hours of notification. A minimum of six (6) location points shall be surveyed at each time. For bidding purposes, the Contractor shall assume that a two (2) person survey crew will be required using the total stationing method for survey control.

3.11.2 Survey Data

Survey data shall be submitted to the Contracting Officer within twenty four (24) hours of the survey, and shall include the location number, date of survey, Lambert coordinates, elevation, and any pertinent data. The

survey data shall be submitted on a data management software program. Completion of a location point survey will be considered when the required survey data for each location is transferred onto a data management software program, and submitted to and approved by the Contracting Officer.

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EMBANKMENT

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SECTION 02212

EMBANKMENT

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM C 136	(1996a) Sieve Analysis of Fine and Coarse Aggregates
ASTM C 117	(1995) Materials Finer than 75 micrometers (No. 200) Sieve in Mineral Aggregates by Washing
ASTM D 698	(1998) Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/cu. ft. (600 kN-m/cu. m.))
ASTM D 2216	(1998) Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass

1.2 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-08 Manufacturer's Instructions

Compaction Equipment

Compaction equipment specification and product data

SD-06 Test Reports
Moisture content tests
Gradation tests
Density
Compaction tests

Moisture content, gradation, density and compaction test results shall be provided to the Contracting Officer.

1.3 LOCATION OF APPLICABILITY

In general, this specification shall be applied to all fill within the trace of the modified embankment and embankment extension. Along the outlet works, this specification is applicable to all fill between Outlet Works Station 9+10 and Outlet Works Station 18+13.50. Outside of these limits, SECTION 02250, FILLS AND SUBGRADE PREPARATION shall be applied. The upstream access roads shall be constructed in accordance with this specification (SECTION 02212), as shall the downstream access road between Station 0+00 to Station 12+14.30. Below Station 12+14.30, SECTION 02250, FILLS AND SUBGRADE PREPARATION shall be applied.

1.4 DEFINITIONS

The term "embankment" as used in this specification is defined as the earth portions of the dam and includes all types of fill for the dam, outlet conduit backfill (as limited above), and all other specified or directed earth fills within the limits of the dam, excepting those stone materials used for slope protection, which are described in SECTION 02600: STONE PROTECTION. "Compacted fill" includes all fill, except backfill, deposited in layers and compacted by rolling or tamping. The types of compacted earth fill are:

a. "Zone I material" forming the upstream and downstream shells,

b. "Zone II material" for the core, cutoff trench, coffer dam and impervious backfill in the outlet conduit trench,

c. "Transition material" for the transition zone.

"New compacted fill," as used in this specification, refers to the compacted fill to be placed in this contract. The "Zone II contact area" refers to the area of contact of the bedrock against which the Zone II material is placed.

1.5 GENERAL

1.5.1 Grade Control

The embankment shall be constructed to the lines, grades, and cross sections indicated on the drawings unless otherwise directed. The Government reserves the right to increase or decrease the foundation widths, to modify the embankment slopes, or to make such other changes in the embankment sections as necessary to meet field conditions and produce a safe structure. The end slopes and side slopes of partial fill sections shall not be steeper than the slopes indicated.

1.5.2 Conduct of the Work

The Contractor shall maintain and protect the embankment in a satisfactory condition at all times until final completion and acceptance of all work under the contract. If, in the opinion of the Contracting Officer, the hauling equipment causes horizontal shears, slicken-sides, rutting, quaking, heaving, cracking or excessive deformation of the embankment, the Contractor shall limit the type, load or travel speed of the hauling equipment on the embankment. Any approved embankment material which is lost in transit or rendered unsuitable after being placed in the embankment and before final acceptance of the work, shall be replaced by the Contractor in a satisfactory manner and at no additional cost to the Government. The Contractor shall excavate and remove from the embankment

any material that does not meet the requirements of the specification and dispose of such material and refill the excavated area at no additional cost to the Government. The Contractor may be required to remove, at his own expense, any embankment material placed outside of prescribed slope lines. The Contractor shall vary his operations where directed to allow the Contracting Officer to conduct sampling and in-place density tests on compacted embankment fill. The Contracting Officer will conduct these quality assurance tests at approximately the same rate as the Contractor shall conduct the quality control tests as required in paragraph Contractor Quality Control Testing. In addition, the Contracting Officer will conduct trenching for record testing of the existing pervious and impervious zones following degrading of the embankment and at approximate 10 to 15-foot intervals within Zone I, Zone II, and the Transition Zone, including those zones in the backfill of the outlet conduit trench. The embankment construction operations shall be conducted in a direction parallel to the embankment axis or as approved by the Contracting Officer.

1.5.3 Haul Roads

Haul roads shall be designed to maintain the intended traffic, to be free draining and shall be maintained in good condition with proper dust control throughout the contract period as specified in SECTION 01200: GENERAL REQUIREMENTS, paragraph: Roads and Culverts in PRADO DAM EMBANKMENT, OUTLET WORKS AND APPURTENANCES. Haul roads approved for use across the face of the embankment shall be removed at the end of the contract period, and the embankment slope shall be constructed to meet the requirements of the required zone. Where haul roads are constructed across the upstream face of the embankment, all existing stone protection shall be replaced with stone protection conforming to SECTION 02600, STONE PROTECTION, at no additional cost to the government. Re-grading shall completely obliterate any visible evidence of the haul road trace. Obliteration of haul roads outside the embankment trace shall be as specified in SECTION 01200: GENERAL REQUIREMENTS, paragraph POST-CONSTRUCTION CLEANUP AND OBLITERATION in PRADO DAM EMBANKMENT, OUTLET WORKS AND APPURTENANCES.

PART 2 PRODUCTS

2.1 GENERAL

Except as designated below, the composition alone of any fill material determines where it may be used in the embankment. Materials for embankment fills shall be secured from required excavations, from stockpiles satisfying specification requirements, and from the borrow areas indicated. The intention is to use the most suitable materials obtainable from these sources. Material to be wasted will be identified by the Contractor at the time the material is excavated. Materials containing brush, roots, sod, or other perishable materials will not be considered suitable. The suitability of the materials shall be subject to the approval of the Contracting Officer and their disposition in the embankment shall be as approved by the Contracting Officer. The Contractor shall excavate in the borrow areas in the location determined by the Contracting Officer, whenever such control is necessary to obtain the type of material required for the embankment. All materials to be used as fill shall be blended during excavation except for those materials that are to be placed in stockpiles. Except as otherwise specified, fill materials shall meet the required gradations specified hereinafter based on the minus 3-inch gradation. Material gradations shall be determined in accordance with ASTM C 136 and ASTM C 117.

2.2 ZONE II MATERIAL

Material for compacted Zone II material shall be obtained from the Zone II stockpile or designated borrow areas, as delineated in SECTION 02200. Material for the Zone II stockpile shall come from the designated borrow areas. Materials shall have not less than 35 percent, by weight based on the minus 3-inch gradation, passing the U.S. Standard No. 200 sieve and shall contain no stone whose greatest dimension is more than 6 inches.

2.3 ZONE I MATERIAL

Material for compacted Zone I material shall be obtained from the designated borrow areas and from required excavation. The materials shall be processed to remove stones larger than 9 inches, and not more than 25 percent, by weight based on the minus 3-inch gradation, shall pass a No. 200 sieve. The material shall be reasonably well graded between 3 inches and the no. 200 sieve.

2.4 TRANSITION ZONE MATERIAL

Material for compacted Transition Zone material shall be obtained from required excavation. The materials shall have a gradation such that not less than 20 percent, and not more than 35 percent by weight based on the minus 3-inch gradation, shall pass a No. 200 sieve. The materials shall be processed to remove stones larger than 6 inches. The material shall be reasonably well graded between 3 inches and the no. 200 sieve.

2.5 MISCELLANEOUS FILL

Material for miscellaneous fill may consist of any or all types of material available from the required excavation. Except as otherwise approved by the Contracting Officer, miscellaneous fill shall not come from the designated borrow areas. Material shall be placed in the areas indicated on the drawings or as otherwise directed. Miscellaneous fill shall be dumped and spread in horizontal layers not to exceed 24 inches thick. Compaction other than that obtained by controlled movement of hauling and spreading equipment over the area will not be required.

2.6 MITIGATION FILL

Material for mitigation fill shall meet the same requirements as miscellaneous fill. Mitigation fill shall be placed in the areas indicated on the drawings or as otherwise directed.

PART 3 EXECUTION

3.1 PREPARATION OF THE EXISTING EMBANKMENT

The removal of the gravel blanket from the downstream slope, the stone protection from the upstream slope and the lowering of the crest of the existing embankment are discussed in SECTION 02200, EXCAVATION. Until new embankment fill has been placed over the exposed existing embankment fill, care shall be taken to maintain the pre-excavation moisture content of the existing core material.

3.1.1 Preparation of the Downstream Berm as Foundation for New Fill

The berm downstream of the existing embankment will act as the foundation for most of the fill for the modified embankment. Following the stripping

of undesirable surface materials, the surface shall be rolled with two passes of the 10-ton vibratory steel-wheeled roller.

3.1.2 Placement of New Embankment Fill over Existing Embankment

The new embankment fill shall be placed in level lifts (except as required for drainage) beginning at the downstream extent of the modified embankment as shown on the drawings and preceding up the embankment. At no time shall any portion of the new compacted fill be higher than any other portion of the new compacted fill, other than as required for drainage. Once the Zone I fill has been raised to the lowest elevation of the Transition Zone fill as indicated on the drawings, the Zone I and Transition Zone fills shall be raised at the same rate. Likewise, the Zone II fills shall be raised evenly with the Transition and Zone I fills. All lifts shall be placed in a direction parallel to the centerline of the embankment crest. The lifts shall all be approximately horizontal and of the specified thickness.

3.1.3 Benching of Existing Embankment

The existing embankment slope shall be benched a minimum of 5 feet horizontally to receive fill as the work is brought up in layers. The benched portion of the existing embankment shall then be disced, the water content adjusted, and compacted to a density equal to or greater than the contiguous embankment material.

3.2 PREPARATION OF ABUTMENTS AND EMBANKMENT EXTENSION FOUNDATION

3.2.1 Alluvium and Compacted Fill

After stripping of the abutments and excavation of the key trench, and after inspection and approval by the Contracting Officer, the foundation soils shall be alternately watered and scarified until the material is uniformly moistened throughout for a depth of not less than 10 inches. All stones larger than 6 inches in diameter shall be removed. The amount of water to be applied shall be that which is required to provide optimum results of compaction under rolling. The foundation material shall then be compacted to a density equal to or greater than the contiguous embankment material. No separate payment will be made for loosening and rolling the foundation or abutment areas, but the entire cost thereof shall be included in the applicable contract price for contiguous fill.

3.2.2 Rock

Where the foundation is on the sandstone bedrock, the bedrock shall not be scarified, except as directed by the Contracting Officer. The bedrock shall be graded to provide an even surface to receive fill. Prior to placement of fill the sandstone shall be moistened by an amount appropriate to enhance bonding between the sandstone and the fill.

3.2.3 Final Clean Up

Within 3 days prior to placement of embankment materials, the bedrock surfaces within the Zone II contact area shall be given a final clean-up as specified herein before. All loose material and standing water shall be removed. No thin coats of mortar shall be left on smooth, intact rock surfaces. All shotcrete shall be removed. Areas approved for material placement which have been exposed for more than 3 days or which have become contaminated by unsuitable material such as dirt or rock debris may require re-cleaning at no additional expense to the Government.

3.3 PLACEMENT

3.3.1 General

No fill shall be placed on any part of the embankment foundation until the foundation treatment has been completed and such areas have been inspected and approved by the Contracting Officer. The gradation and distribution of materials throughout the compacted fill section of the embankment shall be such that the embankment will be free from lenses, pockets, streaks, and layers of material differing substantially in the texture or gradation from surrounding material of the same class. All types of compacted fill shall be completely scarified to a minimum depth of 2 inches, prior to placement of subsequent lifts. Successive loads of material shall be dumped at locations on the fill as approved by the Contracting Officer. Travel by heavy hauling and compacting equipment will be restricted to a distance greater than 3 feet horizontally and vertically from structures and hauling equipment shall be dispersed throughout the fill to avoid heavy concentration of loads in any one area, unless otherwise permitted by the Contracting Officer. Within restricted areas or areas where heavy compaction equipment cannot be used, the material shall be compacted by hand with power tampers or "walk behind" compaction units. Contact with the abutments shall be made by ramping the fill within 15 feet of the abutment up to the abutment contact on a slope of 10 horizontal to 1 vertical so that compaction equipment may work close to the abutment. Fill areas which are loosened, rutted or contaminated by construction equipment shall be reworked or removed to meet specification requirements.

3.3.2 Placement of Material Excavated from Existing Embankment

Materials excavated from the existing embankment and meeting the specified gradation requirements shall be reused in the modified embankment. Materials from the existing pervious upstream shell and existing pervious downstream shell may be placed directly in the Zone I or Transition Zone fill. Additional blending may be required on the fill.

3.3.3 Rate of Placement

The new embankment fill shall be maintained at approximately the same level regardless of the number of types of materials being placed except for stone protection.

3.3.4 Spreading

After dumping, the materials shall be spread as hereinafter specified for each material type, except backfill, which shall be spread in accordance with requirements in paragraph: BACKFILL. In the main embankment, below elevation 558, the fill shall be raised with a grade to the downstream not to exceed 4 percent so that the fill surface will drain freely. Above elevation 558 the central portion of the embankment shall be raised or crowned with grades not to exceed 4 percent. When work is stopped on any section of the Zone II material on account of precipitation or impending precipitation, the surface shall be smoothed to facilitate drainage. During the dumping and spreading process, the Contractor shall maintain at all times a force of men adequate to remove all roots, oversize stones and debris from all embankment materials. Stone removed shall be placed in the outer slopes of the embankment in locations approved by the Contracting Officer. Roots and debris shall be removed from the embankment and

disposed of in an approved manner. The entire surface of any section of the embankment under construction shall be maintained in such condition that construction equipment can travel on any part of any one section, and that travel over any zone shall be routed to distribute the compactive effort. Ruts in the surface on any layer shall be filled before compacting as approved by the Contracting Officer.

3.3.5 Zone II Material

Zone II material shall be placed in Zone II of the embankment, outlet conduit trench, and coffer dam. After dumping, the Zone II fill materials shall be spread by motor graders or other approved means in approximately horizontal layers over the entire fill areas. Unless otherwise directed by the Contracting Officer, the thickness of the layers before compaction shall not be more than 8 inches. Zone II materials next to abutments or within the first two feet above the Outlet Conduit, materials in areas that have been used as haul routes, and any layer of Zone II material that is determined to be too smooth to bond properly with the succeeding layer shall be loosened by discing, or by any other approved method, before the succeeding layer is placed thereon.

3.3.6 Zone I Material

Zone I material shall be placed in the Zone I sections of the embankment. In general, the Zone I sections of embankment shall be placed with the less pervious material near the Transition Zone and the more pervious materials near the outer slopes of the embankment. After dumping, the Zone I materials shall be spread by motor graders or other approved means in approximately horizontal layers over the entire fill areas. Unless otherwise directed, the thickness of the layers before compaction shall not be more than 12 inches.

3.3.7 Transition Zone Material

Transition Zone material shall be placed in the Transition Zone sections of the embankment. In general, the Transition Zone material shall be placed with the less pervious material near Zone II and the more pervious materials near Zone I. After dumping, the Transition Zone materials shall be spread by motor graders or other approved means in approximately horizontal layers over the entire fill areas. Unless otherwise directed, the thickness of the layers before compaction shall not be more than 8 inches.

3.4 MOISTURE CONTROL

3.4.1 General

The materials in each layer of the fill shall contain the amount of moisture, within the limits specified below or as directed. Water shall be added prior to excavation, during excavation, processing or transportation, or uniformly applied to the material on grade by power spray or other approved equipment to preclude moisture loss, facilitate compaction, and improve trafficability. Material that is not within the specified limits after compaction shall be reworked, regardless of density.

3.4.2 Zone II Material

The moisture content after compaction shall be as uniform as practicable throughout any one layer of the Zone II materials. The moisture content

after compaction as determined by ASTM D 2216 shall be within the limits of 2 percentage points above optimum and 2 percentage points below optimum. Optimum moisture content shall be determined in accordance with ASTM D 698 test methods using a 4-inch diameter mold. Material that is too wet shall be spread on the embankment or stockpile area and permitted to dry, assisted by discing and/or harrowing, if necessary, until the moisture content is uniform and reduced to an amount within the specified limits. When the material is too dry, the Contractor shall be required to sprinkle each layer on the fill. Discing, harrowing, or other approved methods will be required to work the moisture into the material until a uniform distribution of moisture is obtained. Water applied on a layer of fill shall be accurately controlled in amount so that free water will not appear on the surface during or subsequent to rolling. Should too much water be added to any part of the embankment, so that the material is too wet to obtain the desired compaction, the rolling on that section of the embankment shall be delayed until the moisture content of the material is reduced to an amount within the specified limits. Should test results indicate uniform distribution of moisture is not being achieved, lift thicknesses and the number of passes will be reduced proportionately at the direction of the Contracting Officer. If, in the opinion of the Contracting Officer, the top or contact surfaces of the partial fill section become too dry to permit suitable bond between these surfaces and the additional fill to be placed thereon, the Contractor shall loosen the dried materials by scarifying or discing to such depths as required, shall dampen the loosened material to an acceptable moisture content, and shall compact this layer in accordance with the applicable requirements specified hereinafter. If the top or contact surfaces of a partial fill section become too wet to permit suitable bond between these surfaces and the additional fill to be placed there on, the wet material shall be scarified and permitted to dry, assisted by discing or harrowing, if necessary, to such depths as required. The material shall be dried to an acceptable moisture content and recompacted in accordance with the applicable requirements specified hereinafter.

3.4.3 Zone I Material

Zone I materials shall be moisture conditioned in the same manner as Zone II materials, except that optimum moisture content shall be determined in accordance with ASTM D 698 test methods using a 6-inch diameter mold.

3.4.4 Transition Zone Material

Transition Zone materials shall be moisture conditioned in the same manner as Zone II materials, except that optimum moisture content shall be determined in accordance with ASTM D 698 test methods using a 6-inch diameter mold.

3.5 COMPACTION

3.5.1 Compaction Equipment

Compaction equipment shall conform to the following requirements and shall be used as prescribed in subsequent paragraphs.

3.5.1.1 Vibratory Rollers

Vibratory rollers for compacting Zone I material shall be equipped with a smooth steel compaction drum and may be either towed or self-propelled. Towed rollers shall have at least 90 percent of their weight transmitted to

the ground through the compaction drum when the roller is standing in a level position hitched to the towing vehicle. A 10-ton vibratory roller will be required. The 10-ton vibratory roller shall have a minimum static weight of 20,000 pounds, and be capable of delivering a total applied force of not less than 8,000 pounds per foot drum width, but not to exceed 9,000 pounds per foot of drum width. The total applied force shall be the sum of the centrifugal force and the drum module weight. The level of amplitude and vibration frequency during compaction shall be maintained uniform throughout the embankment zone within which it is operating. Rollers shall be operated at speeds which will result in a minimum of 10 impacts per foot of roller travel. The equipment manufacturer shall furnish sufficient data, drawings, and compaction for verification of the above specifications. The character and efficiency of this equipment shall be subject to approval of the Contracting Officer.

3.5.1.2 Tamping Rollers: Towed

Where space is not restricted, tamping rollers shall consist of two or more non-vibratory roller drums mounted side-by-side in a suitable frame and towed by either a crawler-type or rubber tired tractor having sufficient power to pull the roller satisfactorily when the drums are fully ballasted. Each drum shall be free to pivot about an axis parallel to the direction of travel. Rollers operated in tandem sets shall be controlled in a manner such that the prints produced by the tamping feet of the tandem units are staggered. The use of towed tandem roller drums that are in true alinement shall not be permitted. Each drum of a roller shall have an outside diameter of not less than 5 feet and shall be not less than 5 feet in length. The space between two adjacent drums, when on a level surface, shall not be less than 12 inches nor more than 15 inches. Each drum ballasted with fluid shall be equipped with at least one pressure-relief value and with at least one safety head. The safety head shall be equal to union-type safety heads equipped with rupture discs suitable for rupturing pressures between 50 and 75 psi as manufactured by Fike Metal Products Corporation, Blue Spring, Missouri. The pressure-relief valve is a manually operated valve and shall be opened periodically. Personnel responsible for opening pressure-relief valves shall be periodically instructed to ascertain that valve openings are free from plugging to assure that any pressure developed in roller drums is released at each inspection. At least one tamping foot shall be provided for each 100 square inches of drum surfaces. The length of each tamping foot from the outside surface of the drum shall not be more than 10 inches and shall be maintained at not less than 7 inches. The bearing surface of each tamping foot shall be flat with a surface area not less than 5 square inches nor more than 10 square inches. During the operation of rolling, the spaces between the tamping feet shall be maintained clear of materials which would impair the effectiveness of the tamping rollers. The weight of a roller when fully loaded shall be not less than 4,000 pounds per foot of length of drum. The weight of a roller when empty shall be not more than 2,500 pounds per foot of drum length. The bearing surface, tamping foot size, the drum loading, and operation of the rollers shall be as required to obtain the desired compaction. If more than one roller is used on any one layer of fill, all rollers so used shall be of the same type and essentially of the same dimensions. Rollers shall be drawn by crawler-type or rubber-tired tractors at a speed not to exceed 5.0 miles per hour. The use of rubber-tired towing equipment shall be discontinued if the tires leave ruts that prevent uniform compaction by the tamping roller, and the substitution of crawler-type towing equipment may be directed by the Contracting Officer.

3.5.1.3 Tamping Rollers: Self-Propelled

The use of self-propelled non-vibratory tamping rollers conforming with the following specification will be permitted, and their design and operation shall be subject to the approval of the Contracting Officer who shall have the right at any time during the prosecution of the work, to direct such modifications to the tamping feet or roller drum weight where applicable, as may be found necessary to secure optimum compaction of the earthfill materials. If use of self-propelled tamping rollers causes shearing of the fill, laminations in the fill, or results in inadequate compaction, the Contracting Officer may direct that such rollers be removed from the fill and that appropriate towed tamping rollers be used. Two- or three-drum side-by-side units that are either in drive position or drawn by separate power equipment shall have a clearance between adjacent drums not less than 12 inches nor more than 15 inches. Two-drum or four-drum equipment separated by cab and differential and arranged in tandem must have its static weight equally distributed to all compaction drums and must have the tandem drum positioned such that the prints of the tamping feet produced by the tandem drums are staggered. The surface on which the tamping feet are mounted shall have a minimum outside diameter of 4 feet and at least one tamping foot for each 110 square inches of drum surface. The distance between the centers of any two adjacent tamping feet shall be not less than 9 inches. The length of each tamping foot from the outside mounting surface of the drum shall be not more than 11 inches and shall be maintained at not less than 7 inches. The bearing surface of each tamping foot shall be flat and have a surface area not less than 7 square inches nor more than 29 square inches. Cupped recesses within the bearing surface of each tamping foot will be permitted but shall not exceed 0.5 inches in depth. During rolling operations, the spaces between the tamping feet shall be maintained clear of materials which would impair the effectiveness of the tamping roller. The weight of all roller drums during compaction of fill materials shall be maintained uniform and with the weight per foot of drum length not less than 4,300 pounds. For self-propelled rollers with drums capable of being ballasted with fluid, each drum shall be equipped with at least one pressure-relief valve and with at least one safety head. The safety head shall be equal to union type safety heads equipped with rupture discs suitable for rupturing pressures between 50 and 75 psi as manufactured by the Fike Metal Products Corporation, Blue Springs, Missouri. The pressure relief valve is a manually operated valve and shall be opened periodically. Personnel responsible for opening pressure-relief valves shall be periodically instructed to ascertain that valve openings are free from plugging to assure that any pressure developed in roller drums is released at each inspection. For self-propelled rollers in which steering is accomplished through the use of rubber-tired wheels, the tire pressure shall not exceed 40 psi. The use of the compactor shall be discontinued if the tires leave ruts that prevent uniform compaction by the tamping rollers and the substitution of appropriate towed tamping rollers may be directed by the Contracting Officer. When a self-propelled roller is provided with a dozer blade, coverages made with the blade in operation shall not be counted as compaction coverages. Self-propelled rollers shall be operated at a speed not to exceed 5.0 mph.

3.5.1.4 Power Tampers and Other Equipment

Compaction of material, in areas where it is impracticable to use a roller shall be performed by the use of approved power tampers, small compactors or rubber-tired front-end loaders.

3.5.1.5 Discs

Discs shall have a minimum of two gangs hooked in tandem and shall be sized to penetrate a minimum fill lift of 8 inches. The width of cut shall not be less than 12 feet. Disc blades shall be notched, spaced a minimum of 16-5/16 inches, and have a minimum diameter of 36 inches. The disc shall be equipped with self cleaning scrapers to prevent the accumulation of mud and debris between and on disc blades. Towed speeds shall not exceed five miles per hour and the angle of cut shall be adjustable while the tool is in operation. For effective operation, worn disc blades should be replaced when the wear exceeds 10 percent of the initial disc diameter.

3.5.2 Zone II Material

Except as hereinafter specified, after a layer of Zone II material has been dumped and spread, it shall be disced to break up and blend the fill material, and to obtain uniform moisture distribution. Discing shall be performed with the specified disc or other approved equipment, to the full depth of the layer. If two passes of the disc does not accomplish the objectives, additional passes of the disc shall be required. Additional passes may be required to dry materials that are too wet as specified in ARTICLE, MOISTURE CONTROL, Paragraph, Zone II Material When the moisture content and the condition of the layer is satisfactory, the lift shall be compacted by not less than 8 complete passes of the tamping roller. A pass shall consist of one movement of the roller over the area to be compacted. Each trip of the roller shall overlap the adjacent trip not less than one foot. Dumping, spreading, sprinkling, and compacting may be performed at the same time at different points along a section when there is sufficient area to permit these operations to proceed simultaneously. Prior to placement of subsequent lifts, the Contracting Officer may require that the compacted material be disced.

3.5.2.1 Zone II Material Placed on Rock

The first two layers of Zone II material placed over rock surfaces shall be compacted with approved rubber-tired equipment to a minimum density of 98 percent of maximum density as determined by ASTM D 698. Following compaction of each lift, prior to placement of the subsequent lift, the material shall be scarified to a minimum depth of 2 inches. The material shall be placed and compacted in a manner which will prevent damage to the rock. Any portion of the rock surface that is damaged during placement and compaction of the initial layer of Zone II material shall be repaired as herein before specified in Paragraph, Rock, at no additional cost to the Government.

3.5.2.2 Abutment-Embankment Contact

Zone II materials to a distance of 4 feet horizontally and 2 feet vertically from the abutment-embankment contact shall be compacted with a front-end loader, power tampers or other approved equipment to a minimum density of 98 percent of maximum density as determined by ASTM D 698.

3.5.3 Zone I Material

Except as hereinafter specified, after each layer of Zone I material has been dumped and spread, the entire surface of the layer shall be compacted by not less than 4 complete passes of the 10-ton vibratory roller. A complete pass shall consist of the entire coverage of the area with one trip of the equipment specified. Each trip of the roller shall overlap the adjacent trip not less than one foot.

3.5.4 Transition Zone Material

Each lift of fill shall be compacted to not less than 98 percent of maximum density as determined by ASTM D698.

3.5.5 Additional Rolling for Compaction

If, in the opinion of the Contracting Officer, the desired compaction of any portion of the embankment is not secured by the minimum number of passes specified, additional complete passes shall be made over the surface area of such designated portion until the desired compaction has been obtained.

3.6 CONTRACTOR QUALITY CONTROL TESTING

3.6.1 Gradation and Moisture Tests

Gradation tests shall be performed by the Contractor in the frequencies specified hereinafter and in such locations to insure that the specified requirements are being obtained. Gradation samples shall be obtained after compaction and shall be of sufficient size to be representative of the total material. Gradation samples for Zone I and Transition Zone material portions of the outlet conduit trench backfill shall be a minimum of 130 pounds each. Moisture content tests shall be conducted on all gradation samples of fill. Test results shall be on approved forms and shall be submitted with the Contractor Quality Control Report on the work day following the test. Minimum testing frequency shall be as follows:

Material	First 20% of Material	Remainder of Material
Zone I	1 per 2,500 Cu. Yd.	1 per 5,000 Cu. Yd.
Zone II	1 per 1,500 Cu. Yd.	1 per 3,000 Cu.Yd.
Transition Zone	1 per 1,500 Cu. Yd.	1 per 3,000 Cu. Yd.

3.7 BACKFILL

3.7.1 General

Note the limitations of the application this paragraph described in ARTICLE, EXTENT OF APPLICABILITY. No backfill or other load shall be placed on or against concrete surfaces before expiration of the minimum period after placing the concrete as indicated below:

Walls and vertical faces	14 days
Conduit	14 days or until the concrete has attained a strength of 3,000 psi in accordance with SECTION 03305: CONCRETE

Before passage of hauling and rolling equipment over the top of the conduit or other structure will be permitted, the depth of fill over the concrete shall be sufficient to permit such passage without inducing harmful stresses or vibrations in the structure. The gross weight of any piece of equipment or the combined weight of any combination of equipment coupled together, used to place, moisten and/or compact fill behind walls and within two feet of the top of the conduit shall not exceed 35,000 pounds including dynamic forces produced by vibrating equipment.

3.7.2 Backfill of Conduit Trench

3.7.2.1 General

The backfill shall be placed to the lines and grades indicated on the drawings unless otherwise directed. Backfill material shall consist of Zone I, and Zone II material as shown on the drawings and described below. The conduit backfill shall be maintained at approximately the same elevation regardless of the number of types of materials being placed. To the greatest extent possible, below elevation 540 feet the material shall be placed and compacted in a direction perpendicular to the centerline of the conduit. Above elevation 540 the material shall be placed and compacted parallel to the alignment of the modified embankment. When the thickness of the backfill over the conduit is greater than 2 feet, the placement, water content control, compaction, and quality control shall conform to that specified herein before. When the thickness of the backfill over the conduit is less than 2 feet, backfill shall be treated as described in paragraph: Backfill Thickness over Conduit less than 2 Feet.

3.7.2.2 Backfill Thickness over Conduit less than 2 Feet

When the thickness of the backfill over the conduit is less than 2 feet, Zone II material or Zone I material, as is appropriate according to the plans, shall be placed in 6-inch loose layers and thoroughly compacted. The maximum stone size shall be 3 inches. Following compaction of each lift, prior to placement of the subsequent lift, smooth surfaces shall be scarified to a depth of two inches. Both Zone I and Zone II backfill materials shall be compacted to not less than 98 percent of maximum density as determined by ASTM D 698. Field density shall be determined at a minimum testing frequency of 1 test per 500 cubic yards for all types of backfill. Gradation samples shall be obtained after compaction and shall be of sufficient size to be representative of the total material. Moisture content tests shall be conducted on all gradation samples. The Contractor shall perform gradation tests at a minimum testing frequency of 1 test per 1,000 cubic yards for all types of backfill.

3.7.3 Backfill for Structures Other Than the Conduit

Only Zone I material shall be used as backfill, except as limited by PARAGRAPH, EXTENT OF APPLICABILITY. Backfill shall be placed in 4-inch loose layers and thoroughly compacted. Unless otherwise directed, the placing and compacting of all backfill material and the control of its moisture content shall conform to the applicable provisions specified herein before. Rollers will not be permitted to operate within 2 feet of structure walls, conduit sides, or conduit top. Within this restricted area, and other areas where rollers cannot be used, the material shall be compacted by means of small compaction equipment, such as power tampers, walk-behind rollers or other approved light equipment. Zone I material shall be compacted to not less than 98 percent maximum density. No separate payment will be made for backfill, but the entire cost thereof shall be included in the applicable contract price for the structure.

3.8 SLIDES

In the event of slides in any part of the embankment prior to final acceptance of the work the Contractor shall remove material from the slide area, as directed, and shall rebuild such portion of the embankment. In case it is determined that the slide was caused through fault or negligence of the Contractor the removal and disposal of material and the rebuilding

of the embankment shall be performed without cost to the Government; otherwise, this work will be paid for at the applicable contract unit prices for borrow excavations and compacted fill or backfill.

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DIVISION 02 - SITE WORK

SECTION 02250

FILLS AND SUBGRADE PREPARATION

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SECTION 02250

FILLS AND SUBGRADE PREPARATION

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM D 1556	(1990; R 1996) Density and Unit Weight of Soil in Place by the Sand-Cone Method
ASTM D 1557	(1991) Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/cu. ft. (2,700 kN-m/cu. m.))
ASTM D 2216	(1998) Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass
ASTM D 2487	(1998) Classification of Soils for Engineering Purposes (Unified Soil Classification System)
ASTM D 2922	(1996el) Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth)

1.2 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-06 Test Reports
Moisture content
Gradation
Density test

Moisture content, gradation, and density test results shall be provided to the Contracting Officer.

1.3 LOCATION OF APPLICABILITY

In general, this specification is to be applied to all fill outside of the trace of the modified embankment and embankment extension. All fill within

the trace of the modified embankment and embankment extension, except as noted herein are to be constructed according to SECTION 02212, EMBANKMENT. Along the outlet works, this current section is applicable to all fills upstream of Outlet Works Station 9+10 and downstream of Outlet Works Station 18+13.50. The upstream access road shall be constructed in accordance with SECTION 02212. The downstream access road shall be constructed in accordance with SECTION 02212 from Station 0+00 to Station 12+11. Below Station 12+11, this section shall be applied.

1.4 EQUIPMENT

All equipment, tools, and machines shall be maintained in satisfactory working condition at all times. Compaction equipment shall be suitable for consistently producing uniform soil densities.

1.5 GENERAL REQUIREMENTS FOR COMPACTED FILLS AND COMPACTED BACKFILLS

1.5.1 Control

Fills and backfills shall be regularly and continuously inspected and tested by the Contractor. The Contractor shall vary his operations to secure the results specified herein. Moisture-density relations shall be established by the Contractor. The soil used for each maximum density test shall be classified in accordance with ASTM D 2487. At least one five point maximum density test shall be made for every 10 field density tests. Moisture-density relations and field densities shall be reported on approved forms. One copy of density data, less dry weight determination, shall be provided on the day each test is taken. The completed test reports shall be provided with the Contractor Quality Control Report on the work day following the test.

1.5.1.1 Laboratory Control

One moisture-density relations shall be made for each classification, blend or change in classification of soil material encountered. Approval of moisture-density relations shall be obtained prior to the compaction of any material in the work. The moisture-density relations shall be determined in a laboratory in accordance with ASTM D 1557. A separate batch of materials will be used for each compaction test specimen. No materials will be re-used. The desired amount of mixing water will be added for each compaction test specimen, mixed well, and the mixture will be placed in a container with an airtight cover and allowed to cure for 24 hours. A shorter curing time may be allowed where tests show that shortening the curing time will not affect the results.

1.5.1.2 Field Control

Field in-place density shall be determined in accordance with ASTM D 1556, except that in each test, the weight of the disturbed sample representing the full depth of layer shall be not less than 10 pounds for fine grain material and 12 pounds for coarse grain material using a scale for weighing of sufficient capacity and sensitive to .01 pounds. The field moisture content shall be determined in accordance with ASTM D 2216. Determination of in-place densities using the nuclear method (ASTM D 2922) may be used to supplement the sand cone density tests (ASTM D 1556). When ASTM D 2922 is used, the calibration curves shall be checked and adjusted using only the sand cone method as described in ASTM D 1556. At least one adjacent sand cone test shall be performed for every five nuclear density tests performed. If field density tests determined by the nuclear method vary by

more than 3 pounds per cubic foot from comparison sand-cone tests, and are consistently high or low, adjustment of the calibration curve is necessary. The density tests shall be well distributed and shall average not less than one test for each 2000 cubic yards of material. At least one test shall be made in each 2 feet of compacted material processed as a unit and at least one test shall be made in each area. One test per 500 cubic yards shall be conducted in backfill areas compacted by hand-operated machines.

1.5.1.3 Settling of Fills or Backfills With Water

Settling of fills or backfills with water will not be permitted.

PART 2 PRODUCTS

2.1 FILL, LEVEE AND ROADS

Levee and road fill shall be obtained from the contractor-developed stockpiles, required excavation, and/or borrow areas. Materials considered unsatisfactory for use as compacted fill include but are not limited to those materials containing sod, roots, brush, debris, trash or other objectionable material, and materials classified in ASTM D 2487 as MH, CH, PT, OH, and OL. Levee and road fill shall contain no stone whose greatest dimension is more than 3/4 of the layer thickness.

2.2 STRUCTURAL BACKFILL

Structural backfill shall be obtained from the Select Zone I sub-borrow area within Borrow Area A after appropriate removal and disposition of the overlying materials. The Select Zone I material shall be blended in the excavation process so that not more than 12 percent, by weight based on the minus 3-inch gradation, shall pass a No. 200 sieve and the maximum size not exceeding three-quarters of the specified lift thickness.

2.3 MISCELLANEOUS FILL

Material for miscellaneous fill may consist of any or all types of material available from the required excavation. Except as otherwise approved by the Contracting Officer, miscellaneous fill shall not come from the designated borrow areas. Material shall be placed in the areas indicated on the drawings or as otherwise directed. Miscellaneous fill shall be dumped and spread in horizontal layers not to exceed 24 inches thick. Compaction other than that obtained by controlled movement of hauling and spreading equipment over the area will not be required.

PART 3 EXECUTION

3.1 PLACEMENT

Fill material shall not be placed against concrete which has not been in place at least 14 days or until the concrete has attained a strength of 2,500 p.s.i. when tested in accordance the Section 03305, CONCRETE. Heavy equipment shall not be operated over pipes and buried structures until at least 2 feet of fill material has been placed and compacted over them in conformance with the requirements of the paragraph: BACKFILL AND COMPACTED FILL ABOUT STRUCTURES. Compacted fill and backfill shall be placed with suitable equipment in horizontal layers which, before compaction, shall not exceed 12 inches in depth for rubber-tired or vibratory rollers and front-end loaders, 6 inches in depth for tamping rollers, and 4 inches in depth when mechanical tampers are used. The Contractor may vary the layer

thickness within these limits for most efficient operations. Material containing stones shall be placed in a manner to prevent the stones from striking the concrete structures and to prevent the formation of voids.

3.2 MOISTURE CONTENT

Material shall have a uniform moisture content while being placed and compacted. Water shall be added at the source, if required, or by sprinkling each layer of material during placement. Uniform distribution of moisture shall be obtained by discing, harrowing, or otherwise manipulating the soil during and after the time water is added. Material containing an excess of moisture shall be manipulated with suitable implements to facilitate maximum aeration and shall be permitted to dry to the proper consistency before being compacted. Fill shall have a maximum moisture content of not more than 2 percent above optimum and a minimum moisture content of not less than 1 percent below optimum.

3.3 COMPACTION

No layer of fill shall be compacted before the practicable uniform moisture content has been obtained. Scarified areas shall be compacted as specified for the fill placed thereon. Rollers will not be permitted to operate within one foot of channel or structure walls or over buried structures until the compacted fill over the top of the structures has reached a depth of 2 feet. Compaction equipment shall be so operated that structures are not damaged nor overstressed during compaction operations. Mechanical tampers shall be used for compaction of fill material adjacent to structures where rolling equipment is impracticable for use in compaction.

3.4 BACKFILL AND COMPACTED FILL AROUND STRUCTURES

3.4.1 Material

Select Zone I material shall be used for backfill and compacted fill around structures unless another material is specifically required.

3.4.2 Limitations on Equipment

The gross weight of any piece of equipment, or the combined weight of any combinations of equipment coupled together, used to place, moisten and/or compact fill behind walls shall not exceed 35,000 pounds, including dynamic forces produced by vibratory equipment. Equipment used to compact the fill behind the walls shall be of such size as to be capable of operating in the area between the cut slope and the wall. Compaction equipment will not be required to operate at elevations lower than 2 feet above the top of wall footings. This equipment shall be of such size as to be capable of operating in the area between the cut slope and wall at any point 2 feet above the top of the heel of wall footings. Below that point, lean mix concrete shall be used.

3.4.3 Compaction

Each layer of fill shall be compacted to not less than 90 percent of maximum density as determined using ASTM D 1557.

3.4.4 Trimming

The top of fill adjacent to walls shall be trimmed to the lines indicated on the drawings with a tolerance of plus or minus one inch. Any material

loosened by trimming shall be recompacted and the berm area moistened and compacted with one pass of a smooth-wheeled roller. Tolerances shall apply after rolling. The fill slopes shall be trimmed to a uniform alinement at top of berm and to a reasonably uniform slope at or outside the lines shown on the drawings.

3.5 COMPACTED FILL, ROAD

3.5.1 Location

Compacted road fill shall consist of fill placed for road and parking area construction, and all other fill and backfill within the rights-of-way of the access roads, except as limited by paragraph: LOCATION OF APPLICABILITY.

3.5.2 Material

Levee and road fill shall be used for compacted fill for the roads.

3.5.3 Compaction

Each lift of fill shall be compacted to not less than 90 percent of maximum density as determined using ASTM D 1557.

3.5.4 Trimming

All shoulders and side slopes shall be neatly and accurately trimmed to the cross sections indicated.

3.6 COMPACTED FILL, LEVEE

3.6.1 Location

Compacted levee fill shall be required where indicated on the drawings.

3.6.2 Material

Levee and road fill shall be used for compacted fill for the channel invert and levees.

3.6.3 Compaction

Each lift of the compacted levee fill shall be compacted to not less than 90 percent of maximum density as determined using ASTM D 1557.

3.6.4 Trimming

All shoulders and side slopes shall be neatly and accurately trimmed to the cross sections indicated.

3.7 SUBGRADE PREPARATION

3.7.1 Subgrade Preparation for Roads and Parking Areas

The subgrade shall be alternately watered and scarified until the material is uniformly moistened throughout for a depth of not less than 10 inches. All stones larger than 6 inches in diameter, and hard ribs of earth shall be removed. The amount of water to be applied shall be that which is required to provide optimum results of compaction under rolling. Following

the above operations, the roadbed shall be shaped to a true cross section sufficiently higher than the specified grade to allow for subsequent compaction and then be thoroughly compacted to not less than 95 percent of maximum density as determined using ASTM D 1557. After the subgrade has been prepared and completed, the surface shall be firm, hard, and unyielding, with a true, even, and uniform surface conforming to the grade and cross section indicated on the drawings. All points of the finished subgrade shall be not more than 1/2 inch below or above true subgrade.

3.7.2 Levee, Invert Subgrade Preparation

After the channel has been excavated to rough grade, the entire subgrade for the channel invert slab and levees shall be proofrolled by 4 passes of the 10-ton vibratory steel-wheeled roller and trimmed to a uniform grade and smoothed with a steel-wheeled roller to make the subgrade ready to receive filter material or concrete. If the subgrade is disturbed by the Contractor's operations or is overexcavated, or is soft or yielding, the subgrade shall be restored to grade and compacted to a density of 90 percent of maximum density as determined using ASTM D 1557. The finished surface of the subgrade shall not be more than 1/2 inch from the indicated grade at any point when tested with a 10-foot straightedge.

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DIVISION 02 - SITE WORK

SECTION 02316

EXCAVATION, TRENCHING, AND BACKFILLING FOR UTILITIES SYSTEMS

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SECTION 02316

EXCAVATION, TRENCHING, AND BACKFILLING FOR UTILITIES SYSTEMS

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A 798	(1997a) Installing Factory-Made Corrugated Steel Pipe for Sewers and Other Applications
ASTM D 422	(1963; R 1990) Particle-Size Analysis of Soils
ASTM D 1557	(1991) Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/cu. ft. (2,700 kN-m/cu. m.))
ASTM D 2321	(1989; R 1995) Underground Installation of Thermoplastic Pipe for Sewers and Other Gravity-Flow Applications
ASTM D 2487	(1998) Classification of Soils for Engineering Purposes (Unified Soil Classification System)
ASTM D 2922	(1996el) Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth)
ASTM D 3017	(1996) Water Content of Soil and Rock in Place by Nuclear Methods (Shallow Depth)

1.2 DEGREE OF COMPACTION

Degree of compaction shall be expressed as a percentage of the maximum density obtained by the test procedure presented in ASTM D 1557.

1.3 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-06 Test Reports

Field Density Tests
Testing of Backfill Materials

Copies of all laboratory and field test reports within 24 hours of the completion of the test.

PART 2 PRODUCTS

2.1 MATERIALS

2.1.1 Satisfactory Materials

Satisfactory materials shall consist of any material classified by ASTM D 2487 as GW, GP, GM, GP-GM, GC, GP-GC, GM-GC, SW, SP, SM, SW-SH, SC, SW-SC, SP-SM, SP-SC, CL, ML, and CL-ML.

2.1.2 Unsatisfactory Materials

Unsatisfactory materials shall be materials that do not comply with the requirements for satisfactory materials. Unsatisfactory materials include, but are not limited to, those materials containing roots and other organic matter, trash, debris, frozen materials and stones larger than 3 inches. Unsatisfactory materials also include man-made fills, refuse, or backfills from previous construction. 36-inch S.A.R.I. line backfill 3 feet above the top of pipe may contain stones up to 3/4 of the compacted layer thickness.

2.1.3 Unyielding Material

Unyielding material shall consist of rock and gravelly soils with stones greater than 3 inches in any dimension or as defined by the pipe manufacturer, whichever is smaller.

2.1.4 Unstable Material

Unstable material shall consist of materials too wet to properly support the utility pipe, conduit, or appurtenant structure.

2.1.5 Select Granular Material

Select granular material shall consist of well-graded sand, gravel, crushed gravel, crushed stone or crushed slag composed of hard, tough and durable particles, and shall contain not more than 10 percent by weight of material passing a No. 200 mesh sieve and no less than 95 percent by weight passing the 1 inch sieve. The maximum allowable aggregate size shall be 1 inches, or the maximum size recommended by the pipe manufacturer, whichever is smaller.

PART 3 EXECUTION

3.1 EXCAVATION

Excavation shall be performed to the lines and grades indicated. During excavation, material satisfactory for backfilling shall be stockpiled in an orderly manner at a distance from the banks of the trench equal to 1/2 the depth of the excavation, but in no instance closer than 2 feet. Excavated material not required or not satisfactory for backfill shall be removed from the site and shall be disposed of by the Contractor. Grading shall be

done as may be necessary to prevent surface water from flowing into the excavation, and any water accumulating therein shall be removed to maintain the stability of the bottom and sides of the excavation. Unauthorized overexcavation shall be backfilled in accordance with paragraph BACKFILLING AND COMPACTION at no additional cost to the Government.

3.1.1 Trench Excavation

Trench walls shall be vertical, unless deeper excavation requires other provisions. The Contractor shall design and submit for approval to the Contracting Officer a proposed trench excavation method for the 36-inch S.A.R.I. sewer relocation upstream of the dam, which shall be in accordance with all applicable safety requirements. The 36-inch S.A.R.I. sewer shall be trenched in accordance with the details shown on the plans. The bottom of the trench shall be accurately graded to provide uniform bearing and support for each section of the conduit at every point along its length.

3.1.2 Trench Excavation for Pipe Culverts, Storm Drains, and Drainage Structures

The width of trenches at any point below the top of the pipe shall be not greater than the outside diameter of the pipe plus 24 inches to permit satisfactory jointing and thorough tamping of the bedding material under and around the pipe. Sheeting and bracing where required shall be placed within the trench width as specified. Care shall be taken not to overexcavate. Where trench widths are exceeded, redesign with a resultant increase in cost of stronger pipe or special installation procedures shall be necessary. Cost of this redesign and increased cost of pipe or installation shall be borne by the Contractor without additional cost to the Government

3.1.3 Removal of Unstable Material

Where wet or otherwise unstable soil incapable of properly supporting the pipe, as determined by the Contracting Officer, is unexpectedly encountered in the bottom of a trench, such material shall be removed to the depth required and replaced to the proper grade with select granular material, compacted as provided in paragraph BACKFILLING. When removal of unstable material is due to the fault or neglect of the Contractor in his performance of shoring and sheeting, water removal, or other specified requirements, such removal and replacement shall be performed at no additional cost to the Government.

3.2 BEDDING

The bedding surface for the pipe shall provide a firm foundation of uniform density throughout the entire length of the pipe. Pipe bedding shall be select granular material.

3.2.1 Concrete Pipe

When no bedding class is specified or detailed on the drawings, concrete pipe shall be bedded carefully in a soil foundation accurately shaped and rounded to conform to the lowest one-fourth of the outside portion of circular pipe or to the lower curved portion of pipe arch for the entire length of the pipe or pipe arch. When necessary, the bedding shall be tamped. Bell holes and depressions for joints shall be only of such length, depth, and width as required for properly making the particular type of joint.

3.2.2 Corrugated Metal Pipe

Bedding for corrugated metal pipe and pipe arch shall be in accordance with ASTM A 798. It is not required to shape the bedding to the pipe geometry.

3.2.3 Plastic Pipe

Bedding for PVC and PE pipe shall meet the requirements of ASTM D 2321. Bedding, haunching, and initial backfill shall be either Class IB or II material.

3.3 BACKFILLING AND COMPACTION

Unless otherwise noted the following shall be used. Backfill material shall consist of satisfactory select granular material. Initial backfill shall be placed in an 8 inch loose layer thickness for compaction by hand tamping. The subsequent backfill layer shall be placed at 6 inches loose thickness or less. The 36 inch S.A.R.I. line backfill 3 feet above the top of the pipe can be compacted with heavy equipment of a 15 inch loose layer thickness. Each layer shall be compacted to at least 90 percent maximum density unless otherwise specified.

3.3.1 Trench Backfill

Trenches shall be backfilled to the grade shown. The trench shall be backfilled to 2 feet above the top of pipe prior to performing the required pressure tests, unless otherwise shown.

3.3.2 36 Inch S.A.R.I. Sewer Line Backfill

The S.A.R.I. sewer shall be backfilled in accordance with the Plans and these specifications. The contractor is given the option to slurry backfill the line at his own expense. The material used in Pipe and Bedding Zone shall consist of select granual material. The Trench Zone shall consist of satisfactory materials and miscellaneous fill, as shown on the plans.

3.3.3 Backfilling Storm Drain Pipe in Trenches

After the pipe has been properly bedded, selected material from excavation or borrow, at a moisture content that will facilitate compaction, shall be placed along both sides of pipe in layers not exceeding 6 inches in compacted depth. The backfill shall be brought up evenly on both sides of pipe for the full length of pipe. Care shall be taken to ensure thorough compaction of the fill under the haunches of the pipe. Each layer shall be thoroughly compacted with mechanical tampers or rammers. This method of filling and compacting shall continue until the fill has reached an elevation of at least 12 inches above the top of the pipe. The remainder of the trench shall be backfilled and compacted by spreading and rolling or compacted by mechanical rammers or tampers in layers not exceeding 8 inches. Tests for density will be made as necessary to ensure conformance to the compaction requirements specified elsewhere in this paragraph. Where it is necessary in the opinion of the Contracting Officer, any sheeting or portions of bracing used shall be left in place and the contract will be adjusted accordingly. Untreated sheeting shall not be left in place beneath structures or pavements.

3.3.4 Backfilling Storm Drain Pipe in Fill Sections

For pipe placed in fill sections, backfill material and the placement and compaction procedures shall be as specified elsewhere in this paragraph. The fill material shall be uniformly spread in layers longitudinally on both sides of the pipe, not exceeding 6 inches in compacted depth, and shall be compacted by rolling parallel with pipe or by mechanical tamping or ramming. Prior to commencing normal filling operations, the crown width of the fill at a height of 12 inches above the top of the pipe shall extend a distance of not less than twice the outside pipe diameter on each side of the pipe or 12 feet, whichever is less. After the backfill has reached at least 12 inches above the top of the pipe, the remainder of the fill shall be placed and thoroughly compacted in layers not exceeding 8 inches.

3.4 SPECIAL REQUIREMENTS

Special requirements for both excavation and backfill relating to the specific utilities are as follows:

3.4.1 Telephone Lines

Trenches shall be of a depth to provide a minimum cover of 30 inches from the existing ground scarface, or from the indicated finished grade, whichever is lower, to the top of the pipe.

3.4.2 Water Lines

Trenches shall be of a depth to provide a minimum cover of 3 feet 6 inches from the existing ground surface, or from the indicated finished grade, whichever is lower, to the top of the pipe.

3.4.3 Electrical Distribution System

Direct burial cable and conduit or duct line shall have a minimum cover of 30 inches from the finished grade, unless otherwise indicated.

3.4.4 Plastic Marking Tape

Warning tapes shall be installed directly above the pipe, at a depth of 18 inches below finished grade unless otherwise shown. Tape shall be as specified in TABLE 1, and shall bear a continous printed inscription describing the specific utility.

TABLE 1. Tape Color

Red:	Electric
Yellow:	Gas, Oil, Dangerous Materials
Orange:	Telephone, Telegraph, Television, Police, and Fire Communications
Blue:	Water Systems
Green:	Sewer Systems

3.5 TESTING

Testing shall be the responsibility of the Contractor and shall be performed at no additional cost to the Government.

3.5.1 Testing Facilities

Tests shall be performed by an approved commercial testing laboratory or

may be tested by facilities furnished by the Contractor. No work requiring testing will be permitted until the facilities have been inspected and approved by the Contracting Officer. The first inspection shall be at the expense of the Government. Cost incurred for any subsequent inspection required because of failure of the first inspection will be charged to the Contractor.

3.5.2 Testing of Backfill Materials

Characteristics of backfill materials shall be determined in accordance with particle size analysis of soils ASTM D 422 and moisture-density relations of soils ASTM D 1557. A minimum of one particle size analysis and one moisture-density relation test shall be performed on each different type of material used for bedding and backfill.

3.5.3 Field Density Tests

Tests shall be performed in sufficient numbers to ensure that the specified density is being obtained. A minimum of one field density test per lift of backfill for every 600 feet of installation shall be performed. One moisture density relationship shall be determined for every meters 1500 cubic yards of material used. Field in-place density shall be determined in accordance with ASTM D 2922. The nuclear gage shall have a built in trench corrector function which shall be used when tests are performed in a trench. The calibration curves shall be checked and adjusted using the sand cone method as described in paragraph Calibration of the ASTM publication. ASTM D 2922 results in a wet unit weight of soil and when using this method, ASTM D 3017 shall be used to determine the moisture content of the soil. The calibration curves furnished with the moisture gauges shall be checked along with density calibration checks as described in ASTM D 3017. The calibration checks of both the density and moisture gauges shall be made at the beginning of a job, on each different type of material encountered, at intervals as directed by the Contracting Officer. Copies of calibration curves, results of calibration tests, and field and laboratory density tests shall be furnished to the Contracting Officer. Trenches improperly compacted shall be reopened to the depth directed, then refilled and compacted to the density specified at no additional cost to the Government.

-- End of Section --

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DIVISION 02 - SITE WORK

SECTION 02378

GEOTEXTILES USED AS FILTERS

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SECTION 02378

GEOTEXTILES USED AS FILTERS

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM D 123	(1993a) Standard Terminology Relating to Textiles
ASTM D 1683	(1990a) Failure in Sewn Seams of Woven Fabrics
ASTM D 3786	(1987) Hydraulic Bursting Strength of Knitted Goods and Nonwoven Fabrics - Diaphragm Bursting Strength Tester Method
ASTM D 4354	(1989) Sampling of Geosynthetic for Testing
ASTM D 4355	(1992) Deterioration of Geotextile from Exposure to Ultraviolet light and Water (Xenon-Arc Type Apparatus)
ASTM D 4491	(1992) Water Permeability of Geotextiles By Permittivity
ASTM D 4533	(1991) Trapezoid Tearing Strength of Geotextile
ASTM D 4632	(1991) Grab Breaking Load and Elongation of Geotextiles
ASTM D 4751	(1993) Determining the Apparent Opening Size of a Geotextile
ASTM D 4833	(1988) Index Puncture Resistance of Geotextiles, Geomembranes, and Related Products
ASTM D 4873	(1988) Guide for Identification, Storage, and Handling of Geotextiles
ASTM D 4884	(1990) Seam Strength of Sewn Geotextiles

1.2 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When

used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-04 Samples

Geotextile

If requested,submit geotextile samples for testing to determine compliance with the requirements in this specification. When required, submit samples a minimum of 30 days prior to the beginning of installation of the same textile. Upon delivery of the geotextile, submit duplicate copies of the written certificate of compliance signed by a legally authorized official of the manufacturer. The certificate shall state that the geotextile shipped to the site meets the chemical requirements and exceeds the minimum average roll value listed in TABLE 1, MINIMUM PHYSICAL REQUIREMENTS FOR DRAINAGE GEOTEXTILE. Upon request, supply quality control and quality assurance tests for the geotextile. All samples provided shall be from the same production lot as will be supplied for the contract, and shall be the full manufactured width of the geotextile by at least 10 feet long, except that samples for seam strength may be a full width sample folded over and the edges stitched for a length of at least 5 feet. Samples submitted for testing shall be identified by manufacturers lot designation. For needle punched geotextile, the manufacturer shall certify that the geotextile has been inspected using permanent on-line metal detectors and does not contain any needles.

SD-07 Certificates

Geotextile

All brands of geotextile and all seams to be used will be accepted on the basis of mill certificates or affidavits. Submit duplicate copies of the mill certificate or affidavit signed by a legally authorized official from the company manufacturing the geotextile. The mill certificate or affidavit shall attest that the geotextile meets the chemical, physical and manufacturing requirements stated in this specification.

1.3 SHIPMENT, HANDLING, AND STORAGE

1.3.1 Shipment and Storage

Only approved geotextile rolls shall be delivered to the project site. All geotextile shall be labeled, shipped, stored, and handled in accordance with ASTM D 4873. No hooks, tongs, or other sharp instruments shall be used for handling geotextile.
Text

PART 2 PRODUCTS

2.1 MATERIALS

2.1.1 Geotextile

2.1.1.1 General

The geotextile shall be a non-woven pervious sheet of plastic yarn as defined by ASTM D 123. The geotextile shall equal or exceed the minimum average roll values listed in TABLE 1, MINIMUM PHYSICAL REQUIREMENTS FOR DRAINAGE GEOTEXTILE. Strength values indicated in the table are for the weaker principal direction.

TABLE 1
MINIMUM PHYSICAL REQUIREMENTS FOR DRAINAGE GEOTEXTILE

PROPERTY	UNITS	ACCEPTABLE VALUES	TEST METHOD
GRAP STRENGTH	lb	180	ASTM D 4632
ABRASION	lb		ASTM D 3884
SEAM STRENGTH	lb	160	ASTM D 4632
PUNCTURE	lb	80	ASTM D 4833
BURST STRENGTH	psi	290	ASTM D 3786
TRAPEZOID TEAR	lb	50	ASTM D 4533
PERMEABILITY	cm/sec		ASTM D 4491
APPARENT OPENING SIZE U.S. SIEVE	mm	0.180 to 0.300	ASTM D 4751
PERMITTIVITY	sec -1	1.1 to 1.8	ASTM D 4491
ULTRAVIOLET DEGRADATION	Percent	50 AT 500 Hrs	ASTM D 4355

2.1.1.2 Geotextile Fiber

Fibers used in the manufacturing of the geotextile shall consist of a long-chain synthetic polymer composed of at least 85 percent by weight of polyolefins, polyesters, or polamides. Stabilizers and/or inhibitors shall be added to the base polymer if necessary to make the filaments resistant to deterioration caused by ultraviolet light and heat exposure. Reclaimed or recycled fibers or polymer shall not be added to the formulation. Geotextile shall be formed into a network such that the filaments or yarns retain dimensional stability relative to each other, including the edges. The edges of the geotextile shall be finished to prevent the outer fiber from pulling away from the geotextile.

2.1.2 Seams

The seams of the geotextile shall be sewn with thread of a material meeting the chemical requirements given above for geotextile yarn or shall be bonded by cementing or by heat. Seams shall be tested in accordance with method ASTM D 1683. The strength of the seam shall be not less than 90 percent of the required grab tensile strength of the unaged geotextile in any principal direction.

2.1.3 Securing Pins

The geotextile shall be secured to the embankment or foundation soil by pins

to prevent movement prior to placement of revetment materials. Other appropriate means to prevent movement such as staples, sand bags, and stone could also be used. Securing pins shall be inserted through both strips of overlapped geotextile along the line passing through midpoints of the overlap. Securing pins shall be removed as placement of revetment or gravel drain materials are placed to prevent tearing of geotextile or enlarging holes. Maximum spacing between securing pins depends on the steepness of the embankment slope. The maximum pins spacing shall be equal to or less than the values listed in TABLE 2, MAXIMUM SPACING FOR SECURING PINS. When windy conditions prevail at the construction site, the number of pins should be increased upon the demand of the Contracting Officer. Terminal ends of the geotextile shall be anchored with key trench or apron at crest, toe of the slope and upstream and downstream limits of installation.

TABLE 2
MAXIMUM SPACING FOR SECURING PINS

EMBANKMENT	SPACING, feet
STEEPER THAN 1V ON 3H	2
1V ON 3H TO 1V ON 4H	3
FLATTER THAN 1V ON 4H	5

2.2 INSPECTIONS, VERIFICATIONS, AND TESTING

2.2.1 Manufacturing and Sampling

Geotextiles and factory seams shall meet the requirements specified in TABLE 1, MINIMUM PHYSICAL REQUIREMENTS FOR DRAINAGE GEOTEXTILE. Geotextiles shall be randomly sampled in accordance with ASTM D 4354 (Procedure Method A). Factory seams shall be sampled at the frequency specified in ASTM D 4884.

2.2.2 Site Verification and Testing

Samples shall be collected at approved locations upon delivery to the site at the request of the Contracting Officer the request of the Contracting Officer. Samples shall be tested to verify that the geotextile meets the requirements specified in TABLE 1, MINIMUM PHYSICAL REQUIREMENTS FOR DRAINAGE GEOTEXTILE. Samples shall be identified by manufacturers name, type of geotextile, lot number, roll number, and machine direction. Testing shall be performed at an approved laboratory. Test results from the lot under review shall be submitted and approved prior to deployment of that lot of geotextile. Rolls which are sampled shall be immediately rewrapped in their protective covering.

PART 3 EXECUTION

3.1 SURFACE PREPARATION

Surface on which the geotextile will be placed shall be prepared, to a relatively smooth surface condition, in accordance with the applicable

portion of this specification and SECTION 02250, FILLS AND SUBGRADE PREPARATION, paragraph Subgrade Preparation for Channel Invert Slab or Filter Material. Ground surface shall be free from obstruction, debris, depressions, erosion feature, or vegetation. Any irregularities will be removed so as to insure continuous, intimate contact of the geotextile with all the surface. Any loose material, soft or low density pockets of material, will be removed; erosion features such as rills, gullies etc. must be graded out of the surface before geotextile placement.

3.2 INSTALLATION OF THE GEOTEXTILE

3.2.1 General

The geotextile shall be placed in the manner and at the locations shown. At the time of installation, the geotextile shall be rejected if it has defects, rips, holes, flaws, deterioration or damage incurred during manufacture, transportation or storage.

3.2.2 Placement

The geotextile shall be placed with the long dimension perpendicular to the centerline of the channel centerline channel and laid smooth and free of tension, stress, folds, wrinkles, or creases. The strips shall be placed to provide a minimum width of 15 inches of overlap for each joint. The Contractor shall adjust the actual length of the geotextile used based on initial installation experience. Temporary pinning of the geotextile to help hold it in place until the gravel drain material is placed shall be allowed. The temporary pins shall be removed as the gravel drain material is placed to relieve high tensile stress which may occur during placement of material on the geotextile. Design protection of riprap should be in compliance with EM 1110-2-1601. Trimming shall be performed in such a manner that the geotextile shall not be damaged in any way.

3.3 PROTECTION

The geotextile shall be protected at all times during construction from contamination by surface runoff and any geotextile so contaminated shall be removed and replaced with uncontaminated geotextile. Any damage to the geotextile during its installation or during placement of gravel drain material shall be replaced by the Contractor at no cost to the Government. The work shall be scheduled so that the covering of the geotextile with a layer of the specified material is accomplished within 7 calendar days after placement of the geotextile. Failure to comply shall require replacement of geotextile. The geotextile shall be protected from damage prior to and during the placement of gravel drain materialriprap or other materials. Before placement of riprap or other materialsconcrete, the Contractor shall demonstrate that the placement technique will not cause damage to the geotextile. In no case shall any type of equipment be allowed on the unprotected geotextile.

3.4 PLACEMENT OF CUSHIONINGGRAVEL DRAIN MATERIAL

Placing of cushioning material gravel drain material shall be performed in a manner to insure intimate contact of the geotextile with the prepared surface and with the cushioning placed material. The placement shall also be performed in a manner that shall not damage the geotextile including tear, puncture, or abrasion. On sloping surfaces the cushioning material shall be placed from the bottom of the slopes upward. During placement, the height of the drop of riprap any material shall not be greater than 12

inches. After the initial 12 inches of material has been placed this requirement is no longer applicable. Any geotextile damaged beneath the cushioning gravel drain or fill material shall be uncovered as necessary and replaced at no cost to the Government.

3.5 OVERLAPPING AND SEAMING

3.5.1 Overlapping

The overlap of geotextile rolls shall be 15 inches. Appropriate measures will be taken to insure required overlap exists after cushion gravel drain material placement.

3.5.2 Sewn Seams

High strength thread should be used such that seam test should conform to ASTM D 1683. The thread shall meet the chemical, ultraviolet, and physical requirements of the geotextile, and the color shall be different from that of the geotextile. The seam strength shall be equal to the strength required for the fabric in the direction across the seam. Overlapping J-type seams are preferable over prayer-type seams as the overlapping fabric reduces the chance of openings to occur at the seam. Double sewing shall be used specially for field seams to provide a safety factor against undetected missed stitches.

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DIVISION 02 - SITE WORK

SECTION 02410

SUBDRAINAGE SYSTEM

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SECTION 02410

SUBDRAINAGE SYSTEM

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS (AASHTO)

AASHTO M 65	(1980; Rev 1986) Vitrified Clay Pipe Extra Strength, Standard Strength and Perforated
AASHTO M 175	(1976) Perforated Concrete Pipe
AASHTO M 177	(1975) Bituminized-Fiber Nonpressure Sewer, Drain, and Underdraingae Pipe System

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A 36	(1997ael) Carbon Structural Steel
ASTM A 74	(1998) Cast Iron Soil Pipe and Fittings
ASTM A 123	(2000) Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
ASTM A 126	(1995) Gray Iron Castings for Valves, Flanges, and Pipe Fittings
ASTM A 536	(1999el) Ductile Iron Castings
ASTM C 14	(1995) Concrete Sewer, Storm Drain, and Culvert Pipe
ASTM C 131	(1996) Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine
ASTM C 136	(1996a) Sieve Analysis of Fine and Coarse Aggregates
ASTM C 425	(1998) Compression Joints for Vitrified Clay Pipe and Fittings
ASTM C 443	(1994) Joints for Circular Concrete Sewer and Culvert Pipe, Using Rubber Gaskets

ASTM C 444	(1995) Perforated Concrete Pipe
ASTM C 700	(1997) Vitrified Clay Pipe, Extra Strength, Standard Strength, and Perforated
ASTM D 75	(1987; R 1992) Sampling Aggregates
ASTM D 1861	(1988) Homogeneous Bituminized Fiber Drain and Sewer Pipe
ASTM D 1862	(1988) Laminated-Wall Bituminized Fiber Drain and Sewer Pipe
ASTM D 2311	(1988) Homogeneous Perforated Bituminized Fiber Pipe for General Drainage
ASTM D 2417	(1988) Perforated Laminated-Wall Bituminized Fiber Pipe for General Drainage
ASTM D 2751	(1996a) Acrylonitrile-Butadiene-Styrene (ABS) Sewer Pipe and Fittings
ASTM D 3034	(1998) Type PSM Poly(Vinyl Chloride) (PVC) Sewer Pipe and Fittings

FEDERAL SPECIFICATIONS (FS)

FS SS-P-361	(Rev E) Pipe, Clay (Vitrified Fittings, and Perforated Pipe
FS SS-S-168	(Am 2) Sealing Compound, Sewer, Bituminous, Two-Compound, Mineral-Filled, Cold-Applied
FS SS-S-169	(Rev B) Sealer, Joint, Sewer, Mineral-Filled, Hot-Pour

1.2 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-06 Test Reports

Flow tests; G.

Flow testing of the system is required in accordance with Paragraph: Flow Tests.

Sand filter and gravel drain materials

Test results of the sand filter and gravel drain materials to determine compliance

SD-07 Certificates

Subdrain Pipe

Certifications from the manufacturers attesting that materials meet specification requirements. Certificates are required for drain pipe, drain tile, fittings, and filter fabric.

1.3 DELIVER, STORAGE, AND HANDLING

1.3.1 Delivery and Storage

Materials delivered to site shall be inspected for damage, unloaded, and stored with minimum handling. Materials shall not be stored directly on the ground. The inside of pipes and fittings shall be kept free of dirt and debris. During shipment and storage, filter fabric shall be wrapped in burlap or similar heavy duty protective covering. The storage area shall protect the fabric from mud, soil, dust, and debris. Plastic pipe shall be installed within 6 months from the date of manufacture unless otherwise approved.

1.3.2 Handling

Materials shall be handled in such a manner as to insure delivery to the trench in sound undamaged condition. Pipe shall be carried and not dragged to the trench.

PART 2 PRODUCTS

2.1 SAND FILTER AND GRAVEL DRAIN MATERIALS

Sand filter and gravel drain materials shall be durable. hard, tough, and free from adherent coatings. The material shall not contain corrosive agents, organic matter or soft, friable, thin or elongated particles in quantities considered deleterious by the Contracting Officer.

2.1.1 Sand Filter Material

Sand filter material shall consist of natural Sand, manufactured sand, or a combination of natural and manufactured sands, and shall be reasonably well graded within the following limits:

Sieve Size	Percent by Weight Passing
3/8 inch	100
No. 4	80-100
No. 8	50-95
No. 16	25-65
No. 30	5-35
No. 50	0-5

2.1.2 Gravel Drain Material

Gravel drain material shall consist of gravel, crushed stone, or processed crushed concrete (excluding asphalt), and shall show a loss in weight of not more than 50 percent when tested in accordance with ASTM C 131, and shall be reasonably well graded within the following limits:

Sieve Size	Percent by Weight Passing
1.5"	100
1.0"	55-100
.75"	40-80
3/8"	10-40
No. 4	0-10

2.1.3 Pervious Backfill Material

Pervious backfill material shall consist of gravel, crushed gravel, crushed rock, natural sands, manufactured sand, or combination thereof. Pervious backfill material shall conform to the following grading requirements:

Sieve Size	Percent by Weight Passing
2"	100
No. 50	0-100
No. 100	0-8
No. 200	0-4

2.1.4 Points

Points on the individual grading curves obtained from representative samples of the sand filter or gravel drain material not only shall lie between the boundary limits as defined by smooth curves drawn through the tabulated grading limits plotted on a mechanical-analysis diagram but also shall exhibit no abrupt changes in slope denoting skip grading, scalping of certain sizes, or other irregularities which would be detrimental to the proper functioning of the filter or drain.

2.1.5 Sampling and Testing

Sampling and testing of the sand filter and gravel drain materials shall be performed by the Contractor to determine compliance of the installed materials with specified requirements in conformance with ASTM C 131, ASTM C 136, and ASTM D 75. Sampling and testing shall be performed at regular intervals with at least one test being made for each 500 cubic yards of material. After the sand filter and gravel drain materials have been placed, one additional sample shall be taken and tested for each 1,000 square yards or fraction thereof, of each material. The location of after placement tests shall be as directed.

2.2 SUBDRAIN PIPE

Subdrain pipe may be concrete, clay, polyvinyl chloride (PVC), acrylonitrile-butadiene-styrene (ABS), or bituminized-fiber pipe, except that only one type shall be used for the entire project.

2.2.1 Non-Perforated Pipe

2.2.1.1 Non-Perforated Concrete Pipe

Non-perforated concrete pipe shall conform to ASTM C 14 or AASHTO M 86.

2.2.1.2 Non-Perforated Clay Pipe

Non-perforated clay pipe shall conform to FS SS-P-361, AASHTO M 65,

or ASTM C 700.

2.2.1.3 Non-Perforated Bituminized-Fiber Pipe

Non-perforated bituminized-fiber pipe shall conform to ASTM D 1861 or ASTM D 1862.

2.2.2 Perforated Pipe

Pipe sizes are 8 and 10 inches. Minimum area of opening shall be at least 1.0 square inch per linear foot and shall be located within an arc of 120 degrees along the top of the pipe. Perforations may be either holes or slots with at least one perforation located in each linear foot of pipe excluding joint areas. The diameter of holes shall be not less than 3/16 inch nor more than 3/8 inch. The slots shall be not less than 3/16 inch nor more than 5/16 inch wide and not more than 4 inches long. Perforations shall be made by the pipe fabricator using methods which will eliminate spalling insofar as practicable. Pipes having spalls extending more than 1/2 inch outside the perforations or more than 1/2 the wall thickness into the perforation shall be rejected.

2.2.2.1 Perforated Concrete Pipe

Perforated concrete pipe shall conform to ASTM C 444 and all applicable requirements of ASTM C 14 or to AASHTO M 175 and all applicable requirements of AASHTO M 86 except that at the option of the Contractor pipe may be perforated as specified above.

2.2.2.2 Perforated Clay Pipe

Perforated clay pipe shall conform -to FS SS-P-361, AASHTO M 65, or ASTM C 700 except that at the option of the Contractor, perforations may be as specified above.

2.2.2.3 Perforated Bituminized-Fiber Pipe

Perforated bituminized-fiber pipe shall conform to ASTM D 2311 or ASTM D 2417, or AASHTO M 177, except that at the option of the Contractor, perforations may be as specified above.

2.2.2.4 Perforated Acrylonitrile-Butadiene-Styrene (ABS) Pipe

Perforated acrylonitrile-butadiene-styrene (ABS) pipe shall conform to ASTM D 2751 with a maximum SDR of 35, perforations shall be as specified herein before.

2.2.2.5 Perforated Polyvinyl Chloride (PVC) Pipe

Perforated polyvinyl chloride (PVC) pipe and fittings shall conform to ASTM D 3034, Type PSM with a maximum SDR of 35, with flexible elastomeric seal joints, perforations shall be as specified herein before.

2.3 PIPE FITTINGS

Pipe fittings shall be cast-iron. concrete, vitrified clay, PVC, ABS or bituminized fiber and shall be suitable for use with the pipe furnished. Fittings shall be furnished with such adaptors as are recommended by the manufacturers of the pipe.

2.4 PIPE PLUGS

Pipe plugs shall be cast-iron. concrete, vitrified clay, PVC, ABS or bituminized fiber and shall be suitable for use with the pipe furnished.

2.5 CAST-IRON PIPE AND FITTINGS

Cast-iron pipe and fittings shall be service weight conforming to the requirements of ASTM A 74, Plug and ferrule shall be similar to that shown in Table 39 (ASTM A 74), except that the brass screw plug shall have a recessed socket head.

2.6 STEEL PIPE

Steel pipe shall conform to the requirements of the SECTION 05120: STRUCTURAL STEEL AND MISCELLANEOUS METALWORK.

2.7 FILTER FABRIC

Filter fabric shall conform to the requirements of the SECTION 02378: GEOTEXTILES USED AS FILTERS.

2.8 AUTOMATIC DRAINAGE GATES

Automatic drainage gates shall be of the size required by the plans, and shall be designed to allow free outflow and prevent backflow for maximum seating heads up to 20 feet. Frame and cover shall be cast-iron conforming to the requirements of ASTM A 126, Class B. Pivot lug shall be ductile iron conforming to the requirements of ASTM A 536. Hinge link shall be structural steel conforming to ASTM A 36, and galvanized in accordance ASTM A 123. Bushings and washers shall be commercial bronze. Assembly hardware and pin shall be 18-8 stainless steel.

PART 3 EXECUTION

3.1 INSTALLATION

3.1.1 General

3.1.1.1 Filter and Drain

The Contractor shall prevent the contamination of drains and filters by runoff containing sediment, dust, construction traffic, and mixing with nearby fine-grained materials during placement and compaction. Placement procedures shall prevent the segregation of the materials. During the installation of each material, that material shall be saturated and manipulated with spreading equipment until a uniform density is achieved.

3.1.1.2 Sand Filter Material

Sand filter material shall be placed, moistened, and spread in a uniform layer to the lines and grades indicated. Placing and spreading equipment shall be operated in such manner as to not disturb the underlying material. After installation of the filter material, equipment shall not be operated over the blanket except for placement of drain material. Any filter material contaminated or rutted by equipment shall be removed and replaced with fresh filter material.

3.1.1.3 Gravel Drain Material

Gravel drain material shall be placed over the sand filter material and spread to a uniform grade to the elevations indicated. At pipe drains, drain material shall be placed to pipe bed elevation. After installation of the collector pipe, the trench shall be filled with drain material to the elevation of the bottom of the invert slab. Any pipe displaced or damaged during placement of the drain material shall be replaced and realigned by the Contractor at no additional cost to the Government. Just prior to placing steel reinforcement for the invert the drain material shall be moistened and shall be kept in a moist state during the entire period steel is being placed. Prior to placing concrete, the material shall be moistened again in conformance with the requirements of the SECTION 03305 : CONCRETE.

3.1.1.4 Pervious Backfill Material

Pervious backfill material shall be placed behind bridge abutments as shown on the plans. Pervious backfill material shall be placed in layers along with and by the same methods specified for structural backfill.

3.1.1.5 Smoothness Test

The finished surface of the combined filter and drain material layers shall not vary more than 1/2 inch from the established grade and in addition every area shall show no deviation greater than 1/2 inch when tested with a 10-foot straightedge applied both parallel with, and at right angles to, the center line of the channel.

3.1.2 Pipe Laying

Each pipe shall be carefully inspected immediately before it is laid, and any damaged or defective pipe shall not be used. The pipe shall be placed in the bedding surface that is accurately shaped to conform to the lower 1/4 of the outside portion of the pipe. Perforated pipe shall be laid with the perforated side uppermost. Pipe shall be laid to the grades and alignment indicated or as directed. The laying shall proceed upgrade from the lower end of the pipe line. Pipe grade shall be maintained within 1/4 inch in 10 feet of that indicated. Upon completion of backfill, the area shall be suitable for placement of concrete invert or fill as applicable.

3.1.2.1 Joints

The Joints between sections of perforated pipe shall be of a type that will hold the pipe securely in alignment and maintain the inner surfaces of abutting pipes flush and even. Except as otherwise specified, Joints for Non-perforated pipe shall be filled with mortar in an approved manner for concrete or clay pipe and shall be of the type recommended by the manufacturer for bituminized-fiber pipe. If mortar Joints are used, sufficient mortar to completely fill the joint shall be applied to the pipe prior to joining and excess mortar shall be removed from the inside of the pipe by wiping or by dragging an approved swab through the pipe as applicable.

3.1.2.2 Mortar

Mortar for joints shall be composed of cement, sand, and water proportioned at the approximate ratio of one part cement to not less than 2 parts nor more than 2-1/2 parts sand. The materials shall conform to the applicable requirements of the SECTION: 03305 CONCRETE. The mortar shall be mixed in

a concrete mixer in the manner specified for concrete, or in a water-tight mixing box. If mixed in a box, the box shall first be filled with the required amount of sand, the volume of which shall be determined with a one cubic foot measuring box. The required amount of cement shall then be added and the material dry mixed by turning at least 3 times with a mortar hoe. Sufficient water shall then be added and the mixing continued until the batch is uniform in color and consistency. Mortar shall not be used after visible signs of setting. No retempering will be permitted.

3.1.2.3 Optional Types of Joints for Non-Perforated Pipe

The following types of joints may be used within the limitations specified.

a. Plastic: Plastic conforming to ASTM C 425 may be used with clay pipe. Plastic shall be molded in the annular space or on the spigot of the pipe. or both, in a plant especially equipped for the purpose.

b. Rubber Caskets: Rubber gaskets conforming to the chemical and physical requirements of ASTM C 443, The configuration of the gasket shall be-as recommended by the pipe manufacturer for the particular type of the pipe joint. The gasket shall be so installed as to provide a tight fit, Rubber gaskets may be used with clay and concrete pipe.

c. Bituminous Sealers: Bituminous sealers conforming to FS SS-S-169, Class 1 or 2 and FS SS-S-168 may be used in the joints of bell and spigot pipe or joints having similar annular space. The inside of the bells and outside of the spigots shall be dry and clean prior to application of the bituminous compound. Jointing surfaces shall be primed when recommended by the manufacturer of the compound. The joint shall be made according to the approved method for the type and class of material.

3.1.2.4 Movement of Construction Machinery

In compacting by rolling or operating heavy equipment parallel with the pipe, displacement of or injury to the pipe shall be avoided. Movement of construction machinery over a subdrain system at any stage of construction shall be at the Contractor's risk. Any damaged pipe shall be repaired or replaced.

3.2 SUBDRAIN MANHOLES

Concrete shall conform to the requirements of the SECTION: 03305 CONCRETE. Metalwork shall conform to the requirements of the SECTION: 05120 STRUCTURAL STEEL AND MISCELLANEOUS METALWORK. Subdrain manholes shall be constructed prior to installation of collector pipe and filter and drain materials. Automatic drainage gates shall be installed in accordance with the manufacturers recommendations.

3.3 TESTS

3.3.1 Flow Tests

The Contractor shall conduct two separate tests to demonstrate the proper functioning of the new collector drains. All collector lines of each reach shall be tested, a reach being defined as beginning at the upstream cleanout and ending at the manhole or parabolic drop structure (for the

last reach). After flushing each collector line of each reach, a minimum flow rate of 10 cubic feet per minute out of the end of the length of pipe being tested, as measured by approved measuring equipment furnished by the Contractor, shall be achieved. The first test of each completed reach of the new subdrain system shall be made immediately prior to placing compacted fill, channel or concrete invert. The second test (acceptance test) shall be made after completion of the compacted fill, channel or concrete invert. Final acceptance will be made, only if the discharge is free of sand, gravel or other debris, and of adequate quantity. Any necessary clearing of drain lines shall be performed at no additional cost to the Government. Manholes shall be cleared of all debris prior and subsequent to each test. Tests shall be conducted in the presence of the Contracting Officer. A description of the testing method and equipment used shall be submitted to the Contracting Officer for approval thirty (30) calendar days prior to the tests.

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DIVISION 02 - SITE WORK

SECTION 02480

MECHANICALLY STABILIZED EARTH WALLS

PART 1 GENERAL

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SECTION 02480

MECHANICALLY STABILIZED EARTH WALLS

PART 1 GENERAL

PART 1 GENERAL

1.1 GENERAL INFORMATION

This section specifies the materials and construction of mechanically stabilized earth walls in conformance with the lines, grades, details and dimensions shown on the plans and approved design and shop drawings.

1.2 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A 36	(1997ael) Carbon Structural Steel
ASTM A 53	(1999b) Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
ASTM A 82	(1997a) Steel Wire, Plain, for Concrete Reinforcement
ASTM A 123	(2000) Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
ASTM A 153	(1998) Zinc-Coating (Hot-Dip) on Iron and Steel Hardware
ASTM A 185	(1997) Steel Welded Wire Fabric, Plain, for Concrete Reinforcement
ASTM A 325	(1997) Structural Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength
ASTM A 497	(1997) Steel Welded Wire Fabric, Deformed, for Concrete Reinforcement
ASTM A 570	(1997) Structural Steel, Sheet and Strip, Carbon, Hot-Rolled
ASTM A 572	(1999) High-Strength Low-Alloy Columbium-Vanadium Structural Steel
ASTM A 722	(1995) Uncoated High-Strength Steel Bar

	for Prestressing Concrete
ASTM D 512	Current Manual
ASTM D 516	Current Manual
ASTM D 648	(1998) Deflection Temperature of Plastics Under Flexural Load
ASTM D 698	(1998) Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/cu. ft. (600 kN-m/cu. m.))
ASTM D 1752	(1984; R 1996) Preformed Sponge Rubber and Cork Expansion Joint Fillers for Concrete Paving and Structural Construction
ASTM D 3080	Current Manual
ASTM G 51	Current Manual
ASTM G 57	Current Manual

1.3 SYSTEM DESCRIPTION

1.3.1 General

The mechanically stabilized earth wall shall consist of a non-structural leveling pad, precast concrete facing panels, and metal soil reinforcement elements mechanically connected to each facing panel. The wall face panel shall extend up into the coping as shown on the plans. Where walls intersect at an angle, a special vertical corner element panel shall be used. The corner element panel shall cover the joint of the panels that abut the corner, and allow for independent movement of the abutting panels.

Standard facing panels shall have at least two levels of earth reinforcements to stabilize the panels against the rotation. Top and bottom half panels shall have at least one level of earth reinforcement.

1.3.2 Design Requirements

The estimated base width shown on the plans is based on the soil parameters and seismic loading indicated and shall be verified by the wall manufacturer. The design by the wall manufacturer shall effectively retain the earth for the loading conditions and the contours. profile or slope line shown on the plans. Estimated length of soil reinforcement is shown on the plans and shall be verified by the wall manufacturer. Design calculations for all the wall elements shall be made by a registered professional engineer experienced in the design of reinforced earth retaining structures.

1.3.3 Instrumentation Requirements

Contractor shall provide different instrumentation required at the various locations, for each wall as shown on the plan. The primary purpose of instrumentation is to provide quantitative data to assess settlement, stress, etc., data useful to verify design parameters and assumptions and verify the performance of the wall. A variety of instruments are being

utilized in a comprehensive monitoring program to ensure that all critical items are covered sufficiently. The selection of the monitoring instruments is to ensure a reliable and dependable data of adequate accuracy that can be obtained throughout the period when the information is needed.

Instrumentation shall be required for monitoring horizontal and vertical displacements of the wall facing, soil pressures on the facing or on a vertical plane near the facing and the base of the wall, tensile forces in the reinforcement, and soil reinforcement corrosion. The locations for the instruments have been determined based on the design concerns and long term monitoring of instruments.

Proper installation of instruments is critical to achieving reliable performance and obtaining desired information. Written step-by-step procedures should be prepared, making use of the manufacturers instruction manual. After completion of MSE wall the instrumentation shall be tested and initial readout made to establish the baseline values.

Instrumentation layout shown on the plan is indicative of basic instrumentation requirements. The actual instrumentation program shall be developed by the Contractor's qualified geotechnical engineer. Contractor installed instrumentation shall be coordinated with and approved by the Contracting Officer.

The following instrumentation shall be provided:

1.3.3.1 Inspection Elements

Contractor shall provide inspection elements as shown on the plans to determine loss of metal, to be placed in each wall system at the location shown on the plans to ensure a 100-year service life.

Inspection elements shall be fabricated of material representative of the soil reinforcement. A set of inspection elements shall be provided for each wall at the location shown on the plans. Inspection elements shall be provided for inspection at 5 years, 10-years and at 10-year intervals thereafter. Locate inspection wire or strip at mid-length of full-face panels.

Steel reinforcement elements in MSE walls shall be designed to have a corrosion resistance durability to ensure the minimum specified design life. The required sacrificial thickness shall be provided in addition to the required structural reinforcement thickness to compensate for the effects of corrosion.

The galvanization and carbon steel loss rates shall be as follows:

Galvanization Loss	= 15 µm/yr for first 2 years = 4 µm/yr for subsequent years
Carbon Steel Loss	= 12 µm/yr after zinc depletion

1.3.3.2 Strain Gages

The distribution of tension in the reinforcement shall be determined using strain gages. This information is used indirectly to determine the location of the failure plane and distribution of earth pressure within the reinforced soil. Strain gages are set at predetermined intervals along

some of the reinforcing elements. Near the bottom of the wall the gages are concentrated more near the facing panels whereas in the upper half of the wall gages are concentrated at a distance from the face thirty percent of the height (0.3 H), as shown on the plans.

The strain gages shall be applied on both the upper and lower surfaces of the reinforcing at each measuring point to eliminate the effects of local bending, and wired to from one measuring point. The strain gages shall be applied directly to the steel with outer layer of zinc galvanizing grounded off to expose the bare steel. The application of strain gages shall follow the manufacturers recommendations. The wired area and gage face shall be coated and sealed to prevent moisture infiltration. Once installed and wired the measurements can be read with a strain indicator.

The allowable reinforcement tension should be based on maintaining allowable material stresses to the end of the 100-year service life.

1.3.3.3 Load Cells

Load cells shall be installed to provide a measurement of internal lateral and vertical stress, the distribution of facing stress, and the bearing stress. Load cells shall be installed in the backfill at the locations shown on the plans.

Earth pressure cells are typically made of steel and are more rigid than soils and can result in over-prediction or under-prediction of stress. To reduce the conformance error, the horizontal earth pressure cells, measuring vertical stress shall be placed in a 1-inch bed of sand, and covered with 1 inch of sand. The bedding sand shall be the granular backfill used in the reinforced zone with the large gravel sized particles removed, so it is the same as the surrounding material. The vertical earth pressure cells, measuring horizontal stress shall be placed in the same fashion as the horizontal cells.

The vertical earth pressure cells measuring horizontal stress at the facing shall be seated against the concrete panel and shall be caulked and protected.

Earth pressure cells shall also be placed horizontally on the first backfill level, congruent with the first level of reinforcement, to measure the applied bearing stress.

A set of pressure cells shall also be placed at approximately 0.3H away from the facing to measure the distribution of stress within the reinforced soil.

1.3.3.4 Settlement Indicator Plate

A settlement plate consists of a square plate attached at various locations of the wall facing. Surveying methods are used to monitor the magnitude and rate of horizontal and vertical deformation of the surface monuments. An accurate record must of course be made of the initial location of the plate for reference.

1.3.3.5 Inclinometers

Inclinometers are tilt-sensing devices for monitoring deformation parallel and normal to the axis of a flexible pipe by means of a probe passing along the pipe. The probe contains gravity sensing transducers designed to

measure inclination with respect to the vertical. The pipe is installed in a near vertical alignment, so that the inclinometer provides data for defining subsurface horizontal deformation.

An inclinometer system consists of four components: a guide casing, a portable probe, a portable readout unit and a graduated electrical cable. Guide casings made of ABS are provided by the inclinometer manufacturer. After installation of the casing and surveying of its tip location, the probe is lowered to the bottom and an inclination readout is made. Additional readings are made as the probe is raised incrementally to the top of the casing, providing data for determination of initial casing alignment. The differences between the initial readings and a subsequent set define any change in alignment.

Three inclinometers shall be installed in the reinforced earth section, one right behind the facing panels, one 15 feet behind the facing panels, and one 30 feet back from the facing panels. The inclinometer casings shall be installed in holes drilled to bedrock.

At the Contractors option and in concurrence with the Contracting Officer digital electronic inclinometers may be used in lieu of conventional probe-type inclinometers which are attached to the wall at predetermined locations with gravity sensing transducer with an option for continuous automatic reading, or an option for connection to a measuring device.

1.3.4 Backfill

The friction angle of the granular backfill used in the reinforced fill zone for the internal stability design of the wall shall be 35 degrees. The friction angle shall be determined by the standard direct shear test, (ASTM D 3080), utilizing a sample of the material compacted to 95 percent at optimum moisture content (ASTM D 648). Before construction begins, the material selected shall be subject to approval to conformance with this frictional requirement. Conformance with the test requirements shall be the responsibility of the Contractor.

1.3.5 Safety Factors

The minimum factors of safety shall be as follows:

1.5 against pullout of the reinforcements based on pullout resistance at 0.75 inch deformation for a representative backfill. (i.e. the resulting deformation should not exceed 0.75 inch at 1.5 times the design load). The design stress in the reinforcement shall be 0.55Fy.

1.5 against sliding of the mass

2.0 against bearing capacity failure

1.5 for overall slope stability

For earthquake loading: 1.5 against sliding

1.4 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office

that will review the submittal for the Government. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Shop drawings; G.

The Contractor shall prepare and submit for approval complete shop drawings showing details and materials for the work, reinforcement details, joints between facing units, etc. Elements of fabricated items inadvertently omitted on plans shall be detailed by the fabricator and indicated on the shop drawings.

SD-05 Design Data

Design calculations; G.

Design calculations shall be submitted for the wall design including facing panel reinforcement and soil reinforcement.

Instrumentation; G

Description of proposed instrumentation shall submitted and approved prior to installation.

SD-07 Certificates

Soil Reinforcement and Attachment Devices
Joint Materials

Certified test reports of required material tests shall be submitted prior to the use of the materials in the work.

SD-08 Manufacturer's Instructions

Instructions; G

Manufacturer's recommended instructions for installation.

PART 2 PRODUCTS

2.1 CONCRETE FACING PANELS

Concrete facing panels shall have a minimum thickness of 5 1/2 inches and a minimum concrete cover on reinforcing steel of 1-1/2 inches. Cement shall be Types II or V, low alkali and shall conform to the requirements of ASTM C 150. Concrete shall have a minimum compressive strength of 4,000 psi at 28 days. The maximum water-cement ratio shall be 0.45.

Additives containing chloride shall not be used without the approval of the Engineer. Soil reinforcement attachment and lifting devices shall be set in place to the dimensions and tolerances shown on the plans and called out in these specifications.

Joints between facing panels shall be as shown on the drawings.

2.1.1 Testing and Inspection

Acceptability of the precast units shall be determined on the basis of

compressive strength tests and visual inspection. The precast units shall be considered acceptable when compressive strength test results indicate conformance to the 28-day requirement. Panels shall be considered acceptable for placement in the wall when the seven-day initial strength equals or exceeds 85 percent of the 28-day requirement.

2.1.2 Casting

The panels shall be cast face down in level forms supported on a flat working surface. Guides shall be used to locate and support soil reinforcement attachment devices set in the back face of the panel. The concrete in each panel unit shall be placed without interruption and shall be consolidated by the use of an approved vibrator, supplemented by such hand tamping as may be necessary to force the concrete into the comers of the forms and to prevent the formation of stone pockets or cleavage planes. Clear form oil or release agent shall be used throughout the casting operation.

2.1.3 Curing

The units shall be cured for a sufficient length of time so that the concrete will develop the specified compressive strength. Any production lot which does not conform to the strength requirements of Section 2.1.7, Compressive Strength, shall be rejected.

2.1.4 Removal of Forms

The forms shall remain in place until they can be removed without damage to the unit.

2.1.5 Concrete Finish

Unless otherwise indicated on the plans or elsewhere in the specifications, the concrete surface for the front face shall have an ordinary steel form finish, and for the rear face an unformed finish. The rear face of the panel shall be free of open pockets of aggregate and surface distortions in excess of 1/4 inch.

2.1.6 Tolerances

All units shall be manufactured within the following tolerances with respect to the dimensions shown on the shop drawings:

a. Soil Reinforcement Attachment Devices Locations -- Lateral position of soil reinforcing attachment devices shall be within one inch. Embedment measured from the back face of the panel shall be within + 1/4 inch, - 1/2 inch.

b. Panel Dimensions -- All panel dimensions shall be within 1/4 inch. All hardware embedded in the panel with the exception of attachment devices shall be within 1/4 inch.

c. Panel Squareness -- Squareness, as detern3ined by the difference between the two diagonals, shall not exceed 1/2 inch.

d. Panel Surface Finish -- Surface defects on smooth-formed surfaces, measured on a length of 5 feet, shall not exceed 1/4 inch. Surface defects on textured-finished surfaces, measured on a length of 5 feet, shall not exceed 5/16 inch.

2.1.7 Compressive Strength

Acceptance of the concrete panels, with respect to compressive strength, shall be determined on the basis of production lots. A production lot is defined as a group of panels that shall be represented by a single set of compressive strength samples and shall consist of not more than 80 panels or a single day's production, whichever is less.

Acceptance of a production lot will be made on the compressive testing as per Section 03305, CONCRETE.

2.1.8 Acceptance Criteria

Precast panels shall be accepted for use in wall construction provided the concrete strength meets or exceeds the minimum compressive strength requirement, the soil reinforcement connection devices and the panel dimensions are within tolerances and any chipping, cracks, honeycomb or other defects are repaired to the satisfaction of the Contracting Officer.

2.1.9 Marking

The date of manufacture, the production lot number, and the piece-mark shall be clearly marked on the side of each panel.

2.1.10 Handling, Storage and Shipping

All units shall be handled, stored and shipped in such a manner to prevent chipping, cracks, fractures and excessive bending stresses. For units found unsatisfactory to the Contracting Officer, they shall be replaced with a new unit at no additional cost to the Government. Panels shall be stored and shipped in stacks, front face down. Firm blocking, of sufficient thickness to prevent the attachment devices from contacting the panel above, shall be located immediately adjacent to the attachment devices. Lifting inserts shall be installed on the top edge of the precast panels to permit lifting at the project site.

2.2 SOIL REINFORCEMENT AND ATTACHMENT DEVICES

All soil reinforcement and attachment devices shall be carefully inspected to insure they are true to size and free from defects that may impair their strength and durability. Soil reinforcement shall either be welded wire mats or ribbed reinforcing strip and shall be galvanized.

2.2.1 Welded Wire Mats

W11 and W20 steel wire shall conform to ASTM A 82. The welded wire mat shall conform to ASTM A 185. D11 and D20 deformed steel wire may be substituted for W11 and W20 steel wire. The welded wire mat utilizing deformed steel wire shall conform to ASTM A 497. Galvanizing shall conform to the requirements of ASTM A 123 such that the corrosion rate is no greater than 1.3 mils/year. Splicing of the welded wire mat along its length shall be by an approved mechanical coupler which will develop the minimum tensile strength of the wire. The coupler at the mat connections shall be a seamless steel sleeve. It shall be applied over the button-headed wires and swaged by means of a hydraulic press. The coupler shall develop the minimum tensile strength of the wire without exceeding a total slip of the wires of 0.25 inch.

The connector plate steel shall conform to ASTM A 36. The connector bolt shall conform to ASTM A 325. The button on the button-headed wires shall conform to the requirements of ASTM A 722.

Pipe for the pipe pin shall conform to ASTM A 53, standard weight, except the weight of the zinc coating per square foot of actual surface shall average not less than 2.0 ounces and no individual specimen shall show less than 1.8 ounces.

Resin bonded cork for horizontal joints shall conform to ASTM D 1752, Type II with compressive load of not less than 100 psi.

2.2.2 Ribbed Reinforcing Strips

Ribbed reinforcing strips shall be hot rolled from bars to the required shape and dimensions. Ribbed reinforcing strips shall have nominal dimensions of 2 inches wide and 3/16 inch thickness conforming to ASTM A 572, Grade 65. Galvanizing shall conform to the requirements of ASTM A 123. The minimum coating thickness shall be 2 oz/SF.

Tie strips and splice plates shall be shop fabricated of hot rolled steel conforming to the minimum requirements of ASTM A 570, Grade 50. Galvanizing shall conform to the minimum requirements of ASTM A 123 or ASTM A 153. The minimum coating thickness shall be 2 oz/SF.

Fasteners shall consist of hexagonal cap screw bolts and nuts conforming to the minimum requirements of ASTM A 325. Galvanizing shall conform to the minimum requirements of ASTM A 153.

2.3 JOINT MATERIALS

Joint materials shall be installed to the dimensions and thicknesses in accordance with the plans and approved shop drawings.

2.3.1 Joint Cover

Horizontal and vertical joints between panels shall be covered by a geotextile. The geotextile may be either a non-woven needle punched polyester geotextile or a woven monofilament polypropylene geotextile. The geotextile filter fabric shall be attached to the rear of the facing panels with an adhesive prior to backfill placement.

2.4 GRANULAR BACKFILL MATERIAL

The granular backfill material for mechanically stabilized earth retaining structures with metallic soil reinforcement shall consist of material free from organic material and substantially free of shale or other soft, poor durability particles; shall not contain slag aggregate or recycled materials, such as glass, shredded tires, portland cement concrete rubble, asphaltic concrete rubble, or other unsuitable material as determined by the Engineer; and shall meet the following requirements:

Gradation Requirements

Sieve Size	Percentage Passing
6"	100
3"	78 - 100
No. 4	---

Gradation Requirements

Sieve Size	Percentage Passing
No. 30	0 - 60
No. 200	0 - 25

Property Requirements

Test	Requirement	
Sand Equivalent	12 min.	
Plasticity Index	10 max.	
Minimum Resistivity	1000 ohm-cm min.	643 (ASTM G 57)
Chlorides	100 ppm max.	422 (ASTM D 512)
Sulfates	200 ppm max.	417 (ASTM D 516)
pH	5.5 to 10.0	643 (ASTM G 51)

If 12 percent or less passes the No. 200 sieve and 50 percent or less passes the No. 4 sieve, the Sand Equivalent and Plasticity Index requirements shall not apply.

PART 3 EXECUTION

3.1 FOUNDATION PREPARATION

The foundation for the structure shall be graded level for a width equal to or exceeding the length of the soil reinforcements, or as shown on the plans. Prior to wall construction, the foundation, if not in rock, shall be compacted as directed by the Engineer.

At each panel foundation level, concrete leveling pad shall be provided to the design elevations shown on the plans. Allowable elevation to tolerances are +0.01 foot (1/8 inch), and -0.02 foot (1/4 inch), from the design elevation.

3.2 WALL ERECTION

Panels shall be handled by means of lifting devices set into the upper edge of the panels. Panels shall be placed vertically in successive horizontal lifts as backfill placement proceeds. As backfill material is placed behind the panels, the panels shall be maintained in a vertical position. External bracing is required for the initial lift. Vertical and horizontal alignment tolerances shall not exceed 3/4 inch in 10 feet. The overall vertical tolerance of the wall (plumbness from top to bottom) shall not exceed 3/4 inch per 10 feet of wall height.

3.3 PLACEMENT OF SOIL REINFORCEMENT

Prior to placing the first layer of soil reinforcement, backfill shall be placed and compacted in accordance with Section, Backfill Placement.

Soil reinforcement shall be placed normal to the face of the wall. If skewing of the reinforcing strips is required due to obstructions in the reinforced fill, the maximum skew angle shall not exceed 15 degrees from the normal position unless specifically designed.

3.4 BACKFILL PLACEMENT

Backfill material shall be placed and compacted simultaneously with the erection of the facing panels. Placement and compaction shall be accomplished without distortion of the soil reinforcement or displacement of facing panels. Any wall materials which become damaged or disturbed during backfill placement shall be either removed and replaced at the Contractor's expense or corrected, as directed by the Contracting Officer. Any backfill material placed within the reinforced soil mass which does not meet the requirements of this specification shall be corrected or removed and replaced at the Contractor's expense, as directed by the Contracting Officer.

Backfill shall be compacted to 95 percent of the maximum density as determined by ASTM D 698.

The maximum lift thickness before compaction shall not exceed 10 inches, regardless of the vertical spacing between layers of soil reinforcements. The Contractor shall decrease this lift thickness, if necessary, to obtain the specified density. Prior to placement of the soil reinforcements, the backfill elevation, after compaction, shall be 2 inches above the attachment device elevation from a point approximately 12 inches behind the back face of the panels to the free end of the soil reinforcement, unless otherwise shown on the plans.

Structure backfill at the front of the wall shall be completed prior to backfilling more than 15 feet above the bottom of the lowermost face element. Hand-held or hand-guided compacting equipment shall be used to compact structure backfill material within 3 feet of the facing panels.

At each level of the soil reinforcement, the structure backfill shall be constructed to a plane 0 - 1 foot above the elevation of the soil reinforcement connection, and shall start 3 feet from the back of the face panel and extend for at least the remaining length of soil reinforcement. This grading shall be complete before placing the next layer of soil reinforcement.

3.5 MONTORING

The U.S. Army Corps of Engineers will monitor the MSE walls performance on a regularly scheduled basis. Procedures for collecting, processing, presenting, interpreting, and reporting instrumentation data should be developed prior to installation of the system. The tasks of interpretation, judgment, and implementation must be performed by competent personnel who should also be able to determine if the instruments are functioning correctly.

Monitoring program shall include planning regular calibration and maintenance of instruments, instrument replacement procurement and installation, data collection, and data management.

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DIVISION 02 - SITE WORK

SECTION 02510

WATER DISTRIBUTION SYSTEM

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SECTION 02510

WATER DISTRIBUTION SYSTEM

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ASME B16.5	(1996; B16.5a) Pipe Flanges and Flanged Fittings NPS 1/2 thru NPS 24
ASME B31.1	(1998) Power Piping

AGRICULTURAL MARKETING SERVICE (AMS)

AMS 3651	Current Manual

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A 47	(1999) Ferritic Malleable Iron Castings
ASTM A 123	(2000) Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
ASTM A 126	(1995) Gray Iron Castings for Valves, Flanges, and Pipe Fittings
ASTM A 240	(1995a) Heat-Resisting Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels
ASTM A 276	(1998) Stainless Steel Bars and Shapes
ASTM A 313	(1995a) Stainless Steel Spring Wire
ASTM B 16	Current Manual
ASTM B 32	(1996) Solder Metal
ASTM B 62	(1993) Composition Bronze or Ounce Metal Castings
ASTM B 88	(1999) Seamless Copper Water Tube
ASTM B 584	(1998a) Copper Alloy Sand Castings for General Applications
ASTM B 813	(2000) Liquid and Paste Fluxes for

	Soldering Applications of Copper and Copper Alloy Tube
ASTM D 1785	(1999) Poly(Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120
ASTM D 2133	Current Manual
ASTM D 2241	(1999a) Poly(Vinyl Chloride) (PVC) Pressure-Rated Pipe (SDR Series)
ASTM D 2464	(1999) Threaded Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80
ASTM D 2466	(1999) Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 40
ASTM D 2467	(1999) Socket-Type Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80
ASTM D 2564	(1996a) Solvent Cements for Poly(Vinyl Chloride) (PVC) Plastic Piping Systems
ASTM D 2855	(1996) Making Solvent-Cemented Joints with Poly(Vinyl Chloride) (PVC) Pipe and Fittings
ASTM D 3308	(1997) PTFE Resin-Skived Tape
ASTM F 477	(1999) Elastomeric Seals (Gaskets) for Joining Plastic Pipe

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME B1.20.1	(1983; R 1992) Pipe Threads, General Purpose (Inch)

AMERICAN WELDING SOCIETY (AWS)

AWS A5.8	(1992) Filler Metals for Brazing and Braze Welding

AMERICAN WATER WORKS ASSOCIATION (AWWA)

AWWA B300	(1999) Hypochlorites
AWWA B301	(1992; Addenda B301a - 1999) Liquid Chlorine
AWWA C110	(1993) Ductile-Iron and Gray-Iron Fittings, 3 In. Through 48 In. (75 mm through 1200 mm), for Water and Other Liquids
AWWA C111	(1990) Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings
AWWA C203	(1997; addenda C203a - 1999) Coal-Tar Protective Coatings and Linings for Steel

	Water Pipelines - Enamel and Tape - Hot-Applied
AWWA C509	(1994) Resilient-Seated Gate Valves for Water and Sewerage Systems
AWWA C651	(1992) Disinfecting Water Mains
AWWA C701	(1988) Cold-Water Meters - Turbine Type, for Customer Service
AWWA C706	(1996) Direct-Reading, Remote-Registration Systems for Cold-Water Meters
AWWA C800	(1989) Underground Service Line Valves and Fittings
AWWA M23	(1980) Manual: PVC Pipe - Design and Installation

ASBESTOS CEMENT PIPE PRODUCERS ASSOCIATION (ACPPA)

ACPPA-01	(1988) Recommended Work Practices for A/C Pipe

FEDERAL SPECIFICATIONS (FS)

FS QQ-B-654	(Rev A; Am 1; Notice 1) Brazing Alloys, Silver

NATIONAL ASSOCIATION OF PLUMBING-HEATING-COOLING CONTRACTORS (NAPHCC)

NAPHCC-01	(1993; Supplement 1994) National Standard Plumbing Code (Non-Illustrated Edition)
NAPHCC-02	(1993) National Standard Plumbing Code (Illustrated Edition)

MANUFACTURERS STANDARDIZATION SOCIETY OF THE VALVE AND FITTINGS INDUSTRY (MSS)

MSS SP-25	(1998) Standard Marking System for Valves, Fittings, Flanges and Unions
MSS SP-80	(1997) Bronze Gate, Globe, Angle and Check Valves

NSF INTERNATIONAL (NSF)

NSF Std 14	(1965; Rev Nov 1990) Plastics Piping System Components and Related Materials

1.2 GENERAL REQUIREMENTS

Water supply and distribution system equipment shall be as indicated on the plans and as per these specifications. This specification shall provide for water distribution and connections to building service at a point approximately 5 feet outside buildings and structures to which service is

required. The Contractor shall have a copy of the manufacturer's recommendations for each material or procedure to be utilized available at the construction site at all times.

1.2.1 Supply Lines 3 Inches or Larger

Piping for buried water supply lines 3 inches or larger shall be polyvinyl chloride (PVC) plastic. Piping for water supply lines, and aboveground piping, less than 3-inch diamenter shall be copper tubing. All piping systems shall be restrained by joint or concrete thrust or anchor block. Pipe through Control Tower Bridge shall be Schedule 80 PVC.

1.2.2 Plastic Pipe

All plastic piping system components (PVC) intended for transportation of water shall comply with NSF Std 14 and shall be legibly marked with their symbol.

1.2.3 Excavation, Trenching, and Backfilling

Excavation, trenching, and backfilling shall be in accordance with the applicable provisions of Section 02316 EXCAVATION, TRENCHING, AND BACKFILLING FOR UTILITIES SYSTEMS, except as modified herein.

1.2.4 Pipe Handling

Pipe and accessories shall be handled so as to ensure delivery to the trench in sound, undamaged condition. Particular care shall be taken not to injure the pipe coating or lining. If the coating or lining of any pipe or fitting is damaged, the repair shall be made by the Contractor at his expense in a satisfactory manner. The interior of pipe and accessories shall be thoroughly cleaned of foreign matter before being lowered into the trench and shall be kept clean during laying operations by plugging or other approved method. Before installation, the pipe shall be inspected for defects. Material found to be defective before or after laying shall be replaced with sound material without additional expense to the Government. Rubber gaskets that are not to be installed immediately shall be stored in a cool and dark place. PVC pipe shall not be stored in direct sunlight, or subjected to excessive direct sunlight, so as to cause damage. The Contracting Officer shall approve all PVC pipe installations, prior to backfilling the trench.

1.3 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-03 Product Data
Pipe; G
Fittings; G
Joints; G
Valves; G
Couplings; G
Valve boxes; G
Water tanks; G
Meters; G

Chlorinator; G

SD-05 Design Data

Design calculations of water piping and alignment; G

Waste Water Disposal Method; G.

The method proposed for disposal of waste water from hydrostatic tests and disinfection, prior to performing hydrostatic tests.

Satisfactory Installation.

A statement signed by the principal officer of the contracting firm stating that the installation is satisfactory and in accordance with the contract drawings and specifications, and the manufacturer's prescribed procedures and techniques, upon completion of the project and before final acceptance.

Method for anchoring the water tank; G

The calculations shall propose a concrete slab dimension and anchorage system as shown on the plans.

SD-06 Test Reports

Bacteriological Disinfection; G.

Test results from commercial laboratory verifying disinfection.

SD-07 Certificates

Water tank; G
Pump control valve; G
Shop applied coating; G
Hydrostatic testing; G

The name and qualifications of the manufacturer's representative and written certification from the manufacturer that the representative is technically qualified in all phases of PE, RTRP, and/or RPMP pipe laying and jointing and experienced to supervise the work and train the Contractor's field installers, prior to commencing installation.

SD-08 Manufacturer's Instructions

Installation
Installation procedures for water piping

The manufacturer's recommendations for each material or procedure to be utilized.

SD-10 Operation and Maintenance Data

Water Distribution System; G

Six Copies of Operation Manuals, which outline step-by-step procedures required for system startup, operation, and shutdown. The manual shall include the manufactures's name, model number,

service manual, parts list, and a brief description of all equipment and their basic operation features. Six copies of maintenance manual listing routine maintenance procedures, possible breakdowns and repairs. The manual shall include piping and equipment layout and simplified wiring and control diagrams of the system as installed; including, but not limited to well casings, submersible well pump, chlorination equipment, water storage tank, water system valves and piping, and electrical pump controller and related equipment.

1.4 HANDLING

Pipe and accessories shall be handled to ensure delivery to the trench in sound, undamaged condition, including no injury to the pipe coating or lining. If the coating or lining of any pipe or fitting is damaged, the repair shall be made by the Contractor in a satisfactory manner, at no additional cost to the Government. No other pipe or material shall be placed inside a pipe or fitting after the coating has been applied. Pipe shall be carried into position and not dragged. Use of pinch bars and tongs for aligning or turning pipe will be permitted only on the bare ends of the pipe. The interior of pipe and accessories shall be thoroughly cleaned of foreign matter before being lowered into the trench and shall be kept clean during laying operations by plugging or other approved method. Before installation, the pipe shall be inspected for defects. Material found to be defective before or after laying shall be replaced with sound material without additional expense to the Government. Rubber gaskets that are not to be installed immediately shall be stored in a cool and dark place.

1.4.1 Coated and Wrapped Steel Pipe

Coated and wrapped steel pipe shall be handled in conformance with AWWA C203.

1.4.2 Polyethylene (PE) Pipe Fittings and Accessories

PE pipe, fittings, and accessories shall be handled in conformance with AWWA C901.

1.4.3 Miscellaneous Plastic Pipe and Fittings

Polyvinyl Chloride (PVC), Reinforced Thermosetting Resin Pipe (RTRP), and Reinforced Plastic Mortar Pressure (RPMP) pipe and fittings shall be handled and stored in accordance with the manufacturer's recommendations. Storage facilities shall be classified and marked in accordance with NFPA 704, with classification as indicated in NFPA 49 and NFPA 325-1.

PART 2 PRODUCTS

2.1 PIPE

Pipe shall conform to the respective specifications and other requirements specified below.

2.1.1 Plastic Pipe

2.1.1.1 Polyvinyl Chloride (PVC) Plastic Pipe

Pipe, couplings and fittings shall be manufactured of material conforming to ASTM D 1785, Type 1 (normal imput), Grade 1 (high chemical resistance),

and is approved by the National Sanitation Foundation in sizes 1/4 inch through 12 inches for use in potabe water service. Pipe shall be schedule 40 with solvent welded joints, except as otherwise shown, or threaded or flanged. Pipe shall conform to dimensional requirements of ASTM D 1785 or ASTM D 2241 with joints meeting the requirements of 150 psi working pressure and 200 psi hydrostatic test pressure. Solvent cement shal be in accordance with ASTM D 2564 and ASTM D 2855. Threaded couplings shall be stainless steel within the well casing.

2.1.2 Copper Tubing

Copper tubing shall be used for all above ground piping, as part of the Well's water distribution system, as indicated on the Plans. Copper tubing shall be type K, rigid. Joints shall be solder sweated, threaded, or flanged, as indicated on the drawings.

2.1.2.1 Flanges

Flanges shall be screwed onto threaded pipe and be in accordance with ASME B16.5 class 150. Flanges shall receive isolation flange kits where connecting to dissimilar metals. Flanged fittings including flanges, bolts, nuts, bolt patterns, etc. shall have the manufacturer's trademark affixed in accordance with MSS SP-25.

2.1.2.2 Brazing Material

Brazing material shall conform to AWS A5.8, BcuP-5.

2.1.2.3 Brazing Flux

Flux shall be in paste or liquid form appropriate for use with brazing material. Flux shall be as follows: lead-free; have a 100 percent flushable residue; contain slightly acidic reagents; contain potassium borides; and contain fluorides. Silver brazing materials shall be in accordance with FS QQ-B-654.

2.1.2.4 Solder Material

Solder metal shall conform to ASTM B 32 95-5 tin-antimony.

2.1.2.5 Solder Flux

Flux shall be liquid form, non-corrosive, and conform to ASTM B 813, Standard Test 1.

2.1.2.6 PTFE Tape

PTFE tape for use with threaded metal or plastic pipe shall be in accordance with ASTM D 3308.

2.1.3 Steel Pipe and Casings

Steel pipe shall be carbon steel material. Pipe shall be of size and dimensions as shown on the plans. When steel pipe is 4-inch and larger in diameter, it shall be in conformance with the latest AWWA Standard that applies.

2.2 FITTINGS AND SPECIALS

2.2.1 Polyvinyl Chloride (PVC) Pipe

For pipe less than 4 inch diameter, fittings for threaded pipe shall conform to requirements of ASTM D 2464, threaded to conform to the requirements of ASME B1.20.1 for use with Schedule 80 pipe and fittings, fittings for solvent cement jointing shall conform to ASTM D 2466 or ASTM D 2467, and fittings for elastomeric-gasket joint pipe shall be iron conforming to AWWA C110 or AWWA C111. PVC, stainless steel, or bronze fittings and specials shall be supplied where noted on the plans.

2.3 JOINTS

2.3.1 Plastic Pipe

2.3.1.1 Polyvinyl Chloride Pipe

Joints, fittings, and couplings shall be as specified for PVC pipe. Joints connecting pipe of differing materials shall be made in accordance with the manufacturer's recommendations and as approved by the Contracting Officer. Isolation flanges or couplings shall be supplied as indicated on the plans.

2.3.2 Transition Couplings

Transition couplings shall be the bolted, mechinical sleeve type and shall provide a tight flexible joint under all reasonable conditions, such as pipe movements caused by expansion, contraction, slight setting or shifting in the ground, minor variations in trench gradients, and traffic vibrations. Couplings shall be of strength not less than the adjoining pipeline, and provide a pressure seal rated at 150 psi. Body shall be constructed of 1010/1020 carbon steel. Middle rings shall be 1010/1020 carbon steel. Bolts and nuts shall be ANSE A21.11 carbon steel. Gaskets shall be Buna-N rubber. Grippings shall be 4140 carbon steel. Back-up rings shall be 1010/1020 carbon steel.

2.3.3 Isolation Joints

Isolation joints shall be installed between nonthreaded ferrous and nonferrous metallic pipe, fittings, and valves. Isolation joints shall consist of a sandwich-type flange isolation gasket of the dielectric type, isolation washers, and isolation sleeves for flange bolts. Isolation gaskets shall be full faced with outside diameter equal to the flange outside diameter. Bolt isolation sleeves shall be full length. Units shall be of a shape to prevent metal-to-metal contact of dissimilar metallic piping elements.

2.4 WATER CONTROL VALVES

2.4.1 General Requirements

The Contractor shall furnish and install control valves, complete and operable, as shown and specified herein, all in accordance with the requirements of the Contract Documents.

Spare parts shall be supplied such as repair gaskets, seals, o-rings, and diaphragm for each size and type of control valve.

The Contractor shall submit detailed shop drawings and data.

2.4.2 Quality Assurance

2.4.2.1 Valve Testing

Unless otherwise specified, each valve body shall be tested under a test pressure equal to twice its design water-working pressure.

2.4.2.2 Bronze Parts

Unless otherwise specified, all interior bronze parts of valves shall conform to the requirements of ASTM B 62, or, where not subject to dezincification, to ASTM B 584.

2.4.3 Manufacturer's Responsibility

The valve manufacturer shall verify valve selection based on the specified range of operation as shown in the valve schedule. In case that the valve size or model differ from the specified, recommended data shall be submitted to the Contracting Officer for review. The Contractor shall include in his bid written certification from the valve manufacturer to the effect that the valve selection has been verified for maximum differential pressure and that the valves when installed will be free from damaging cavitation throughout the operating range.

2.4.4 Deep Well Pump control Valve

2.4.4.1 General

The valves shall be designed to protect pipelines from surges during the starting and stopping of a well pump and to dissipate air and the initial rush of sand from the pump column to atmosphere. The main valve shall be hydraulically operated, diaphragm actuated in globe pattern. The body shall be hydrotested to the rated working pressure. The main valve shall contain a resilient synthetic rubber disc having a rectangular cross section, contained on three and one-half sides by a disc holder and a disc retainer. The seat ring shall be held firmly in place. The seat ring shall not be press fitted into the main body and must be removable in the field without the use of special tools. The main valve shall incorporate two operation chambers sealed form each other by a fabric reinforced diaphragm. The diaphragm shall not be used as a seating surface. Each operation chamber shall be accessible to the pilotry control system. Pressure applied to the upper chamber shall tend to close the valve and pressure applied to the lower chamber shall tend to open the valve. The diaphragm assembly shall be the only moving par. The diaphragm assembly shall be fully guided to ensure positive contact with the seat. Packing glands and/or stuffing boxes are not permitted and there should be no pistons operating the valve. All necessary repairs shall be possible without removing the main valve from the line.

2.4.4.2 Main Valve

The main valve shall be controlled by the use of a four way solenoid pilot valve operating form a line pressure. The supply line to the solenoid shall be protected by a wye strainer. A limit switch must be provided which is adjustable over the entire valve stroke.

The supply pressure for the solenoid shall be piped from the downstream side of the mainline check valve so that the highest operating pressure will be used at all times. Opening and closing speed controls shall be provided.

2.4.4.3 Main Valve Components

The valve shall be similar in all respects to the Ames Model 985G, CLA-VAL Model 61-02, or approved equal.

2.4.5 Check Valve for Well

2.4.5.1 Well Check Valve

The Well Check Valve shall be hydraulically operated, diaphragm actuated in globe pattern. The valve shall close drip tight upon the reversal of pressure at a preset speed. The main valve body shall contain a resilient synthetic rubber disc having a rectangular cross section, contained on three and one-half sides by a disc retainer. The seat ring shall be held firmly in place and not pressed in to the body. The diaphragm assembly shall be fully guided to assure positive contact with the seat. The diaphragm assembly shall be the only moving part. The diaphragm shall consist of a nylon fabric reinforced Buna-N rubber and shall not be used as a seating surface. All necessary repairs shall be possible without removing the valve from the line.

2.4.5.2 Valve Interior Components

The valve interior components shall be manufactured from non-corrosive materials. The valve shall be similar in all respects to the Ames Model 940-04, CLA-VAL Model 81-02, or approved equal.

2.4.6 Installation

2.4.6.1 General

Control valves shall be installed in strict accordance with the valve supplier's printed recommendations, and provisions of the Standard Specifications.

2.4.6.2 Valve Inspection

After installation, all valves shall be inspected by the manufacturer's factory representative. Final setting shall be adjusted.

2.4.7 Operator's Training

The Contractor shall employ the service of a factory-trained technician to train plant operators for a period of one day in the operation, repair, and maintenance of the valves.

2.4.8 Gate Valves

Gate valves shall be designed for a working pressure of not less than 150 psi. Valve connections shall be as required for the piping in which they are installed. Valves shall have a clear waterway equal to the full nominal diameter of the connecting pipe, and shall be opened by turning counterclockwise. Valves installed above ground shall have a wheel operator, and valves installed below ground shall have a square nut operator. The operating nut or wheel shall have an arrow, cast in the metal, indicating the direction of opening.

a. Valves smaller than 3 inches shall be all bronze and shall conform

to MSS SP-80, Type 1, Class 150.

b. Valves 3 inches and larger shall be iron body, resilient wedge and shall conform to AWWA C509. Flanges mating to copper, bronze, or brass shall receive an isolation flange kit.

2.4.9 Vacuum and Air Relief Valves (Combination Air/Vac)

Vacuum and air relief valves shall be of the size shown and shall be of a type that will release air and prevent the formation of a vacuum. The valves shall automatically release air when the lines are being filled with water and shall admit air into the line when water is being withdrawn in excess of the inflow. Valves shall be iron body with bronze trim and stainless steel float.

2.4.10 Deep Well Air Valve

Valve size shall be 1/2-inch. Body shall be cast iron (ASTM A 126 Gr. B). Baffle, size shall be 1/2-inch Delrin (ASTM D 2133). Float shall be Stainless Steel (ASTM A 240). Seat shall be Buna-N. Water diffuser shall be brass (ASTM B 16). Housing shall be malleable iron (ASTM A 47). Adjustable screw and nut shall be Stainless Steel (ASTM A 276 T304). Spring shall be Stainless Steel (ASTM A 313 T316). Plug shall be teflon (AMS 3651).

2.4.11 Rubber Check Valve

Rubber check valve shall be all rubber and of the flow operated check type with a slip-on end connection. Inlet port areas shall be 100 percent of pipe connection size. The discharge port area shall contour down to a duckbill, which shall allow passage of flow in one direction while preventing reverse flow. The check valve shall be designed to slip over the specified pipe outside diameter. The flexible duckbill sleeve shall be one piece of rubber construction with fabric reinforcement. The check valve shall also have a protective EPDM exterior wrapping for protection against sunlight attack. Check valves shall be attached to the pipe outside diameter by means of vendor furnished clamps. Company name, plant location, and valve size and serial number shall be bonded to the exterior of the valve. Valve shall be instlled per manufacturer's recommendations.

2.5 VALVE BOXES

Valve box covers and frame shall be cast iron. Boxes shall be extension type with slide-type adjustment and with flared base. The minimum thickness of metal shall be 3/16 inch. The word "WATER" shall be cast in the cover. The box length shall adapt, without full extension, to the depth of cover required over the pipe at the valve location. The PVC valve box shaft pipe shall be set on 3/4 inch gravel on top of the valve. The valve box shaft shall extend below valve nut so that permanent valve operation is available from ground surface.

2.6 FLOW MEASUREMENT

2.6.1 Turbine Flow Meter

2.6.1.1 Type

Meters shall be of the in-line horizontal-axis type per AWWA Class II.

2.6.1.2 Capacity

The capacity of the meter shall be 4 to 200 gpm. The maximum loss of water energy across the valve shall be 4.5 psi. The maximum continuous flow shall be 200 gpm. The maximum intermittent capacity shall be 250 gpm.

2.6.1.3 Size

The 2-inch diameter meter shall have a laying length of not greater than 10 inches, and the combined length with strainer shall not exceed 17 inches.

2.6.1.4 Case and Cover

The maincase and cover shall be cast of water works bronze containing not less than 57% copper. The size, model, and arrows indicating direction of flow shall be cast in raised characters on the maincase or cover. The cover shall contain a calibration vane for the purpose of calibrating the turbine measuring element while in-line and under pressure. The calibration vane shall be mounted under the register or shall be covered by a protective cap that is attached in a tamper-resistant device.

2.6.1.5 External Bolts

Casing bolts shall be made of type 316 stainless steel.

2.6.1.6 Connections

Maincases shall be flanged.

2.6.1.7 Registers

Registers shall be permanently rolled-sealed, straight reading, indicating gallons. Registers shall include a center-sweep test hand, a low flow indicator and glass lens. Register shall be serviceable without interruption of the meter's operation.

2.6.1.8 Register Box

Register boxes and covers shall be of bronze composition. No plastic retainer rings will be acceptable. The name of the manufacturer and the meter serial number shall be clearly identifiable and located on the register box cover.

2.6.1.9 Register Box Sealing

The register box shall be affixed to the top cover by means of a plastic tamperproof seal pin that must be destroyed in order to remove the register.

2.6.1.10 Meter Serial Number

The meter serial number shall be imprinted on the meter maincase or cover as well as the register box cover.

2.6.1.11 Measuring Chamber

The turbine measuring chamber shall be a self-contained unit attached to the cover for easy removal. The turbine spindles shall be stainless steel.

2.6.1.12 Intermediate Gear Train

The intermediate gear train shall be directly-coupled to the turbine spindle and magnetically coupled to the register through the meter cover. The gear train shall be capillary sealed. All moving parts of the gear train shall be made of a self-lubricating polymer or stainless steel for operation in water.

2.6.1.13 Performance

Registration accuracy over the normal operating range shall be 98.5 percent to 101.5 percent.

2.6.1.14 Remote Capacity

All meters shall be equipped with generator remotes per AWWA C706, shall meet all AWWA C701 performance standards, and shall include all hardware. Two-wire cable shall not be included in quoted meter prices.

2.7 MISCELLANEOUS ITEMS

2.7.1 Corporation Stops

Corporation stops shall have standard corporation stop thread conforming to AWWA C800 on the inlet end, with flanged joints, compression pattern flared tube couplings, or wiped joints for connections to goosenecks.

2.7.2 Goosenecks

Copper tubing for gooseneck connections shall conform to the applicable requirements of ASTM B 88, Type K, annealed. Length of cable requirement connections shall be in accordance with standard practice.

2.7.3 Disinfection

Chlorinating materials shall conform to the following:

Chlorine, Liquid: AWWA B301.

Hypochlorite, Calcium and Sodium: AWWA B300.

2.8 PIPE SUPPORTS

2.8.1 General

The Contractor shall provide all tools, supplies, materials, equipment, and all labor necessary for the furnishing, construction, and installation of all pipe supports, hangers, guides, and anchors shown, specified or required for a complete and operable piping system, in accordance with the requirements of the contract specifications.

2.8.2 Product Requirements

2.8.2.1 Code Compliance

All piping systems and pipe connections to equipment shall be properly supported, to prevent undue deflection, vibration, and stresses on piping, equipment and structures. All supports and parts thereof shall conform to the requirements of ASME B31.1, except as supplemented or modified by these

specifications. Supports for plumbing piping shall be in accordance with the latest edition of the applicable plumbing code, or local administration requirements.

2.8.2.2 Structural Members

Wherever possible, pipes shall be attached to structural members. Where it is necessary to frame structural members between existing members, such supplementary members shall be provided by the Contractor at no additional cost to the Owner. All supplementary members shall be in accordance with the requirements of the building code and the American Institute of Steel Construction.

2.8.2.3 Support Spacing

Supports for piping with the longitudinal axis in approximately a horizontal position shall be spaced to prevent excessive sag, bending and shear stresses in the piping, with special consideration given where components, such as flanges and valves, impose concentrated loads. Where calculations are not made or more stringent requirements from pipe manufacturers prevail, suggested maximum spacing of supports are given in the in the tables below. Vertical supports shall be spaced to prevent the pipe from being overstressed from the combination of all loading effect.

2.8.2.4 Riser Supports

Where practical, risers shall be supported on each floor with riser clamps and lugs, independent of the connected horizontal piping.

2.8.2.5 Freestanding Piping

Freestanding pipe connections to equipment, like chemical feeders, pumps, etc. shall be firmly attached to fabricated steel frames made of angles, channels, or I-beams anchored to the structure. Exterior, free standing overhead piping shall be supported on fabricated pipe stands, consisting of pipe columns anchored to concrete footings, with horizontal, welded steel angles and U-bolts or clamps, securing the pipes.

2.8.2.6 Noise Reduction

To reduce transmission of noise in piping systems, all copper tubes in buildings and structures shall be supplied with a two-inch wide strip of rubber fabric or similar, suitable materials, at each pipe support, bracket, clip, or hanger.

2.8.3 Manufactured Supports

Where not specifically shown or detailed, designs, generally accepted as exemplifying good engineering practice, using stock or production parts, shall be utilized wherever possible. Such parts shall be locally available, new, of best commercial quality, designed and rated for the intended purpose.

2.8.4 Coating

2.8.4.1 Galvanizing

Unless otherwise shown or specified, all fabricated pipe supports, other than stainless steel or nonferrous supports, shall be blast-cleaned after

fabrication and hot-dip galvanized in accordance with ASTM A 123.

2.8.4.2 Other Support

All other support shall receive an epoxy coating in accordance with the requirements of Section 09920, "COATING SYSTEMS."

2.8.5 Installation

2.8.5.1 General

All pipe supports, brackets, anchors, guides and insets shall be fabricated and installed in accordance with the manufacturer's printed instructions and ASME B31.1. All concrete inserts for pipe hangers and supports shall be coordinated with the formwork.

2.8.5.2 Appearance

Pipe supports shall be positioned in such a way as to produce an orderly, neat piping system.

2.8.6 Fabrication

Pipe supports shall be fabricated and installed by experienced welders and fitters, using the best welding procedures available. Fabricated supports shall be neat in appearance without sharp corners, burrs, and edges.

2.9 BLOW-OFF ASSEMBLY

Blow-off assembly shall consist of a 2-inch diameter schedule 80 PVC pipe riser off the 3-inch well distribution pipeline. The 2-inch PVC pipe riser shall terminate in a concrete meter box with cast iron lid marked "water," and shall have a 2-inch bronze ball valve on the end of the pipe with 2-inch brass plug. The concrete meter box shall be set flush with the concrete well slab foundation in the location indicated on the plans. The meter box shall be open on the bottom and have a 3/4-inch crushed rock base approximately 6-inches deep and 1-foot wider than the box in footprint in all sides.

2.10 DRY PELLET CHLORINATOR

The well shall be equipped with a dry pellet chlorinator. The chlorinator shall be an approved dry pellet type with a capacity to deliver 3 pellets per minute and a minimum pellet storage capacity of 3-1/2 pounds. The chlorinator shall be connected to the well pump controls. The chlorinator shall operate on 115 volts, 60 Hz, single-phase power. The chlorinator shall be equipped with all necessary controls to provide for automatic operation.

2.11 BLADDER TYPE WATER TANK

A bladder type water tank shall be installed on the discharge piping of the well. The tank shall be constructed for a minimum capacity of 500 gallons and a standard operating pressure of 125 psi. The tank shall be constructed in conformance with ASME Section VIII. The bladder shall be NSF approved and replaceable. The tank shall be factory pre-charged and field adjustable.

PART 3 EXECUTION

3.1 INSTALLATION

3.1.1 Cutting of Pipe

Cutting of pipe shall be done in a neat and workmanlike manner without damage to the pipe. Unless otherwise recommended by the manufacturer and authorized by the Contracting Officer, cutting shall be done with an approved type mechanical cutter. Wheel cutter shall be used when practicable. Copper tubing shall be cut square and all burrs shall be removed.

3.1.2 Adjacent Facilities

3.1.2.1 Sewer Lines

Where the location of the water pipe is not clearly defined in dimensions on the drawings, the water pipe shall not be laid closer horizontally than 10 feet from a sewer except where the bottom of the water pipe will be at least 12 inches above the top of the sewer pipe, in which case the water pipe shall not be laid closer horizontally than 6 feet from the sewer. Where water lines cross under gravity-flow sewer lines, the sewer pipe for a distance of at least 10 feet each side of the crossing shall be fully encased in concrete or shall be made of pressure pipe with no joint located within 3 feet horizontally of the crossing. Water lines shall in all cases cross above sewage force mains or inverted siphons and shall be not less than 2 feet above the sewer main. Joints in the sewer main, closer horizontally than 3 feet to the crossing, shall be encased in concrete.

3.1.2.2 Water Lines

Water lines shall not be laid in the same trench with sewer lines, gas lines or fuel lines.

3.1.3 Joint Deflection

3.1.3.1 Flexible Plastic Pipe

Maximum offset in alignment between adjacent pipe joints shall be as recommended by the manufacturer and approved by the Contracting Officer, but in no case shall it exceed 5 degrees.

3.1.3.2 Rigid Copper Tubing

Deflection of threaded and flanged joints is not acceptable.

3.1.4 Placing and Laying

Pipe and accessories shall be carefully lowered into the trench by means of derrick, ropes, belt slings, or other authorized equipment or method. Under no circumstances shall any of the water-line materials be dropped or dumped into the trench. Care shall be taken to avoid abrasion of the pipe coating. Except where necessary in making connections with other lines or as authorized by the Contracting Officer, pipe shall be laid with the bells facing in the direction of laying. The full length of each section of pipe shall rest solidly upon the pipe bed, with recesses excavated to accommodate bells, couplings, and joints. Pipe that has the grade or joint disturbed after laying shall be taken up and relaid. Pipe shall not be laid in water or when trench conditions are unsuitable for the work. Water

shall be kept out of the trench until joints are complete. When work is not in progress, open ends of pipe, fittings, and valves shall be securely closed so that no trench water, earth, or other substance will enter the pipes or fittings. Where any part of the coating or lining is damaged, the repair shall be made by the Contractor at his expense in a satisfactory manner. Pipe ends left for future connections shall be valved, plugged, or capped, and anchored, as shown on the construction plans.

3.1.4.1 Plastic Pipe Installation

PVC pipe shall be installed in accordance with AWWA M23. Copper tubing shall be installed in accordance with NAPHCC-01 and NAPHCC-02, unless otherwise shown.

3.1.4.2 Connections

Where connections are made between new work and existing mains, the connections shall be made by using specials and fittings to suit the actual conditions. When made under pressure, these connections shall be installed using standard methods as approved by the Contracting Officer. Connections to existing asbestos-cement pipe shall be made in accordance with ACPPA-01.

3.1.4.3 Penetrations

Pipe passing through walls of structures shall be provided with ductile-iron or Schedule 40 steel wall sleeves. Unless otherwise specified, the annular space between walls and sleeves shall be filled with rich cement mortar, and the annular space between pipe and sleeves shall be filled with mastic, unless otherwise specified.

3.1.4.4 Flanged Pipe

Flanged pipe shall only be installed above ground or where installed below ground shall receive an 8-mil coating of coal tar.

3.1.5 Jointing

3.1.5.1 Polyvinyl Chloride (PVC) Plastic Pipe

a. Pipe less than 4 inch diameter: Threaded joints shall be made by wrapping the male threads with approved thread tape or applying an approved lubricant, then threading the joining members together. The joint shall be tightened using strap wrenches to prevent damage to the pipe and/or fitting. To avoid excessive torque, joints shall be tightened no more than one thread past hand-tight. Preformed rubber-ring gaskets for elastomeric-gasket joints shall be made in accordance with requirements of ASTM F 477 and as required herein. All pipe ends for push-on joints shall be beveled to facilitate assembly and marked to indicate when the pipe is fully seated. The gasket shall be prelubricated to prevent displacement. The gasket and ring groove in the bell or coupling shall match. The manufacturer of the pipe or fitting shall supply the elastomeric gasket. Couplings shall be provided with stops or centering rings to assure that the coupling is centered on the joint. Solvent cement joints shall use sockets conforming to the requirements of ASTM D 2467. The solvent cement used shall meet the requirements of ASTM D 2564; the joint assembly shall be made in accordance with ASTM D 2855 and the manufacturer's specific recommendations.

3.1.5.2 Steel Pipe, Not Galvanized

a. Mechanical Couplings: Mechanical couplings shall be installed in accordance with the recommendations of the couplings manufacturer.

b. Rubber Gaskets: Rubber gaskets shall be handled, lubricated where necessary, and installed in accordance with the recommendations of the pipe manufacturer.

3.1.5.3 Isolation Joints

Isolation joints and dielectric fittings shall be installed in accordance with details specified in paragraph: JOINTS.

3.1.5.4 Connections

Connections between different types of pipe and accessories shall be made with transition fittings approved by the Contracting Officer.

3.1.6 Service Lines

Service lines shall include the pipeline connecting building piping to water distribution lines to the connections with the building service at a point approximately 5 feet outside the building where such building service exists. Where building services are not installed, the Contractor shall terminate the service lines approximately 5 feet from the site of the proposed building at a point designated by the Contracting Officer. Such service lines shall be closed with plugs or caps. All service stops and valves shall be provided with service boxes.

3.1.7 Field Coating and Lining of Pipe

3.1.7.1 Steel Pipe 3 Inches and Larger, Not Galvanized

Coal-tar enamel coating, lining and wrapping: Field jointing shall conform to AWWA C203. The applied materials shall be tested by means of a spark-type electrical inspection device in accordance with the requirements of AWWA C203. Any flaws or holidays found in the coating and/or lining of pipe and joints shall be repaired by patching or other approved means. The repaired areas shall be at least equal in thickness to the minimum coating and/or lining required for the pipe.

3.1.8 Setting of Valves and Valve Boxes

3.1.8.1 Valves

After delivery, valves, including those in hydrants, shall be drained to prevent freezing and shall have the interiors cleaned of all foreign matter before installation. Stuffing boxes shall be tightened and hydrants and valves shall be fully opened and fully closed to ensure that all parts are in working condition. Check, pressure reducing, vacuum, and air relief valves shall be installed in valve pits. Valves and valve boxes shall be installed where shown or specified, and shall be set plumb. Valve boxes shall be centered on the valves. Boxes shall be installed over each outside gate valve unless otherwise shown. Where feasible, valves shall be located outside the area of roads and streets. Earth fill shall be carefully tamped around each valve box or pit to a distance of 4 feet on all sides of the box, or the undisturbed trench face if less than 4 feet.

3.1.8.2 Service Boxes

Where water lines are located below paved streets having curbs, the boxes shall be installed directly back of the curbs. Where no curbing exists, service boxes shall be installed in accessible locations, beyond the limits of street surfacing, walks and driveways.

3.1.9 Thrust Restraint

Plugs, caps, tees and bends deflecting 11-1/4 degrees or more, either vertically or horizontally, on waterlines 4 inches in diameter or larger, shall be provided with thrust restraints. Valves shall be securely anchored or shall be provided with thrust restraints to prevent movement. Thrust restraints shall be either thrust blocks or restrained joints.

3.1.9.1 Thrust Blocks

Thrust blocking shall be concrete of a mix not leaner than: 1 cement, 2-1/2 sand, 5 gravel; and having a compressive strength of not less than 2,000 psi after 28 days. Blocking shall be placed between solid ground and the hydrant or fitting to be anchored. Unless otherwise indicated or directed, the base and thrust bearing sides of thrust blocks shall be poured directly against undisturbed earth. The sides of thrust blocks not subject to thrust may be poured against forms. The area of bearing shall be as shown, as directed or per applicable pipe manufacture's recommendations. Blocking shall be placed so that the fitting joints will be accessible for repair. Steel rods and clamps, protected by galvanizing or by coating with bituminous paint, shall be used to anchor vertical down bends into gravity thrust blocks.

3.1.9.2 Restrained Joints

Restrained joints shall be designed by the Contractor or the pipe manufacturer in accordance with standard practices.

3.1.10 Installation of Dry Pellet Chlorinator

The dry pellet chlorinator shall be installed on the well per the manufacturer's instructions.

3.1.11 Installation of Bladder Type Water Tank

The bladder type water tank shall be installed and anchored to the concrete slab in accordance with the manufacturer's recommendations. The Contractor shall field-adjust the pressure charge in the tank for proper operation of the water system. Prior to installation of the well slab foundation the contractor shall propose a method for anchoring the water tank to the concrete well slab foundation.

3.2 HYDROSTATIC TESTS

Where any section of a water line is provided with concrete thrust blocking for fitting or hydrants, the hydrostatic tests shall not be made until at least 5 days after installation of the concrete thrust blocking, unless otherwise approved.

3.2.1 Pressure Test

After the pipe is laid, the joints completed, fire hydrants permanently installed, and the trench partially backfilled leaving the joints exposed for examination, the newly laid piping or any valved section of piping shall, unless otherwise specified, be subjected for 1 hour to a hydrostatic pressure test of 100 psi or 150 percent of the working pressure, whichever is greater. Each valve shall be opened and closed several times during the test. Exposed pipe, joints, fittings, and valves shall be carefully examined during the partially open trench test. Joints showing visible leakage shall be replaced or remade as necessary. Cracked or defective pipe, joints, fittings, hydrants and valves, discovered in consequence of this pressure test shall be removed and replaced with sound material, and the test shall be repeated until the test results are satisfactory.

3.2.2 Leakage Test

Leakage test shall be conducted after the pressure tests have been satisfactorily completed. The duration of each leakage test shall be at least 2 hours, and during the test the water line shall be subjected to the specified test pressure. Leakage is defined as the quantity of water to be supplied into the newly laid pipe, or any valved or approved section thereof, necessary to maintain pressure within 5 psi of the specified leakage test pressure after the pipe has been filled with water and the air expelled. No piping installation will be accepted if leakage exceeds the allowable leakage which is determined by the following formula:

L = 0.0001351ND(P raised to 1/2 power)

L = Allowable leakage in gallons per hour
N = Number of joints in the length of pipeline tested
D = Nominal diameter of the pipe in inches
P = Average test pressure during the leakage test, in psi gauge

Should any test of pipe disclose leakage greater than that calculated by the above formula, the defective joints shall be located and repaired until the leakage is within the specified allowance, without additional cost to the Government.

3.2.3 Time for Making Test

Except for joint material setting or where concrete thrust blocks necessitate a 5-day delay, pipelines jointed with rubber gaskets, mechanical or push-on joints, or couplings may be subjected to hydrostatic pressure, inspected, and tested for leakage at any time after partial completion of backfill. Cement-mortar lined pipe may be filled with water as recommended by the manufacturer before being subjected to the pressure test and subsequent leakage test.

3.3 DISINFECTION

3.3.1 Bacteriological Disinfection

Before acceptance of potable water operation, each unit of completed waterline shall be disinfected as prescribed by AWWA C651. Apply chlorine by the continuous feed method.

3.4 CLEANUP

Upon completion of the installation of water equipment, pipe and appurtenances, all debris and surplus materials resulting from the work

shall be removed.

-- End of Section --

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DIVISION 02 - SITE WORK

SECTION 02521

WATER WELLS

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SECTION 02521

WATER WELLS

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM C 150	(1997) Portland Cement
ASTM F 480	(1994) Thermoplastic Well Casing Pipe and Couplings Made in Standard Dimension Ratios (SDR), SCH 40 AND SCH 80

AMERICAN WATER WORKS ASSOCIATION (AWWA)

AWWA-10062JU	(1992) Standard Methods for the Examination of Water and Wastewater

1.2 GENERAL REQUIREMENTS

The well shall be located as shown. The well shall be to such depth as may be necessary to penetrate a desirable water-bearing stratum and produce a continuous yield of 25 gpm of water. This will be a non-potable well water source. The water shall be used for Prado Dam Control restroom facilities and for washdown purposes. "Non-Potable" water signs shall be clearly posted at all water takeout locations. The driller shall be registered with the County of Riverside. The well driller must apply for a well drilling permit from the County of Riverside following award of contract.

1.3 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Work Plan; G.

Proposed plan for drilling test holes and constructing production wells, before beginning work. The plan shall include, but not be limited to, the proposed method of drilling and equipment to be used, details on proposed casing, well screen, grouting materials, gravel pack material and method for placing gravel pack, and methods and equipment proposed for developing the

well and for performing pump tests. No work shall be performed until the drilling plan has been approved and no deviation from the approved drilling plan will be permitted without approval of the Contracting Officer. Details of specific methods to be employed to control potential contamination or pollution arising from well installation activities, shall also be included.

SD-02 Shop Drawings

Installation Diagrams; G.

As-built installation diagram for each well installed, prepared by the geologist present during well installation operations, within 14 working days of the completion of the well installation procedure.

SD-03 Product Data

Submersible vertical turbine pump and motor; G
Well casings, screening and caps; G
Gravel pack; G
Catalog Data; G.

Catalog data, and name of supplier, for well screens (to include the screen slot size), casing, riser pipe, filter pack material, bentonite, cement, centralizers, surface protective covers, well vaults, locking caps, airline oil filters for pneumatic drilling, dedicated sampling equipment, pumps, and chemical specifications on drill lubricants, tracers, disinfecting agents, and drill fluid additives, if used. Catalog data shall include any information, written or otherwise, supplied by the manufacturers or suppliers of the above listed items.

Permits; G

A copy of all permits, licenses, or other requirements necessary for execution of the work. Before beginning work, the local United States Geological Survey office (USGS) and local health department, and the Regional Water Quality Control Board shall be notified of the type and location of wells to be constructed, the method of construction and anticipated schedule for construction of the wells. A copy of all such correspondence shall be furnished to the Contracting Officer. The drilling contractor must furnish a copy of his State Contractors Drilling License.

Boring Logs

During the drilling of the test hole an accurate log shall be maintained. As a minimum, the log shall include depths, elevations, and descriptions of all formations encountered; identification of each stratum according to the Unified Soil Classification System; or standard rock nomenclature, as necessary; and depths at which groundwater is encountered. Soil samples shall be taken each 10 feet with a split-spoon sampler. The Contractor shall prepare a graphic boring log to scale showing the required details. Five prints of the boring log drawing shall be submitted. This drawing shall be used for determining the well design, design of the gravel filter, well screen location and screen openings.

SD-06 Test Reports

Well Development Records

A well development record, for each well, within 3 working days of the completion of development.

Tests; G.

Test Reports within 24 hours following the conclusion of each test.

SD-10 Operation and Maintenance Data

Water Distribution System; G (See Section 02510 WATER DISTRIBUTION SYSTEM)

Six Copies of Operation Manuals, which outline step-by-step procedures required for system startup, operation, and shutdown. The manual shall include the manufactures's name, model number, service manual, parts list, and a brief description of all equipment and their basic operation features. Six copies of maintenance manual listing routine maintenance procedures, possible breakdowns and repairs. The manual shall include piping and equipment layout and simplified wiring and control diagrams of the system as installed.

1.4 ENVIRONMENTAL PROTECTION

The Contractor shall take all precautions as may be required to prevent contaminated water or water having undesirable physical or chemical characteristics from contaminating the ground surface or of surface waters resulting from drilling of the well. The contractor will be allowed to pump test and discharge well test water to a local ground surface to be defined at time of well construction by the Contracting Officer.

PART 2 PRODUCTS

2.1 CASING

The casing shall be of sufficient size for the maximum yield as specified. All casing, screen, and other well materials shall be of compatible materials to prevent galvanic reaction between components of the completed well.

2.1.1 Well Casing and Couplings

The well casing shall be 6" Schedule 80 PVC. The well casing shall be directly connected to the top of the well screen by an approved method. The well casing shall have watertight joints of approved connection method.

2.1.2 Conductor Casing

No conductor casing is proposed to be installed.

2.2 WELL SCREENS

Well Screens shall be a minimum of 6 inches nominal diameter, and shall be

directly connected to the bottom of the well casing by an approved method. The screen shall be of sufficient length and shall provide an intake area capable of passing not less than the minimum required yield of the well at an entrance velocity not exceeding 0.1 fps. The opening size shall be compatible with the material surrounding the screen and shall be submitted for approval as part of the drilling plan. The well screen shall be of sufficient size and design to hold back and support the gravel used in the gravel envelope and in-situ material surrounding the screen. The screen and all accessories required for satisfactory operation shall be essentially standard products of reliable manufacturers regularly engaged in the production of such equipment. Field constructed screen is not acceptable. "Blanks" in the well screen may be utilized in nonproductive zones and shall be considered "casing."

2.2.1 Plastic Screen

2.2.1.1 Plastic Pipe Screens

Plastic pipe screens shall be thermoplastic manufactured by a molding, extrusion or sonic welding process. The plastic compounds shall be uniform in composition and contain no additives or foreign matter. Clean material generated during the manufacturer's own pipe production may be reused if blended back into the same type and kind of virgin compound and if the pipe produced meets the requirements of this specification. The molding or extrusion process shall produce pipe screens that are homogeneous throughout and free from visible cracks, holes, foreign inclusions or other defects. Pipe produced by simultaneous multiple extrusion shall have strong uniform bonds between any two layers so that the layers cannot be separated. Plastic pipe shall be uniform in color, opacity, density and other physical properties. The plastic pipe screen strength properties shall be equivalent to those for the plastic casing with which the screen is used.

2.2.1.2 Bonding Materials

Bonding materials, proportions and preparation of adhesives, the method of application, and the procedure used for making and curing the connections shall conform to the recommendations of the plastic pipe manufacturer and ASTM F 480. The pot life, initial setting time and external heating requirements for curing of the adhesive shall be suitable for the procedure and climatic and other conditions and shall be varied as required to suit changes in climatic and other conditions. The system for making joints at the well site shall provide a curing period adequate to develop the ultimate strength of the completed joint. Self-tapping screws or other devices for holding adhesive-coated pipe in the couplings during the setting period may be utilized. In no case shall a newly-made joint in the casing be stressed, lowered into the well or be submerged in water prior to complete curing of the adhesive.

2.2.1.3 Plastic Well Screen

Plastic well screen shall be provided with perforations which shall consist of either machine-sawed slots, or drilled, formed, or molded openings, and which shall have smooth, sharp-edged openings free of burns, chipped edges, or broken pieces on the interior and exterior surfaces of the pipe. The pattern of the openings shall be uniformly spaced around the periphery of the well screen. Compatible slot sizes of screens and gravel-pack gradations shall be designed by the Contractor and furnished the Contracting Officer, with a representative sample of materials in which the

screen is to be placed.

2.2.2 Combination Screen

Well screens that are fabricated from two or more different materials may be substituted with prior approval. Approval will be based in part on past history of successful performance.

2.3 GRAVEL PACK

Gravel pack shall be a product of a commercial sand and gravel manufacturer, shall be properly sized and graded for the surrounding soil and water encountered, and shall be composed of round, hard, waterworn siliceous gravel, free of flat or elongated pieces, organic matter, or other foreign matter. The gravel shall be of such size as will allow the maximum flow of water into the well and prevent the infiltration of sand and silt. The gradation of the filter gravel shall be such that the uniformity coefficient is not more than 2.5.

2.4 CEMENT GROUT

Cement grout shall consist of portland cement conforming to ASTM C 150, Type I or II, sand and water. Cement grout shall be proportioned not to exceed 6 gallons of water per cubic foot of cement, with a mixture of such consistency that the well can be properly grouted. Not more than 3 percent by weight of bentonite powder may be added to reduce shrinkage.

2.5 PERMANENT PUMP

Permanent pump shall be an approved, submersible type with a capacity sufficient to deliver 20 gpm at 112 psi. The pump shall be connected to the pump controls as recommended by pump manufacturer. The pump shall be manufactured with one continuous length of power cable to accommodate the well depth. Piping for the well drop line shall be 1-1/2" stainless steel, Schedule 80, with NPT to connect to submersible pump's discharge, as shown on the plans. The pump motor shall operate on 460 volts, 60 Hz, three-phase power, and the motor shall be of sufficient size to operate the pump under the maximum operating conditions without exceeding its rating. Pump shall be restrained within the 6 inch well casing with a "torque arrestor" manufactured for submersible well applications. All steel parts shall be stainless steel on the arrester. Pump shall be equipped with all necessary controls to provide for automatic operation of the pumping system.

PART 3 EXECUTION

3.1 WELL CONSTRUCTION

3.1.1 General Requirements

The method of drill shall be as approved by the Contracting Officer and shall conform to all state and local standards for water well construction. The execution of the work shall be by competent workmen and performed under the direct supervision of an experienced well driller. Casing pipe, well screens, and joint couplings shall be of compatible materials throughout each well. The well shall be a gravel pack well developed in the water-bearing stratum. The well hole shall be drilled straight, plumb, and circular from top to bottom. The well hole shall be drilled from the ground surface to the bottom elevation shown on the plans. The hole shall fully penetrate the water bearing stratum at a sufficient depth to produce

the required amount of water without causing excessive velocities through the aquifer.

A minimum of 4 hours shall be allowed for drilling the well.

3.1.2 Construction of Well Casing and Screen

The well hole shall be bored at the required diameter, indicated on the Plans, to the required depth by an approved method which will prevent caving of the hole before or during installation of the gravel pack, well screen, and well casing. The well screen and well casing shall be lowered into the hole by a method which will allow for control of the rate of fall of the well screen and well casing at all times. Well screen and well casing shall not be dropped or allowed to fall uncontrolled into the hole. The well casing shall extend above the ground surface as shown on the Plans. Approved centering devices shall be installed on the well casing to center the well casing within the well casing bore hole. The centering device (casing guide) shall be constructed of stainless steel and strap directly to the well casing. The casing guide shall have minimum of 4 equally spaced guides. All nuts and bolts shall be stainless steel. The casing guides shall be spaced beginning 5 feet from the top of the submersible pump or bottom of well casing at 25 foot intervals. The upper most guide(s) shall be rotated as required to coordinate clearance from sounding tube and gravel fill tube.

3.1.3 Construction of Gravel Pack

After the screen and well casing have been concentrically set in the hole the approved gravel pack shall be constructed around the screen by filling the entire space between the screen and the wall of the hole in the water bearing stratum with gravel pack. Well screen and well casing used for gravel pack wells shall have approved centering devices. Gravel conductor pipe having an inside nominal diameter of not less than 1-1/2 inches shall be lowered to not less than 2'-6" below the bottom of the cement annular seal between the well bore hole and well screen/casing. Gravel conductor pipe shall be arranged and connected at the surface of the ground to water pumping and graveling equipment so that water and gravel fed at uniform rates are discharged uniformly. As gravel fills the annular space between well casing and maximum bore hole diameter from the bottom up, the gravel and water conductor shall be raised at a rate that will keep the bottom of the pipe between 1 and 3 feet under the gravel level at all times. If the Contractor desires to use methods of placing gravel other than those specified, he shall submit to the Contracting Officer, for approval, details of the method and equipment proposed, before gravel placing is begun. Dumping filter gravel from the ground surface and agitating the well in an effort to settle the filter will not be allowed. The gravel pack shall be installed continuously and without interruption until the gravel has been placed to within 1 foot of the top of the conductor casing.

3.1.4 Placing Packer

After the well casing, screen, and gravel pack have been installed, the annular space between the well casing and bore hole shall be sealed by use of an approved packer.

3.1.5 Painting Above Ground PVC Casings

Above ground portions of PVC casings shall receive a minimum of 8 mils of acrylic paint coating for protection against ultraviolet rays from the sun.

The paint coating shall be applied in conformance with manufacturer's recommendations and all applicable health and safety code requirements.

3.2 WELL DEVELOPMENT

After construction, the well shall be developed in accordance with the submitted drilling plan. The Contractor shall develop the well by such methods as approved until the water pumped from the well is substantially free from sand and until the turbidity is less than 5 on the Jackson Turbidity Scale specified in AWWA-10062JU. Developing equipment shall be of an approved type and of sufficient capacity to remove all cutting fluids, sand, rock cuttings, and any other foreign material. The well shall be thoroughly cleaned from top to bottom before beginning the well tests.

3.3 TESTS

During construction of the well, whenever sufficient water is found to indicate that a well of required capacity may be developed, or when directed, a capacity test shall be performed. If the capacity test indicates that the required capacity can be obtained, the tests for quality of water shall be made. If the capacity and quality tests indicate that the required capacity and quality can be obtained, the permanent well, as specified, shall be completed at that depth. Prior to making quality tests, drilling equipment, tools, and pumps contacting well water shall be cleaned with live steam.

3.3.1 Capacity Test

The Contractor shall furnish and install an approved temporary test pump, with discharge piping of sufficient size and length to conduct the water being pumped to point of discharge, and equipment necessary for measuring the rate of flow and water level in the well. A continuous 8 hour capacity test shall be run with the pumping rate and drawdown at the pump well and observation wells recorded every 30 minutes. Observation wells (piezometers) shall be read on the same schedule as the pump well. The test shall begin at the rate of the expected capacity of well and at least that rate maintained throughout the duration of the test. If this capacity cannot be maintained for the test period, the capacity test shall be terminated and the test hole drilled deeper or relocated as directed. The record of the test, in triplicate, shall be delivered to the Contracting Officer.

3.3.2 Test for Plumbness and Alignment

Upon completion of the permanent well, plumbness and alignment shall be tested by lowering into the well, to the total depth of the well, a plumb 40 feet long or a dummy of the same length. The outer diameter of the plumb shall not be more than 1/2 inch smaller than the diameter of that part of the hole being tested. If a dummy is used, it shall consist of a rigid spindle with three rings, each ring being 10 inches wide. The rings shall be cylindrical and shall be spaced one at each end of the dummy and one in the center thereof. The central member of the dummy shall be rigid so that it will maintain the alignment of the axis of the rings. Should the plumb or dummy fail to move freely throughout the length of the casing or well screen for the depth of well or should the well vary from the vertical in excess of two-thirds the inside diameter of that part of the well being tested for each 100 feet of depth, the plumbness and alignment of the well shall be corrected by the Contractor.

3.4 INSTALLATION OF PERMANENT PUMP

The permanent well pump shall be installed in the well at a minimum depth of 25 feet below the maximum drawdown groundwater level after the drawdown test has been completed. The pump shall be secured at the required elevation as recommended by the pump manufacturer.

3.5 WELL SLAB FOUNDATION

Well slab foundation shall be constructed so as to prohibit the infiltration of surface water or precipitation into the well. The slab shall be constructed of reinforced concrete of the dimensions indicated on the plans. The top of the outer casing shall extend a minimum of 12 inches above the top of the finished floor of the slab or as shown on the plans.

3.6 CLEAN-UP

Upon completion of the well construction and other incidentals, all debris and surplus materials resulting from the work shall be removed from the jobsite.

-- End of Section --

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DIVISION 02 - SITE WORK

SECTION 02522

OBSERVATION WELLS

-- End of Section Table of Contents --

SECTION 02522

OBSERVATION WELLS

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM C 150	(1997) Portland Cement
ASTM F 480	(1994) Thermoplastic Well Casing Pipe and Couplings Made in Standard Dimension Ratios (SDR), SCH 40 AND SCH 80

1.2 GENERAL REQUIREMENTS

The well shall be located as shown. The well shall be to such depth as may be necessary to penetrate a desirable water-bearing stratum and provide a piezometric level of the groundwater surface for monitoring purposes.

1.3 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-03 Product Data

Work Plan; G
Method of drill; G
Connection method; G
Well Screens; G
Centering devices; G

Proposed plan for drilling holes and constructing observation wells, before beginning work. The plan shall include, but not be limited to, the proposed method of drilling and equipment to be used, details on proposed casing, well screen, grouting materials, gravel pack material and method for placing gravel pack, and methods and equipment proposed for completion of observation well. No work shall be performed until the drilling plan has been approved and no deviation from the approved drilling plan will be permitted without approval of the Contracting Officer. Details of specific methods to be employed to control potential contamination or pollution arising from well installation activities, shall also be included.

Borehole Logs

During the drilling of the test hole an accurate log shall be maintained. As a minimum, the log shall include depths, elevations, and descriptions of all formations encountered; identification of each stratum according to the Unified Soil Classification System; or standard rock nomenclature, as necessary; and depths at which groundwater is encountered. Soil samples shall be taken each 10 feet with a split-spoon sampler. The Contractor shall prepare a graphic boring log to scale showing the required details. Five prints of the boring log drawing shall be submitted. This drawing shall be used for determining necessary modifications to the well design, design of the gravel filter, well screen location and screen openings.

Permits; G

A copy of all permits, licenses, or other requirements necessary for execution of the work. Before beginning work, the local United States Geological Survey office (USGS), the local health department, and the Regional Water Quality Control Board shall be notified of the type and location of wells to be constructed, the method of construction and anticipated schedule for construction of the wells. A copy of all such correspondence shall be furnished.

SD-04 Samples

Gravel-pack gradations

A representative sample of materials.

SD-06 Test Reports

Test for Plumbness and Alignment

Copy of test results.

1.4 ENVIRONMENTAL PROTECTION

The Contractor shall take all precautions as may be required to prevent contaminated water or water having undesirable physical or chemical characteristics from seepage from the ground surface. The Contractor also shall take all precautions necessary to prevent contamination of the ground surface or of surface waters resulting from drilling of the well.

PART 2 PRODUCTS

2.1 CASING

The casing shall be sized as specified. All casing, screen, and other well materials shall be of compatible materials to prevent galvanic reaction between components of the completed well.

2.1.1 Well Casing and Couplings

The well casing shall be 4 inch Schedule 80 PVC. The well casing shall be directly connected to the top of the well screen by an approved method.

The well casing shall have watertight joints of approved connection method.

2.1.2 Conductor Casing

No outer (conductor) casing is required.

2.2 WELL SCREENS

Well Screens shall be a minimum of 4 inches nominal diameter, and shall be directly connected to the bottom of the well casing by an approved method. The screen shall be sized and located based on the drilling log. The opening size shall be compatible with the material surrounding the screen and shall be submitted for approval as part of the drilling plan. The well screen shall be of sufficient size and design to hold back and support the gravel used in the gravel envelope and in-situ material surrounding the screen. The screen and all accessories required for satisfactory operation shall be essentially standard products of reliable manufacturers regularly engaged in the production of such equipment. Field constructed screen is not acceptable.

2.2.1 Plastic Screen

2.2.1.1 Plastic Pipe Screens

Plastic pipe screens shall be thermoplastic manufactured by a molding, extrusion or sonic welding process. The plastic compounds shall be uniform in composition and contain no additives or foreign matter. Clean material generated during the manufacturer's own pipe production may be reused if blended back into the same type and kind of virgin compound and if the pipe produced meets the requirements of this specification. The molding or extrusion process shall produce pipe screens that are homogeneous throughout and free from visible cracks, holes, foreign inclusions or other defects. Pipe produced by simultaneous multiple extrusion shall have strong uniform bonds between any two layers so that the layers cannot be separated. Plastic pipe shall be uniform in color, opacity, density and other physical properties. The plastic pipe screen strength properties shall be equivalent to those for the plastic casing with which the screen is used.

2.2.1.2 Bonding Materials

Bonding materials, proportions and preparation of adhesives, the method of application, and the procedure used for making and curing the connections shall conform to the recommendations of the plastic pipe manufacturer and ASTM F 480. The pot life, initial setting time and external heating requirements for curing of the adhesive shall be suitable for the procedure and climatic and other conditions and shall be varied as required to suit changes in climatic and other conditions. The system for making joints at the well site shall provide a curing period adequate to develop the ultimate strength of the completed joint. Self-tapping screws or other devices for holding adhesive-coated pipe in the couplings during the setting period may be utilized. In no case shall a newly-made joint in the casing be stressed, lowered into the well or be submerged in water prior to complete curing of the adhesive.

2.2.1.3 Plastic Well Screen

Plastic well screen shall be provided with perforations which shall consist of either machine-sawed slots, or drilled, formed, or molded openings, and

which shall have smooth, sharp-edged openings free of burns, chipped edges, or broken pieces on the interior and exterior surfaces of the pipe. The pattern of the openings shall be uniformly spaced around the periphery of the well screen. Compatible slot sizes of screens and gravel-pack gradations shall be designed by the Contractor and furnished to the Contracting Officer, with a representative sample of materials in which the screen is to be placed.

2.2.2 Combination Screen

Well screens that are fabricated from two or more different materials may be substituted with prior approval. Approval will be based in part on past history of successful performance.

2.3 GRAVEL PACK

Gravel pack shall be a product of a commercial sand and gravel manufacturer, shall be properly sized and graded for the surrounding soil and water encountered, and shall be composed of round, hard, waterworn siliceous gravel, free of flat or elongated pieces, organic matter, or other foreign matter. The gravel shall be of such size as will allow the maximum flow of water into the well and prevent the infiltration of sand and silt. The gradation of the filter gravel shall be such that the uniformity coefficient is not more than 2.5.

2.4 CEMENT GROUT

Cement grout shall consist of portland cement conforming to ASTM C 150, Type I or II, sand and water. Cement grout shall be proportioned not to exceed 6 gallons of water per cubic foot of cement, with a mixture of such consistency that the well can be properly grouted. Not more than 3 percent by weight of bentonite powder may be added to reduce shrinkage.

2.5 PROTECTIVE COVER

The aboveground portion of the PVC well casing shall be protected by a steel or aluminum casing set in concrete with a locking cover, per the plans. The lock shall be provided by the governing agency, which owns the well.

PART 3 EXECUTION

3.1 WELL CONSTRUCTION

3.1.1 General Requirements

The method of drill shall be as approved by the Contracting Officer and shall conform to all state and local standards for water well construction. The execution of the work shall be by competent workmen and performed under the direct supervision of an experienced well driller. Casing pipe, well screens, and joint couplings shall be of compatible materials throughout each well. The well shall be a gravel pack well developed in the water-bearing stratum. The well shall be drilled straight, plumb, and circular from top to bottom. The well shall be initially drilled from the ground surface to the uppermost level of the water bearing strata and the bottom of the outer casing set at this elevation. The hole below the outer casing shall fully penetrate the water bearing stratum as indicated on the plans.

3.1.2 Construction of Well Casing and Screen

The hole shall be reamed at the required diameter to the required depth by an approved method which will prevent caving of the hole before or during installation of the gravel pack, well screen, and well casing. The well screen and well casing shall be lowered into the hole by a method which will allow for control of the rate of fall of the well screen and well casing at all times. Well screen and well casing shall not be dropped or allowed to fall uncontrolled into the hole. The well casing shall extend up above the ground surface. Approved centering devices shall be installed on the well casing to center the well casing within the well casing bore hole. The centering device (casing guide) shall be constructed of stainless steel and strap directly to the well casing. The casing guide shall have minimum of 4 equally spaced guides. All nuts and bolts shall be stainless steel. The casing guides shall be spaced beginning 5 feet from the bottom of well casing at 25 foot intervals. The upper most guide(s) shall be rotated as required to coordinate clearance from sounding tube and gravel fill tube.

3.1.3 Construction of Gravel Pack

After the screen and well casing have been concentrically set in the hole, the approved gravel pack shall be constructed around the screen by filling the entire space between the screen and the wall of the hole in the water bearing stratum with gravel pack. Well screen and well casing used for gravel pack wells shall have approved centering devices. Gravel conductor pipe having an inside nominal diameter of not less than 1-1/2 inches shall be lowered into the annular space between the well bore hole and well screen/casing. Gravel conductor pipe shall be arranged and connected at the surface of the ground to water pumping and graveling equipment so that water and gravel fed at uniform rates are discharged uniformly. As gravel fills the annular space between well casing and maximum bore hole diameter from the bottom up, the gravel and water conductor shall be raised at a rate that will keep the bottom of the pipe between 1 and 3 feet under the gravel level at all times. If the Contractor desires to use methods of placing gravel other than those specified, he shall submit to the Contracting Officer, for approval, details of the method and equipment proposed, before gravel placing is begun. Dumping filter gravel from the ground surface and agitating the well in an effort to settle the filter will not be allowed. The gravel pack shall be installed continuously and without interruption until the gravel has been placed to within 1 foot of 5 feet above the top of the screening.

3.1.4 Placing Packer

After the well screen and gravel pack have been installed, the annular space between the well bore hole and casing shall be sealed by use of an approved packer.

3.2 WELL DEVELOPMENT

The observation wells shall not be developed unless directed by the Contracting Officer.

3.3 TESTS

The following tests shall be performed.

3.3.1 Test for Plumbness and Alignment

Upon completion of the permanent well, plumbness and alignment shall be tested by lowering into the well, to the total depth of the well, a plumb 40 feet long or a dummy of the same length. The outer diameter of the plumb shall not be more than 1/2 inch smaller than the diameter of that part of the hole being tested. If a dummy is used, it shall consist of a rigid spindle with three rings. The rings shall be cylindrical and shall be spaced one at each end of the dummy and one in the center thereof. The central member of the dummy shall be rigid so that it will maintain the alignment of the axis of the rings. Should the plumb or dummy fail to move freely throughout the length of the casing or well screen for the depth of well or should the well vary from the vertical in excess of two-thirds the inside diameter of that part of the well being tested for each 100 feet of depth, the plumbness and alignment of the well shall be corrected by the Contractor.

3.4 PROTECTIVE CASING

The protective casing and cover shall be installed to allow the protected space to vent air and drain freely.

3.5 CLEAN-UP

Upon completion of the well construction and other incidentals, all debris and surplus materials resulting from the work shall be removed from the jobsite and disposed of in a proper manner.

-- End of Section --

SECTION TABLE OF CONTENTS

DIVISION 02 - SITE WORK

SECTION 02531

SANITARY SEWERS

-- End of Section Table of Contents --

SECTION 02531

SANITARY SEWERS

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ASME B31.1	(1998) Power Piping

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM C 94	(1998c) Ready-Mixed Concrete
ASTM C 443	(1994) Joints for Circular Concrete Sewer and Culvert Pipe, Using Rubber Gaskets
ASTM C 478	(1997) Precast Reinforced Concrete Manhole Sections
ASTM C 478M	(1997) Precast Reinforced Concrete Manhole Sections (Metric)
ASTM C 828	(1990) Low-Pressure Air Test of Vitrified Clay Pipe Lines
ASTM C 924	(1989) Concrete Pipe Sewer Lines by Low-Pressure Air Test Method
ASTM D 412	(1998; Rev. A) Vulcanized Rubber and Thermoplastic Rubbers and Thermoplastic Elastomers - Tension
ASTM D 624	(1991) Tear Strength of Conventional Vulcanized Rubber and Thermoplastic Elastomers
ASTM D 1784	(1992) Rigid Poly(Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds
ASTM D 2680	(1995)Acrylonitrile-Butadiene-Styrene (ABS) and Poly(Vinyl Chloride) (PVC) Composite Sewer Piping
ASTM D 2751	(1996a) Acrylonitrile-Butadiene-Styrene (ABS) Sewer Pipe and Fittings

ASTM D 3034	(1998) Type PSM Poly(Vinyl Chloride) (PVC) Sewer Pipe and Fittings
ASTM D 3212	(1996a) Joints for Drain and Sewer Plastic Pipes Using Flexible Elastomeric Seals
ASTM D 3350	(1993) Polyethylene Plastics Pipe and Fittings Materials
ASTM F 402	(1993) Safe Handling of Solvent Cements, Primers, and Cleaners Used for Joining Thermoplastic Pipe and Fittings
ASTM F 714	(1994) Polyethylene (PE) Plastic pipe (SDR-PR) Based on Outside Diameter
ASTM F 794	(1995a) Poly(Vinyl Chloride) (PVC) Profile Gravity Sewer Pipe and Fittings Based on Controlled Inside Diameter
ASTM F 894	(1995) Polyethylene (PE) Large Diameter Profile Wall Sewer and Drain Pipe
ASTM F 949	(1996a) Poly(Vinyl Chloride) (PVC) Corrugated Sewer Pipe With a Smooth Interior and Fittings

AMERICAN WATER WORKS ASSOCIATION (AWWA)

AWWA C200	(1997) Steel Water Pipe 6 in. (150 mm) and Larger
AWWA C205	(1995) Cement-Mortar Protective Lining and Coating for Steel Water Pipe - 4 In. (100 mm) and Larger - Shop Applied
AWWA C206	(1997) Field Welding of Steel Water Pipe
AWWA C208	(1996) Dimensions for Fabricated Steel Water Pipe Fittings
AWWA M11	Current Manual

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 49	(1994) Hazardous Chemicals Data
NFPA 325M	(1991) Fire Hazard Properties of Flammable Liquids, Gases, and Volatile Solids
NFPA 704	(1990) Identification of the Fire Hazards of Materials

UNI-BELL PVC PIPE ASSOCIATION (UBPPA)

UBPPA UNI-B-6	(1990) Recommended Practice for the Low-Pressure Air Testing of Installed Sewer Pipe

UBPPA UNI-B-9	(1990; Addenda 1994) Recommended Performance Specification for Polyvinyl Chloride (PVC) Profile Wall Gravity Sewer Pipe and Fittings Based on Controlled Inside Diameter (Nominal Pipe Sizes 4-48 inch)

1.2 GENERAL REQUIREMENTS

The construction required herein shall include the 36-inch diameter sewer relocation upstream of Prado Dam (S.A.R.I. Line Reach IVB, Section 1) and the Reinforced Concrete Encasement of the 60-inch diameter sewer downstream of the Prado Dam (S.A.R.I. Line Reach IV). Appurtenant structures and building sewers and leach field is also to be constructed for the Control Tower to a point 5 feet from the building, to which the sewer system is to be connected. The septic tank and leach field shall be as specified under Section 15400, "Plumbing, General Purpose." The Contractor shall replace damaged material and redo unacceptable work at no additional cost to the Government. Excavation and backfilling is specified in Section 02316 EXCAVATION, TRENCHING, AND BACKFILLING FOR UTILITIES SYSTEMS. Backfilling shall be accomplished after inspection by the Contracting Officer. Before, during, and after installation, plastic pipe and fittings shall be protected from any environment that would result in damage or deterioration to the material. The Contractor shall have a copy of the manufacturer's instructions available at the construction site at all times and shall follow these instructions unless directed otherwise by the Contracting Officer. Solvents, solvent compounds, lubricants, elastomeric gaskets, and any similar materials required to install the plastic pipe shall be stored in accordance with the manufacturer's recommendation and shall be discarded if the storage period exceeds the recommended shelf life. Solvents in use shall be discarded when the recommended pot life is exceeded.

Upon contract award the Contractor shall undertake three first items of business. First, the Contractor shall pothole the 60-inch S.A.R.I. Line as identified on the plans under the new Dam Outlet Channel, see Sheet C-26. Second, the Contractor shall verify the existing 36-inch S.A.R.I. Line Reach IVB, Section 1 outside pipe diameter to establish pipe wall thickness so that the proper pipe joint may be designed, if different then shown on plans, for the 36-inch sewer pipe used for the construction of the relocation, shown on sheets C-67 through C-69. Third, the Contractor shall pothole the connection points of the 36-inch S.A.R.I. Line to verify horizontal location and vertical invert of the pipes nearest joints for making connection so that pipe alignment and elevation may be determined prior to construction.

1.3 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Waste Water Disposal Method; G.

The method proposed for disposal of waste water from hydrostatic tests.

SD-02 Shop Drawings

Fabrication drawings; G

Detailed fabrication drawings for any pipe specials, including cleanouts and outlet sleeves.

36-inch Reinforced Concrete Pipeline (RCP); G.

Drawings showing the proposed pipeline connection diagrams with details of connections to existing pipelines, new pipe, and manholes, if different from shown on plans.

Method of Dewatering; G.

Detailed Drawings showing the proposed dewatering system including all pumps, motors, fuel storage, fencing, pipeline, valving, and appurtenances.

SD-03 Product Data

Sanitary sewer piping, fittings, and joints; G.
Manholes; G.

Submit manufacturer's standard drawings or catalog cuts, except submit both drawings and cuts for push-on and rubber-gasketed bell-and-spigot joints. Include information concerning gaskets with submittal for joints

Temporary Sewer Bypass System; G
Sewer Bypass Implementation Plan; G

Detailed Catalog cut sheets for each component of the temporary bypass system, including but not limited to the proposed wastewater containment system and the proposed pumping system; including all pumps, motors, fuel storage, fencing, pipeline, valving, and appurtenances, as they apply.

SD-05 Design Data

Design calculations of 36" RCP sewer piping; G.

Design calculations of sewer manhole structures; G.

Method of 36" S.A.R.I. Line reconnection; G.

Invert elevations, lateral locations; G.

Method of Restraint of 60-inch S.A.R.I. Line during construction of concrete encasement; G.

SD-06 Test Reports

Pothole Data

Report identifying the exact location and grade of the existing 60-inch RCP sewer crossing under the new outlet channel between the limits of grading, and specifically at the low flow channel.

Report shall identify the survey benchmark used, which shall be the same as that used in the development of the topography contours and elevations identified on the Construction Drawings.

SD-07 Certificates

Sanitary sewer piping, fittings, joints; G
Shop-applied lining and coating; G
Leakage Tests; G

Certificates shall attest that tests set forth in each applicable referenced publication have been performed, whether specified in that publication to be mandatory or otherwise and that production control tests have been performed at the intervals or frequency specified in the publication. Other tests shall have been performed within three (3) years of the date of submittal of certificates on the same type, class, grade, and size of material as is being provided for the project.

Steel Manhole Structures

Certificate shall identify that the manhole structures are constructed to be installed as alignment or grade breaks in a watertight wastewater conveyance system that flows by gravity and is subject to as much as 70 psi of external stress (total, soil and water) with atmospheric pressure inside the manholes.

36-inch Reinforced Concrete Pipeline

Certificate shall identify that the pipeline is constructed to be installed as a watertight wastewater conveyance system that flows by gravity and is subject to as much as 70 psi of external stress (total, soil and water pressure) with atmospheric pressure inside the pipe.

Statement of Satisfactory Installation

A statement signed by the principal officer of the contracting firm stating that the installation is satisfactory and in accordance with the contract plans and specifications and the manufacturer's prescribed procedures and techniques, upon completion of the project and before final acceptance.

SD-08 Manufacturer's Instructions

Installation procedures for sewer piping; G.

Manufacturer's Installation Instructions for 36-inch RCP

PART 2 PRODUCTS

2.1 PIPE

Pipe shall conform to the respective specifications and other requirements specified below.

2.1.1 Plastic Pipe

Acrylonitrile-butadiene-styrene (ABS) and polyvinyl chloride (PVC)

composite sewer piping shall conform to ASTM D 2680. Size 8 inch through 15 inch diameter.

2.1.1.1 PVC Pipe

ASTM D 3034, Type PSM with a maximum SDR of 35, Size 15 inches or less in diameter. Smooth interior. PVC shall be certified by the compounder as meeting the requirements of ASTM D 1784, cell Class 12454B. The pipe stiffness shall be greater than or equal to 735/D for cohesionless material pipe trench backfills.

2.1.1.2 High Density Polyethylene Pipe

ASTM F 894, Class 63, size 18 inch through 120 inch. ASTM F 714, size 4 inch through 48 inch. The polyethylene shall be certified by the resin producer as meeting the requirements of ASTM D 3350, cell Class 334433C. The pipe stiffness shall be greater than or equal to 1170/D for cohesionless material pipe trench backfills.

2.1.2 Reinforced Concrete Pipe (S.A.R.I. Line Sewer)

Concrete pipe for S.A.R.I. Line sewer shall be of reinforced concrete design and conform to the applicable ASTM standards listed, herein. All pipe shall be new, and constructed for the specific application, as indicated on the drawings and in these specifications by a manufacturer that has no less than 30 years design and construction experience with said pipe material.

2.1.2.1 Dimensions and Construction

Pipe shall have a minimum internal diameter of not less than 36 inches. Pipe lengths shall be 16 feet. Pipe thickness shall be designed to provide a D-Load of 4000, and not exceed 7-1/2 inches. Pipe shall have a dual, steel wall reinforcement cage design. Pipes shall be constructed in vertical casting forms. Pipes shall be certified for the application indicated by the Plans and these specifications.

2.1.2.2 Joints

Pipe joints shall be flush with no flared bell and spigot ends. They shall have steel flanges and a rubber O-Ring Gaskets on inside pipe mating surfaces but not on ends of pipe. Joint gap shall receive a field applied cement mortar, Type V for sewer applications. Joints shall be constructed to resist a total external stress of 70 psi (total water and soil pressure) when pressure inside the pipe is at atmospheric conditions.

2.1.2.3 Lining

PVC Lining shall be cast integrally with the pipe in accordance with Section 09880, PVC LINERS FOR CONCRETE PIPE AND STRUCTURES, and the SSPWC.

2.1.2.4 Coating

Coating shall be shop applied Coal Tar Epoxy to a minimum of 2 mils.

2.1.3 Steel Pipe (36" S.A.R.I. Line)

Steel pipe shall be in accordance with AWWA C200 and AWWA M11. Design calculations shall be provided by the manufacturer and stamped by a Civil

Engineer. Other steel pipe, not for use on the 36" S.A.R.I. Line shall be as specified on the plans or elsewhere.

S.A.R.I. Line manholes shall be manufactured by the same pipe manufacturer for the 36" RCP to ensure joint mating is per specifications.

2.1.3.1 General

Welded steel pipe and fittings shall be manufactured of steel plate with a minimum thickness of 3/8-inch diameter, unless otherwise noted on the plans or designed by manufacturer and approved.

Pipe materials, fabrications and shop testing of straight pipe; shall conform to the requirements of Section 207-10, "STEEL PIPE," of the SSPWC.

All pipe and fittings shall be in accordance with the latest revision of the applicable AWWA Standards.

2.1.3.2 Joints

Joints for S.A.R.I. Line manholes shall receive full-penetration, circumferential welds all the way around the joint. Welds shall be performed by welders certified in the type of welding required. All field welds shall be inspected. All welding shall be certified in accordance with Appendix II of the "Code of Pressure Piping: (ASME B31.1) or AWWA C206, "Standard for Field Welding of Steel Water Pipe Joints." See also, Section 05120 "STRUCTURAL STEEL AND MISCELLANEOUS METAL WORK."

2.1.3.3 Flanges

Pipe flanges and blind flanges shall be per AWWA 207, "Steel Pipe Flanges for Waterworks Service."

2.1.3.4 Fittings

Fittings shall be per AWWA C208, "Dimensions for Fabricated Steel Water Pipe Fittings."

2.1.3.5 Lining

Except as otherwise provided, welded steel pipe and fittings shall be lined with cement mortar in accordance with AWWA C205, "Standard Cement-Mortar Protective Lining and Coating for Steel Water Pipe." Additionally, an interior PVC lining shall be placed on the inside of the pipe per Section 09880, "PVC LINERS FOR CONCRETE PIPE AND STRUCTURES," and per manufacturer's recommendations.

2.1.3.6 Coating

All buried pipe and fittings shall receive a cement mortar coating, except as otherwise indicated. The cement mortar coating shall be in accordance with AWWA C205, "Standard for Cement-Mortar Protective Lining and Coating for Steel Water Pipe." The date of coating shall be plainly marked on the inside of each pipe length. Additionally, steel pipe shall receive a minimum of 2-mils of exterior coal tar epoxy coating over the cement mortar coating by the manufacturer.

2.2 FITTINGS

Fittings shall be compatible with the pipe supplied and shall have a strength not less than that of the pipe. Fittings shall conform to the respective specifications and other requirements specified below.

2.2.1 Plastic Pipe

ABS and PVC composite sewer pipe fittings shall conform to ASTM D 2680.

2.2.1.1 ABS Pipe

ASTM D 2751.

2.2.1.2 PVC Pipe

ASTM D 3034 for type PSM pipe. ASTM F 949 for corrugated sewer pipe with a smooth interior. UBPPA UNI-B-9 and ASTM F 794, Series 46, for ribbed sewer pipe with smooth interior.

2.2.1.3 High Density Polyethylene Pipe

ASTM F 894.

2.3 JOINTS

Joints installation shall comply with the manufacturer's instructions.

2.3.1 Plastic Pipe

Flexible plastic pipe (PVC or high density polyethylene pipe) gasketed joints shall conform to ASTM D 3212.

2.3.1.1 ABS Pipe

ASTM D 2751, solvent weld or bell and spigot O-ring joint, size 12 inches or less in diameter, dimensions and tolerances in accordance with Table 2 therein.

2.3.1.2 High Density Polyethylene Pipe

Rubber gasket joints shall conform to ASTM C 443.

2.3.2 Reinforced Concrete Pipe

Deflection of 36-inch sewer pipe joints shall not be allowed, unless approved by the Contracting Officer. Joints for the 36-inch sewer shall be watertight and constructed per the details provided by the pipe manufacturer. All 36-inch sewer pipeline joint exteriors shall receive a field applied polyurethane coating, Type 2. The coating shall be applied in two coats to a minimum thickness of 60 mils in accordance with the manufactures recommendations and Section 09920, COATING SYSTEMS. Coverage at joint shall extend a minimum of 2 feet each side of the joint.

2.4 BRANCH CONNECTIONS

Branch connections shall be made by use of regular fittings or solvent cemented saddles as approved. Saddles for ABS and PVC composite pipe shall conform to Figure 2 of ASTM D 2680; saddles for ABS pipe shall comply with Table 3 of ASTM D 2751; and saddles for PVC pipe shall conform to Table 4 of ASTM D 3034.

2.5 FRAMES AND COVERS

Frames and covers shall be cast iron, ductile iron or reinforced concrete, unless otherwise indicated in the drawings. Cast iron frames and covers shall be as indicated or shall be of type as suitable for the application, circular, without vent holes. The frames and covers shall have a combined weight of not less than 400 pounds. Reinforced concrete frames and covers shall be as indicated or shall conform to ASTM C 478 or ASTM C 478M. The word "Sewer" shall be stamped or cast into covers so that it is plainly visible.

2.6 CEMENT MORTAR

Cement mortar shall be Type V cement, for use with sewers, unless otherwise specified.

2.6.1 Portland Cement

Portland cement shall conform to Type V for concrete used in concrete sewer pipe, concrete pipe fittings, and manholes and type optional with the Contractor for cement used in concrete cradle, concrete encasement, and thrust blocking.

2.6.2 Portland Cement Concrete

Portland cement concrete shall conform to ASTM C 94, compressive strength of 4000 psi at 28 days, except for concrete cradle and encasement or concrete blocks for manholes. Concrete used for cradle and encasement shall have a compressive strength of 2500 psi minimum at 28 days. Concrete in place shall be protected from freezing and moisture loss for 7 days.

2.7 STRUCTURES

2.7.1 Precast Reinforced Concrete Manhole Sections

Precast reinforced concrete manhole sections shall conform to ASTM C 478, except that portland cement shall be as specified herein. Joints shall be cement mortar, an approved mastic, rubber gaskets, a combination of these types; or the use of external preformed rubber joint seals and extruded rolls of rubber with mastic adhesive on one side, or as shown on the drawings. Manholes shall be lined with a PVC liner in accordance with Section 09880: PVC LINERS FOR CONCRETE PIPE AND STRUCTURES.

2.7.2 Steel Manholes (S.A.R.I. Line)

The following specifications apply to the 36-inch diameter Santa Ana Regional Interceptor (S.A.R.I.) Reach IVB, Section 1 Manholes, as located and identified on the Plans.

2.7.2.1 Construction and Shipping

Manholes shall be constructed of shop fabricated steel pipe in accordance with the latest applicable AWWA Standards; to the dimensions, and location shown on the Plans. Manhole riser pipe and manhole base shall be shipped loose to the jobsite for field welding. The base tee, bends, eccentric reducers, and steel pipeline connection spools shall be welded together at the shop. No flanges shall be allowed on below grade components.

2.7.2.2 Design

The manholes shall be designed to withstand an external stress of 70 psi (total water and soil pressure), with only atmospheric pressure inside the manhole. Complete shop fabrication drawings and calculations shall be submitted for approval. The manhole components shall be completely shop fabricated.

2.7.2.3 Lining and Coating

The manholes shall be shop lined and coated as indicated. They shall be 100% spark tested by the fabricator for holidays in the field after being set in place. Field coating touch-up shall be as necessary and as directed by the Contracting Officer. Manholes shall receive a PVC liner in accordance with Section 09880, "PVC LINERS FOR CONCRETE PIPE AND STRUCTURES," and manufactures recommendations. Exposed portions of steel shall receive an epoxy coating as indicated on the Plans.

PART 3 EXECUTION

3.1 INSTALLATION

3.1.1 Adjacent Facilities

3.1.1.1 Water Lines

Where the location of the sewer is not clearly defined by dimensions on the drawings, the sewer shall not be closer horizontally than 10 feet to a water-supply main or service line, except that where the bottom of the water pipe will be at least 12 inches above the top of the sewer pipe, the horizontal spacing may be a minimum of 6 feet. Where gravity-flow sewers cross above water lines, the sewer pipe for a distance of 10 feet on each side of the crossing shall be fully encased in concrete or shall be acceptable pressure pipe with no joint closer horizontally than 3 feet to the crossing. The thickness of the concrete encasement including that at the pipe joints shall be not less than 4 inches.

3.1.2 Pipe Laying

a. Pipe shall be protected during handling against impact shocks and free fall and the pipe interior shall be free of extraneous material.

b. Pipe laying shall proceed upgrade with the spigot ends of bell-and-spigot pipe and tongue ends of tongue-and-groove pipe pointing in the direction of the flow. Each pipe shall be laid accurately to the line and grade shown on the drawings. Pipe shall be laid and centered so that the sewer pipe and lining system has a uniform invert. As the work progresses, the interior of the sewer shall be cleared of all superfluous materials.

c. The specified grade and alignment will be considered met if the inspectors field measurements show compliance with a maximum departure from stated grade of 1-inch or 0.08 feet. The maximum rate of departure from and return to the established grade shall not exceed 1/16-inch or 0.0005 feet per linear foot. The maximum departure from established alignment shall not exceed 1-1/4 inches or 0.1 foot on tangents and 2-inches or 0.17 feet on curves. Departure from and return to established alignment shall not

exceed 1/4-inch or 0.02 feet per linear foot.

d. Before making pipe joints all surfaces of the portions of the pipe to be joined shall be clean and dry. Lubricants, primers, and adhesives shall be used as recommended by the pipe manufacturer. The joints shall then be placed, fitted, joined, adjusted, and patched and sealed per the manufacturer's recommendations and the drawings to obtain the degree of water tightness required.

e. Installations of solvent weld joint pipe, using ABS or PVC pipe and fittings shall be in accordance with ASTM F 402. All required precautions shall be taken to assure adequate trench ventilation and protection for workers installing the pipe.

3.1.2.1 Trenches

EXTENSIVE DEWATERING OF TRENCHES SHALL BE ANTICIPATED. Construction of the 36-inch Santa Ana River Interceptor (S.A.R.I.) Line without dewatering shall require special approval by the Engineer prior to signing of Contract. Contractor shall submit a full and complete descriptive proposal of the method of dewatering (or the method of construction without dewatering) to the Engineer. Sufficient drawings and details shall be submitted so that the Engineer can make an evaluation.

The soils report prepared by John R. Byerly, Inc. on January 12, 1981, entitled: Preliminary Soils Investigation, Santa Ana Watershed Project Authority, Santa Ana River Interceptor Sewer, Reach IV-B, Corona Area, Riverside County, California, which was prepared for the existing 36-inch S.A.R.I. Line constructed in 1981, suggests certain permeability factors with regard to estimates of flow for determination of pumping requirements. CONTRACTOR SHALL MAKE HIS OWN DETERMINATIONS but the Soil Engineer's results suggest that the well point dewatering method may be difficult to use because of the long time indicated to dewater the inplace material. Dewatering cross trench sumps placed at either end of a working trench, excavated prior to or simultaneously with dewatering pumping, may be indicated.

Disposal of trench water shall be such that it is not a menace to the public health or safety and it shall be in accordance with Regional Water Quality Control Board Standards, and other affected public jurisdictions.

Trenches shall be kept free of water and as dry as possible during bedding, laying, and jointing and for as long a period as required. When work is not in progress, open ends of pipe and fittings shall be satisfactorily closed so that no trench water or other material will enter the pipe or fittings. All trenches shall be in conformance with the latest OSHA safety requirements, and applicable codes and standards. See also SECTION 02316, "EXCAVATION, TRENCHING AND BACKFILLING FOR UTILITIES."

3.1.2.2 Maximum and Minimum Width of 36-inch S.A.R.I. Line Trench

Difficult caving trench conditions are expected throughout. The drawings show minimum trench width requirements and define "controlled" trench as approximately 6.5 feet at top of pipe and "overwidth" trench as being greater in width than the "controlled," and bedding and backfill is predicated on these two conditions. No special payments are provided for overwidth trench conditions and Contractor shall bid as he sees fit in accordance with his expectations and be prepared to do whatever is necessary to obtain the specified results. If "overwidth" trench

conditions obtain where the pipe strength is matched to "controlled" trench, the pipe shall be replaced or the bedding condition shall be upgraded, as approved by the Engineer.

3.1.2.3 Bracing Excavations

The permit from the Division of Industrial Safety shall be submitted to the Engineer prior to deep trench excavations. Also, slope trench and shoring calculations and drawings shall be submitted by Contractor to Engineer prior to deep trench excavations. Such drawings shall be prepared by (with seal affixed) a California Licensed Civil Engineer.

Thick timber sheeting for trench support shall not be removed from the trench (after backfilling) and shall be cut off at the top of the pipe. Thin steel sheeting may be removed, subject to Engineer's judgment as to whether there is a potential for detrimental side subsidence of trench sidewall support.

3.1.2.4 Bedding

If foundation soils are disturbed by or loosened by upward seepage of water or an uncontrolled flow of water, the affected areas shall be excavated and replaced with the imported crushed rock (C.R.) as shown on the drawings.

3.1.2.5 Backfill

As soon as possible after the joint is made, sufficient backfill material shall be placed along the pipe to prevent pipe movement off line or grade. Plastic pipe shall be completely covered to prevent damage from ultraviolet light. See SECTION 02316, "EXCAVATION, TRENCHING AND BACKFILLING FOR UTILITIES," SECTION 02250, "FILLS AND SUBGRADE PREPARATION" and the plans for materials and other requirements.

3.1.2.6 Width of Trench

If the maximum width of the trench at the top of the pipe, as specified in Section 02316 EXCAVATION, TRENCHING, AND BACKFILLING FOR UTILITIES SYSTEMS, is exceeded for any reason other than by direction, the Contractor shall install at no additional cost to the Government such concrete cradling, pipe encasement, or other bedding required to support the added load of the backfill.

3.1.2.7 Joints

Joints between different pipe materials shall be made as specified, using approved jointing materials.

3.1.2.8 Handling and Storage

Pipe, fittings and joint material shall be handled and stored in accordance with the manufacturer's recommendations. Storage facilities for plastic pipe, fittings, joint materials and solvents shall be classified and marked in accordance with NFPA 704, with classification as indicated in NFPA 49 and NFPA 325M.

3.1.3 Leakage Tests

Lines shall be tested for leakage by low pressure air testing, infiltration tests or exfiltration tests, as appropriate. Low pressure air testing for

PVC pipe shall be as prescribed in UBPPA UNI-B-6. Low pressure air testing procedures for other pipe materials shall use the pressures and testing times prescribed in ASTM C 828 and ASTM C 924, after consultation with the pipe manufacturer. Prior to infiltration or exfiltration tests the trench shall be backfilled up to at least the lower half of the pipe. If required, sufficient additional backfill shall be placed to prevent pipe movement during testing, leaving the joints uncovered to permit inspection. Visible leaks encountered shall be corrected regardless of leakage test results. Leakage as measured by either the infiltration test or exfiltration test shall not exceed 0.2 gallons per inch diameter per 100 feet of pipeline per hour. When leakage exceeds the maximum amount specified, satisfactory correction shall be made and retesting accomplished. Testing, correction, and retesting shall be made at no additional cost to the Government.

3.1.4 Testing 36-inch S.A.R.I. Line

The following shall apply for leakage testing fo the 36-inch S.A.R.I. Line.

3.1.4.1 General

Contractor shall clean and dewater each section of pipeline of water and foreign matter such as mud and solid unsuitable materials in preparation for Inspector's visual inspection. Visual inspection will be made prior to testing. Contractor shall provide additional cleaning as the Inspector may find warranted.

All types of pipe allowed in these specifications shall be tested for leakage and joint integrity by internal water pressure test and water infiltration test as well as by visual inspection from the interior of the pipe. The pipeline shall pass both tests and excessive leakage visually observed, which is the result of a bad joint, shall be repaired as necessary.

3.1.4.2 Water Infiltration Test

The end of the sewer at the upper structure shall be closed sufficiently to prevent the entrance of water, and pumping of groundwater shall be discontinued for at least 3 days, after which the section shall be tested for infiltration.

The water infiltration test shall be done after the water pressure test. Measured infiltration shall not exceed 100 gallons per inch diameter per mile of line for 36-inch diameter pipe, for example:

E = ((100 x 36) / (5,280 x 1,440)) x L; where E is infiltration in GPM and

L = The length tested in feet

3.1.4.3 Water Pressure Test

Preparatory to testing, the section of the pipeline to be tested shall be filled with water and placed under a slight pressure for at least 48 hours. The pipeline shall then be brought up to a water test pressure of 10 psi at the highest elevation of the test section. This water pressure shall be maintained for a period of not less than 4 hours.

Accurate means shall be provided for measuring the quantity of water

required to maintain full pressure on the line for the test period, which volume shall not exceed:

For SI Units:

L=CND(square root of P)/32,600

For U.S. Std. Measure:

L=CND(square root of P)/1,850

Where:

L = Maximum allowable leakage in liters (gallons) per hour for section of pipeline tested.
N = Number of joints in length tested.
D = Diameter of pipe in mm (inches)
P = Test pressure in kPa (psi).
C = C shall be taken as 1.0 for all types of pipe in the specifications.

3.1.5 Test for Deflection

When flexible pipe is used, a deflection test shall be made on the entire length of the installed pipeline not less than 30 days after the completion of all work including the leakage test, backfill, and placement of any fill, grading, paving, concrete, or superimposed loads. Deflection shall be determined by use of a deflection device or by use of a spherical, spheroidal, or elliptical ball, a cylinder, or circular sections fused to a common shaft. The ball, cylinder, or circular sections shall have a diameter, or minor diameter as applicable, of 92.5 percent of the inside diameter of the pipe, but 95 percent for RPMP and RTRP. A tolerance of plus 0.5 percent will be permitted. The ball, cylinder, or circular sections shall be of a homogeneous material throughout, shall have a density greater than 1.0 as related to water at 39.2 degrees F, and shall have a surface brinell hardness of not less than 150. It shall be center bored and through bolted with a 1/4 inch minimum diameter steel shaft having a yield strength of 70,000 psi or more, with eyes at each end for attaching pulling cables. The eye shall be suitably backed with flange or heavy washer such that a pull exerted on the opposite end of the shaft shall produce compression throughout the remote end of the ball, cylinder or circular section. Circular sections shall be so spaced that the distance from the external faces of the front and back sections shall equal or exceed the diameter of the circular section. Failure of the ball, cylinder, or circular section to pass freely through a pipe run, either by being pulled through or by being flushed through with water, shall be cause for rejection of that run. When a deflection device is used for the test in lieu of the ball, cylinder, or circular sections described, such device shall be approved prior to use. The device shall be sensitive to 1.0 percent of the diameter of the pipe being measured and shall be accurate to 1.0 percent of the indicated dimension. Installed pipe showing deflections greater than 7.5 percent of the normal diameter of the pipe, or 5 percent for RTRP and RPMP, shall be retested by a run from the opposite direction. If the retest also fails, the suspect pipe shall be replaced at no cost to the Government.

3.2 CONCRETE CRADLE AND ENCASEMENT

The pipe shall be supported on a concrete cradle, or encased in concrete in strict conformance with the details indicated on the drawings, or as

directed by the Contracting Officer.

3.3 WYE BRANCHES

Wye branches shall be installed where sewer connections are indicated or where directed. Cutting into piping for connections shall not be done except in special approved cases. The installation of wye branches in an existing sewer shall be made by a method which does not damage the integrity of the existing sewer.

3.4 MANHOLES

3.4.1 General

Manholes shall be constructed as indicated. Pipe connections shall be made in accordance with the manufacturer's recommendation. Manholes shall be first set in place as indicated on the Plans, then pipeline shall be connected. Connection manholes to the existing 36-inch S.A.R.I line will be made per the approved method submitted by the Contractor, and as recommended by the pipe manufacturer.

3.4.2 Jointing, Plastering and Sealing

Mortar joints shall be completely filled and shall be smooth and free from surplus mortar on the inside of the manhole. Mortar and mastic joints between precast rings shall be full-bedded in jointing compound and shall be smoothed to a uniform surface on both the interior and exterior of the manhole. Installation of rubber gasket joints between precast rings shall be in accordance with the recommendations of the manufacturer. Precast rings may also be sealed by the use of extruded rolls of rubber with mastic adhesive on one side.

3.4.3 Frames and Covers

Unless otherwise indicated, tops of frames and covers shall be set flush with finished grade in paved areas or 2 inches higher than finished grade in unpaved areas. Frame and cover assemblies shall be sealed to manhole sections using external preformed rubber joint seals that meet the requirements of ASTM D 412 and ASTM D 624, or other methods specified in paragraph: Jointing, Plastering and Sealing, unless otherwise specified.

3.4.4 Excavation, Bedding, and Backfill for 36" S.A.R.I. Line Manholes

Manhole excavation shall be performed when the 36" S.A.R.I. Line is excavated, with the exception that the manholes located at the points of connection to the existing system shall be excavated just prior to making the connection. Precautions shall be taken to restrain the exposed S.A.R.I. line when making the connection to the existing system, so that the existing alignment and grade are not disturbed, as well as the function of the system. Bedding shall be Unyielding Material, as defined in Section 02316, "EXCAVATION, TRENCHING, AND BACKFILLING FOR UTILITIES SYSTEMS," and backfill shall be Select Granular Material, as defined by Section 02316, "EXCAVATION, TRENCHING, AND BACKFILLING FOR UTILITIES SYSTEMS." Manhole Excavation, Bedding, and Backfill limits shall be similar to 36" S.A.R.I. Line trench.

3.5 TEMPORARY SEWER BYPASS SYSTEM

3.5.1 General

It is considered to be possible to plug the S.A.R.I. Line during periods of low flow at night to make the connection of the 36-inch line to the existing system. At the time of design, SAWPA indicated the following flow rates, which they have experienced:

Low Average Flow Rate in December 1999 = 2.9442 million gallons per day (mgd)
Average Flow Rate in June 2000 = 5.9337 mgd

It was estimated by SAWPA that this line will experience the following flow rates in the year 2001.

Estimated Peak Flow Rate in 2001 = 4-7 mgd
Estimated Low Nighttime Flow Rate in 2001 = 2.0 mgd

The Contractor shall contact SAWPA to obtain the most up to date peak and low flow rate information, as required to design the bypass system needed to make the connection of the 36-inch S.A.R.I. Line to the existing system. The bypass system shall be proposed and submitted for approval.

Santa Ana Watershed Project Authority (SAWPA)
Phone: (909) 785-5411
Contact: Eldon Horst, Executive Manager Engineering/Planning Division
Regarding: Santa Ana Regional Interceptor (S.A.R.I.) Line, Reach IVB, Section 1 Relocation

The Contractor shall provide all labor, materials, equipment and power required to install, test and maintain a temporary sewer bypass system. The bypass system shall be in accordance with these specifications. All costs associated with permitting, installing, testing, operating and maintaining the sewer bypass, shall be the responsibility of the Contractor, and there shall be no additional compensation to the Contractor.

The Contractor shall also provide containment to prevent discharge into the streambed in the vicinity of the work being performed. The containment shall be adequate to contain all raw wastewater discharged into the streambed, and prevent it from continuing downstream or infiltrating into the groundwater. The containment shall be completed prior to beginning any excavation for work for the sewer pipeline connections.

All materials and equipment specified herein are to be used exclusively for the sewer bypass system. The sewer bypass system shall include the required pumps, piping manifolds, suction pipeline, force main and plugs for the upstream and downstream manholes. The bypass system shall be installed, tested and ready for operation prior to the beginning of any excavation. The sewer bypass system shall remain operational until work on the connections to the 36-inch sewer are completed, the excavations are backfilled, and all work related to the connections has been approved by the Contracting Officer. In the event of delays to work being performed for the pipeline connections, the Contractor shall receive no additional compensation for sewer bypass system.

A qualified operator, approved by the Contracting Officer, shall be employed for the duration of the pipeline connection work. The operator shall be on site and ready to startup and operate the Sewer Bypass System at anytime during construction. An operator shall remain on-site 24-hours per day, while the bypass system is in operation.

The Contractor shall protect bypass and secure the pump area by means of temporary chainlink fencing in accordance with these specifications.

3.5.2 Sewer Bypass Implementation Plan

The Contractor shall submit a Sewer Bypass Implementation Plan to the Contracting Officer for approval at least one (1) month prior to the required implementation. The Sewer Bypass Implementation Plan shall include a detailed step-by-step procedure for the installation. Should a pumping system be used for sewer bypass, it shall include suction and discharge piping, plugs for each pipe in the manholes, startup and operation of the Sewer Bypass System. Notification of appropriate regulatory agencies shall be coordinated by SAWPA.

3.5.3 Force Main

Should a pumping system be used for sewer bypass, it shall be a temporary force main consisting of 16-inch diameter standard steel pipeline. The force main shall be installed parallel to the existing 36-inch sewer with adequate clearance so as not to interfere with the excavation and installation of the new 36-inch sewer pipeline. The Contractor shall provide victaulic couplings or other means of thrust restraint, as approved by the Contracting Officer.

Portions of the force main may need to be buried to maintain access for construction equipment. In such cases, the Contractor shall take precautions to protect existing subsurface utilities in place and provide adequate cover over the pipeline to withstand H-20 traffic loads. Construction equipment shall cross the force main in a perpendicular direction. At no time shall construction equipment travel longitudinally above buried portions of the force main. In no case, shall construction equipment be parked or stored over the force main.

The force main shall be hydrostatically pressure tested at 120 percent of maximum operating pressure, as determined in Section 3.5.4. There shall be no leakage from the force main at any time.

3.5.4 Pumping Equipment

Should a pumping system be used for sewer bypass, it shall be capable of providing peak sewer system flowrates during time of bypass operation; see paragraph 3.5.1, this section. All pumps shall be of equal capacity and a redundant pump shall be provided. All pumps shall be skid-mounted, self-priming type, diesel powered, and capable of providing a minimum of 20 feet of suction head and the Total Dynamic Head (TDH), as required for each point of connection, to bypass flow from the manhole immediately upstream to the manhole immediately downstream of the work.

All pumping equipment, including but not limited to pumps, piping manifolds, suction and discharge headers, shall be installed within a secured, fenced enclosure. All pumping equipment shall be tested to the satisfaction of the Contracting Officer prior to work beginning in the streambed.

Pumps shall be of variable speed, which can be manually operated. The pumping system startup and operation procedure shall be included in the step-by-step procedure for the Sewer Bypass Implementation Plan provided by the Contractor. The Contractor shall make provisions such that additional diesel fuel is available as required to keep pumps operating for the

duration of the sewer pipeline connection work.

3.5.5 Manhole Structures

Access to the manholes is to remain closed at all times while the sewer is in normal operation. When the Sewer Bypass System is implemented, the Contractor shall install a balloon-type plug, or approved equal in each end of the 36-inch RCP pipelines to prevent discharge to the streambed.

Once the Sewer Bypass System is implemented, the high water level in the upstream manhole shall not exceed a level which would cause another upstream manhole structure to overflow with wastewater, or cause adverse effect in any way to the S.A.R.I. Line.

3.5.6 Notification in Event of Bypass System Failure

In the event of failure of the Sewer Bypass System, the Contractor shall immediately notify the Contracting Officer and SAWPA. Notification of appropriate regulatory agencies shall be coordinated by SAWPA. The Contractor shall stop all other work on the project until the Sewer Bypass System has been returned to satisfactory operation, as determined by the Contracting Officer.

The Contractor shall be responsible for all costs associated with the cleanup of the Santa Ana River or any other bodies of water or areas impacted by sewage spilled. The Contractor shall also be responsible for all fines and penalties assessed by the California Department of Fish & Game, the Regional Water Quality Control Board or any other agency having jurisdiction over the impacted areas. There shall be no additional compensation to the Contractor.

3.6 CLEANOUTS AND OTHER APPURTENANCES

Cleanouts and other appurtenances shall be installed where shown on the drawings or as directed by the Contracting Officer, and shall conform to the detail of the drawings.

-- End of Section --

SECTION TABLE OF CONTENTS

DIVISION 02 - SITE WORK

SECTION 02551

BITUMINOUS PAVING FOR ROADS, STREETS AND OPEN STORAGE AREAS

-- End of Section Table of Contents --

SECTION 02551

BITUMINOUS PAVING FOR ROADS, STREETS AND OPEN STORAGE AREAS

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM C 88	(1990) Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulfate
ASTM C 117	(1995) Materials Finer Than 75 micrometer (No. 200) Sieve in Mineral Aggregates by Washing
ASTM C 127	(1988; R 1993) Specific Gravity and Absorption of Course Aggregate
ASTM C 128	(1993) Specific Gravity and Absorption of Fine Aggregate
ASTM C 131	(1996) Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine
ASTM C 136	(1996a) Sieve Analysis of Fine and Coarse Aggregates
ASTM C 150	(1997) Portland Cement
ASTM C 183	(1995) Sampling and the Amount of Testing of Hydraulic Cement
ASTM D 5	(1994) Penetration of Bituminous Materials
ASTM D 75	(1987; R 1992) Sampling Aggregates
ASTM D 140	(1993) Sampling Bituminous Materials
ASTM D 422	(1963; R 1990) Particle-Size Analysis of Soils
ASTM D 977	(1991) Emulsified Asphalt
ASTM D 1856	(1995a) Recovery of Asphalt from Solution by Absorption Method

ASTM D 1559	(1989) Resistance to Plastic Flow of Bituminous Mixtures Using Marshall Apparatus
ASTM D 2041	(1995) Theoretical Maximum Specific Gravity and Density of Bituminous Paving Mixtures
ASTM D 2172	(1995) Quantitative Extraction of Bitumen from Bituminous Paving Mixtures
ASTM D 2216	(1998) Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass
ASTM D 3381	(1992) Viscosity-Graded Asphalt Cement for Use in Pavement Construction
ASTM D 3515	(1989) Hot-Mixed, Hot-Laid Bituminous Paving Mixtures

1.2 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-03 Product Data

Job Mix Formula; G.

Copy of Mix Design selected. Report to be submitted and sealed by a Civil Engineer licensed to Practice in the State of California.

SD-06 Test Reports

Aggregates; G.
Aggregate Gradation; G
Aggregate Moisture Content; G

Copies of test results.

Properties of Bituminous Mixtures; G.
Asphalt Properties; G
Asphalt Content; G
Temperature; G
Density; G

Copies of test results. Reports to be submitted and sealed by a Civil Engineer licensed to Practice in the State of California.

Grade and Surface Smoothness; G
Thickness; G

Copies of test results. Reports to be submitted and sealed by a Civil Engineer or Licensed Land Surveyor licensed to Practice in the State of California.

SD-07 Certificates

Waybills and Delivery Tickets; G.

Waybills and delivery tickets, during progress of the work.

1.3 PLANT, EQUIPMENT, MACHINES, AND TOOLS

1.3.1 General

The bituminous plant shall be of such capacity to produce the quantities of bituminous mixtures required. Hauling equipment, paving machines, rollers, miscellaneous equipment, and tools shall be provided in sufficient numbers and capacity and in proper working condition to place the bituminous paving mixtures at a rate equal to the plant output.

1.3.2 Mixing Plants

The mixing plant shall be an automatic or semiautomatic controlled commercially manufactured unit designed and operated to consistently produce a mixture within the job-mix formula (JMF). The plant shall have a minimum capacity of 100 tons per hour. Drum mixers shall be prequalified at the production rate to be used during actual mix production. The prequalification tests will include extraction and recovery of the asphalt cement in accordance with ASTM D 2172 and ASTM D 1856. The penetration of the recovered asphalt binder shall not be less than 60 percent of the original penetration, as measured in accordance with ASTM D 5.

1.3.3 Straightedge

The Contractor shall furnish and maintain at the site, in good condition, one 12-foot straightedge for each bituminous paver. Straightedge shall be made available for Government use. Straightedges shall be constructed of aluminum or other lightweight metal and shall have blades of box or box-girder cross section with flat bottom reinforced to insure rigidity and accuracy. Straightedges shall have handles to facilitate movement on pavement.

1.4 WEATHER LIMITATIONS

1.4.1 Asphaltic Concrete Pavement

Unless otherwise directed, bituminous courses shall not be constructed when temperature of the surface of the existing pavement or base course is below 40 degrees F.

1.4.2 Bituminous Tack Coat

Bituminous tack coat shall be applied only when the surface to receive the bituminous tack coat is dry. Bituminous tack coat shall be applied only when the atmospheric temperature in the shade is 50 degrees F or above and when the temperature has not been below 35 degrees F for the 12 hours prior to application.

1.5 PROTECTION OF PAVEMENT

After final rolling, no vehicular traffic of any kind shall be permitted on the pavement until the pavement has cooled to 140 degrees F.

1.6 GRADE AND SURFACE-SMOOTHNESS REQUIREMENTS

Finished surface of bituminous courses shall conform to gradeline and elevations shown and to surface-smoothness requirements specified.

1.6.1 Plan Grade

The grade of the completed surface shall not deviate more than 0.05 foot from the plan grade.

1.6.2 Surface Smoothness

When a 12 foot straightedge is laid on the surface parallel with the centerline of the paved area or transverse from crown to pavement edge, the surface shall vary not more than 1/4-inch from the straightedge.

1.7 GRADE CONTROL

Lines and grades shall be established and maintained by means of line and grade stakes placed at the site of the work. Elevations of bench marks used by the Contractor for controlling pavement operations at the site of work will be determined, established, and maintained by the Government. Finished pavement elevations shall be established and controlled at the site of work by the Contractor in accordance with bench mark elevations furnished by the Contracting Officer.

1.8 SAMPLING AND TESTING

1.8.1 Aggregates

1.8.1.1 General

Samples of aggregates shall be obtained by the Contractor for approval of aggregate sources and stockpiles prior to the start of production and at times during production of the bituminous mixtures. Times and points of sampling will be designated by the Contracting Officer. Samples will be the basis of approval of specific sources or stockpiles of aggregates for aggregate requirements. Unless otherwise directed, ASTM D 75 shall be used in sampling coarse and fine aggregate, and ASTM C 183 shall be used in sampling mineral filler. All tests necessary to determine compliance with requirements specified herein will be performed by the Contractor.

1.8.1.2 Sources

Sources of aggregates shall be selected well in advance of the time the materials are required in the work. If a previously developed source is selected, evidence shall be submitted 15 days before starting production, indicating that the central-plant hot-mix bituminous pavements constructed with the aggregates have had a satisfactory service record of at least five years under similar climatic and traffic conditions. The Contractor will make such tests and other investigations as necessary to determine whether aggregates meeting requirements specified herein can be produced from proposed sources. If a sample of material from a new source fails to meet specification requirements, the material represented by the sample shall be replaced, and the Contractor will be required to submit new test data on the submitted materials. Approval of the source of aggregate does not relieve the Contractor of responsibility for delivery at the jobsite of aggregates that meet the requirements specified herein.

1.8.2 Bituminous Materials

Bituminous materials shall be sampled in accordance with ASTM D 140. Tests necessary to determine conformance with requirements specified herein shall be performed by the Contractor. Sources where bituminous materials are obtained shall be selected in advance of the time when materials will be required in the work. In addition to initial qualification testing of bituminous materials, samples shall be taken before and during construction when shipments of bituminous materials are received or when necessary to assure some condition of handling or storage has not been detrimental to the bituminous material.

1.8.3 Bituminous Mixtures

Sampling and testing of bituminous mixtures will be performed by the Contractor.

1.9 DELIVERY, STORAGE, AND HANDLING OF MATERIALS

1.9.1 Mineral Aggregates

Mineral aggregates shall be delivered to the site of the bituminous mixing plant and stockpiled in such manner as to preclude fracturing of aggregate particles, segregation, contamination, or intermingling of different materials in the stockpiles or cold-feed hoppers. Mineral filler shall be delivered, stored, and introduced into the mixing plant in a manner to preclude exposure to moisture or other detrimental conditions.

1.9.2 Bituminous Materials

Bituminous materials shall be maintained at appropriate temperature during storage but shall not be heated by application of direct flame to walls of storage tanks or transfer lines. Storage tanks, transfer lines, and weigh buckets shall be thoroughly cleaned before a different type or grade of bitumen is introduced into the system. The asphalt cement shall be heated sufficiently to allow satisfactory pumping of the material; however, the storage temperature shall be maintained below 300 degrees F.

1.10 ACCESS TO PLANT AND EQUIPMENT

The Contracting Officer shall have access at all times to all parts of the paving plant for checking adequacy of the equipment in use; inspecting operation of the plant; verifying weights, proportions, and character of materials; and checking temperatures maintained in preparation of the mixtures.

1.11 WAYBILLS AND DELIVERY TICKETS

Before the final statement is allowed, the Contractor shall file with the Contracting Officer certified waybills and certified delivery tickets for all aggregates and bituminous materials actually used in construction.

PART 2 PRODUCTS

2.1 BITUMINOUS HOT MIX

Shall consist of coarse aggregate, fine aggregate, mineral filler, bituminous material, and approved additives, if required, of the qualities

and in the proportions specified and shall conform to the requirements contained in paragraph: PROPORTIONING OF MIXTURE.

2.1.1 Aggregates

Aggregates shall consist of stone, crushed stone, gravel, screening, sand, and mineral filler, as required. The portion of materials retained on the No. 4 sieve shall be known as coarse aggregate, the portion passing the No. 4 sieve and retained on the No. 200 sieve as fine aggregate, and the portion passing the No. 200 sieve as mineral filler. Aggregate gradation as determined by ASTM C 117 and ASTM C 136 shall conform to the following:

Sieve Opening	Percent by Weight Passing
3/4"	100
1/2"	95-100
3/8"	72-88
No. 4	46-60
No. 8	28-42
No. 30	15-27
No. 50	10-20
No. 200	2-7

2.1.1.1 Coarse Aggregate

Coarse aggregate shall consist of clean, sound, durable particles meeting the following requirements.

a. The portion of the material larger than the 3/8-inch screen shall contain at least 50 percent of particles having 3 or more fractured faces. Not over 5 percent of shall be pieces that show no faces resulting from crushing.

b. Percentage of loss shall not exceed 15 after 100 revolutions and 52 after 500 revolutions, as determined in accordance with ASTM C 131.

c. Percentage of loss shall not exceed 18 after five cycles performed in accordance with ASTM C 88, using magnesium sulfate.

2.1.1.2 Fine Aggregate

Fine aggregate shall consist of clean, sound, durable particles including natural sand or crushed stone, or gravel that meets requirements for wear and soundness specified for coarse aggregate. Fine aggregate produced by crushing gravel shall have at least 90 percent by weight of crushed particles having two or more fractured faces in the portion retained on the No. 30 sieve. Natural sand shall be clean and free from clay and organic matter. Percentage of loss shall not exceed 18 percent after five cycles of the soundness test performed in accordance with ASTM C 88, using magnesium sulfate.

2.1.1.3 Mineral Filler

Mineral filler shall consist of portland cement conforming to ASTM C 150 or shall be mechanically reduced rock with the following gradation.

Grain size in mm	Percent Finer
0.075	75-100
0.05	65-100
0.02	35-65
0.01	26-35
0.005	10-22

Grain size shall be determined in accordance with ASTM D 422.

2.1.2 Bituminous Material

Asphalt cement shall conform to ASTM D 3381, Table 3, Grade AR-4000 or AR-8000.

2.1.2 Additives

The use of additives such as antistripping and antifoaming agents is subject to approval.

2.2 PROPORTIONING OF MIXTURE

2.2.1 Job Mix Formula

The JMF for the bituminous mixture will be prepared by the Contractor and approved by the Contracting Officer. The formula will indicate the percentage of each stockpile and mineral filler, the percentage of each size aggregate, the percentage of bitumen, and the temperature of the completed mixture when discharged from the mixer. Tolerances are given in TABLE I for asphalt content, temperature, and aggregate grading for tests conducted on the mix as discharged from the mixing plant. Bituminous mix that deviates more than 25 degrees F from the JMF shall be rejected. The JMF may be adjusted during construction to improve paving mixtures. Adjustments to the JMF are subject to the approval of the Contracting Officer.

TABLE I. JOB-MIX TOLERANCES

Material	Tolerance, Plus or Minus
Aggregate passing No. 4 sieve or larger	5 percent
Aggregate passing Nos. 8,16, 30, and 50 sieves	4 percent
Aggregate passing Nos. 100 and 200 sieves	2 percent
Bitumen	0.25 percent
Temperature of mixing	25 degrees F

2.2.2 Test Properties of Bituminous Mixtures

Finished mixture shall meet requirements described below when tested in accordance with ASTM D 1559. All samples will be compacted with 50 blows of specified hammer on each side of sample. When bituminous mixture fails to meet the requirements specified below, the paving operation shall be stopped until the cause of noncompliance is determined and corrected.

2.2.2.1 Stability, Flow, and Voids

Requirements for stability, flow, and voids are shown in TABLES II and III for non-absorptive and absorptive aggregates, respectively.

TABLE II. NON-ABSORPTIVE-AGGREGATE MIXTURE

	Wearing Course	Intermediate Course
Stability minimum, pounds	1000	1000
Flow maximum, 1/100-inch units	20	20
Voids total mix, percent (1)	3-5	4-6
Voids filled with bitumen, percent (2)	75-85	65-75

TABLE III. ABSORPTIVE-AGGREGATE MIXTURE

	Wearing Course	Intermediate Course
Stability minimum, pounds	1000	1000
Flow maximum, 1/100-inch units	20	20
Voids total mix, percent (1)	2-4	3-5
Voids filled with bitumen, percent (2)	80-90	70-80

(1) The Contracting Officer may permit deviations from limits specified when gyratory method of design is used to develop the JMF.

(2) The Contracting Officer may permit deviation from limits specified for voids filled with bitumen in the intermediate course in order to stay within limits for percent voids total mix.

a. When the water-absorption value of the entire blend of aggregate does not exceed 2.5 percent as determined in accordance with ASTM C 127 and ASTM C 128, the aggregate is designated as non-absorptive. The theoretical specific gravity computed from the apparent specific gravity or ASTM D 2041 will be used in computing voids total mix and voids filled with bitumen, and the mixture shall meet requirements in TABLE II.

b. When the water-absorption value of the entire blend of aggregate exceeds 2.5 percent as determined in accordance with ASTM C 127 and ASTM C 128, the aggregate is designated as absorptive. The theoretical specific gravity computed from the bulk-impregnated specific gravity method contained in ASTM D 2041 shall be used in computing percentages of voids total mix and voids filled with bitumen; the mixture shall meet requirements in TABLE III.

2.2.2.2 Stability

The index of retained stability must be greater than 75 percent as determined by ASTM D 1559. When the index of retained stability is less than 75, the aggregate stripping tendencies may be countered by the use of hydrated lime or by treating the bitumen with an approved antistripping agent. The hydrated lime is considered as mineral filler and should be considered in the gradation requirements. The amount of hydrated lime or antistripping agent added to bitumen shall be sufficient, as approved, to produce an index of retained stability of not less than 75 percent. No additional payment will be made to the Contractor for addition of antistripping agent required.

2.3 BITUMINOUS TACK COAT

Bituminous material used for the Tack Coat shall be an asphalt emulsion conforming to the requirements of ASTM D 977, Type SS-1h.

PART 3 EXECUTION

3.1 BASE COURSE CONDITIONING

The surface of the base course will be inspected for adequate compaction and surface tolerances specified in paragraph: GRADE AND SURFACE-SMOOTHNESS REQUIREMENTS. Unsatisfactory areas shall be corrected.

3.2 PREPARATION OF BITUMINOUS MIXTURES

Rates of feed of aggregates shall be regulated so that the moisture content and temperature of aggregates will be within specified tolerances. Aggregates, mineral filler, and bitumen shall be conveyed into the mixer in proportionate quantities required to meet the JMF. Mixing time shall be as required to obtain a uniform coating of the aggregate with the bituminous material. Temperature of bitumen at time of mixing shall not exceed 300 degrees F. Temperature of aggregate and mineral filler in the mixer shall not exceed 325 degrees F when bitumen is added. Overheated and carbonized mixtures or mixtures that foam shall not be used.

3.3 WATER CONTENT OF AGGREGATES

Drying operations shall reduce the water content of mixture to less than 0.75 percent. The water content test will be conducted in accordance with ASTM D 2216; the weight of the sample shall be at least 500 grams. If the water content is determined on hot bin samples, the water content will be a weighted average based on composition of blend.

3.4 STORAGE OF BITUMINOUS PAVING MIXTURE

Storage shall conform to the applicable requirements of ASTM D 3515; however, in no case shall the mixture be stored for more than 4 hours.

3.5 TRANSPORTATION OF BITUMINOUS MIXTURE

Transportation from paving plant to site shall be in trucks having tight, clean, smooth beds lightly coated with an approved releasing agent to prevent adhesion of the mixture to the truck bodies. Excessive releasing agent shall be drained prior to loading. Each load shall be covered with canvas or other approved material of ample size to protect mixture from weather and to prevent loss of heat. Loads that have crusts of cold, unworkable material or that have become wet will be rejected. Hauling over freshly placed material will not be permitted.

3.6 SURFACE PREPARATION OF UNDERLYING COURSE

Prior to placing of asphaltic pavement, the underlying course shall be cleaned of all foreign or objectionable matter with power brooms and hand brooms.

3.7 TACK COATING

3.7.1 General

Contact surfaces of previously constructed pavement, curbs, manholes, and other structures shall be sprayed with a thin coat of bituminous material conforming to paragraph: BITUMINOUS TACK COAT.

3.7.2 Equipment

All equipment, tools, and machines used in performance of work required by this section shall be subject to approval and shall be maintained in satisfactory working condition.

3.7.3 Preparation of Surface

Immediately before applying the bituminous coat, all loose material, dirt, clay, or other objectionable material shall be removed from the surface to be treated. The surface shall be dry and clean at the time of treatment. After the cleaning operation, and prior to application of the tack coat, an inspection of the area to be treated will be made by the Contracting Officer to determine fitness of the area to receive the bituminous coating.

3.7.4 Application Rate

The exact quantities within the range specified, which may be varied to suit field conditions, will be determined by the Contractor, based on trials completed by the Contractor. Bituminous material for the tack coat shall be applied in quantities of not less than 0.05 gallon nor more than 0.15 gallon per square yard of pavement surface.

3.7.5 APPLICATION TEMPERATURE

3.7.5.1 Viscosity Relationship

Asphalt application temperature shall provide an application viscosity between 10 and 60 seconds, Saybolt Furol, or between 20 and 120 centistokes, kinematic. The temperature viscosity relation shall be furnished to the Contracting Officer.

3.7.5.2 Temperature Ranges

The viscosity requirements shall determine the application temperature to be used. The normal range of application temperatures, for SS-1h materials is 70-160 degrees F.

3.8 PLACING

Bituminous courses shall be constructed only when the base course or existing pavement has no free water on the surface. Bituminous mixtures shall not be placed without ample time to complete spreading and rolling during daylight hours, unless approved satisfactory artificial lighting is provided.

3.8.1 Offsetting Joints

The wearing course shall be placed so that transverse joints in the wearing course shall be offset by at least 1-foot from transverse joints in the intermediate or underlying courses.

3.8.2 General Requirements for Use of Mechanical Spreader

Range of temperatures of mixtures, when dumped into the mechanical

spreader, shall be as determined by the Contracting Officer. Mixtures having temperatures less than 225 degrees F when dumped into the mechanical spreader shall not be used. The mechanical spreader shall be adjusted and the speed regulated so that the surface of the course being laid will be smooth and continuous without tears and pulls, and of such depth that, when compacted, the surface will conform to the cross section indicated. Placing with respect to high side with one-way slope shall be as directed. Placing of the mixture shall be as nearly continuous as possible, and speed of placing shall be adjusted, as directed, to permit proper rolling. When segregation occurs in the mixture during placing, the spreading operation shall be suspended until the cause is determined and corrected.

3.8.3 Placing Strips Succeeding Initial Strips

In placing each succeeding strip after initial strip has been spread and compacted as specified below, the screed of the mechanical spreader shall overlap the previously placed strip 2 to 3-inches and be sufficiently high so that compaction produces a smooth dense joint. Mixture placed on the edge of a previously placed strip by the mechanical spreader shall be pushed back to the edge of the strip by use of a lute. Excess mixture shall be removed and wasted.

3.8.4 Handspreading in Lieu of Machine Spreading

In areas where the use of machine spreading is impractical, the mixture shall be spread by hand. Spreading shall be in a manner to prevent segregation. The mixture shall be spread uniformly with hot rakes in a loose layer of thickness that, when compacted, will conform to required grade, density, and thickness.

3.9 COMPACTION OF MIXTURE

3.9.1 General

Rolling shall begin as soon after placing as the mixture will bear a roller without undue displacement. Delays in rolling freshly spread mixture will not be permitted. After initial rolling, preliminary tests of grade and smoothness shall be made by the Contractor. Deficiencies shall be corrected so that the finished course will conform to requirements for grade and smoothness specified herein. Grade and smoothness will be checked in each section of completed pavement by the Contractor for compliance. Rolling of the courses shall be continued until all roller marks are eliminated and at least 95 percent of the density of a laboratory specimen of the same mixture has been obtained. Places inaccessible to rollers shall be thoroughly compacted with hot hand tampers.

3.9.2 Correcting Deficient Areas

Mixtures that become contaminated or are defective shall be removed to the full thickness of the course. Edges of the area to be removed shall be cut so that sides are perpendicular and parallel to the direction of traffic and so that the edges are vertical. Edges shall be sprayed with bituminous materials conforming to paragraph: Tack Coating. Fresh paving mixture shall be placed in the excavated areas in sufficient quantity so that the finished surface will conform to grade and smoothness requirements. Paving mixture shall be compacted to the density specified herein. Skin patching of an area that has been rolled shall not be permitted.

3.10 JOINTS

3.10.1 General

Joints between old and new pavements, between successive work days, or joints that have become cold (less than 175 degrees F) shall be made to insure continuous bond between the old and new sections of the course. All joints shall have the same texture and smoothness as other sections of the course. Contact surfaces of previously constructed pavements coated by dust, sand, or other objectionable material shall be cleaned by brushing or shall be cut back as directed. When directed by the Contracting Officer, the surface against which new material is placed shall be sprayed with a thin, uniform coat of bituminous material conforming to paragraph: Tack Coating. Material shall be applied far enough in advance of placement of a fresh mixture to insure adequate curing. Care shall be taken to prevent damage or contamination of the sprayed surface.

3.10.2 Transverse Joints

The roller shall pass over the unprotected end of a strip of freshly placed material only when placing is discontinued or delivery of the mixture is interrupted to the extent that the material in place may become cold. In all cases, prior to continuing placement, the edge of previously placed pavement shall be cut back to expose an even vertical surface for full thickness of the course. In continuing placement of a strip, the mechanical spreader shall be positioned on the transverse joint so that sufficient hot mixture will be spread to obtain a joint after rolling that conforms to the required density and smoothness specified herein.

3.11 QUALITY CONTROL

3.11.1 General

Quality Control Testing shall be the responsibility of the Contractor. Testing shall be performed by an acceptable commercial testing laboratory or by the Contractor on approval of the Contracting Officer. Materials shall be tested to establish compliance with the specified requirements. Samples of Bituminous material, unless otherwise specified, shall be in accordance with ASTM D 140. Certificates of compliance shall be furnished. All core holes from which specimens are taken will be patched by the contractor with fresh bituminous mixture, conforming to the specified JMF.

3.11.2 Inspection Details and Frequency of Testing

In addition to other tests specified elsewhere, the Contractor shall perform the following tests on materials as specified hereinafter. At least one set of tests, as described below, shall be completed for each days placement of asphalt.

3.11.2.1 Aggregate Gradation

A test for aggregate gradation for each 500 tons of aggregate produced.

3.11.2.2 Aggregate Moisture Content

A test of aggregate moisture content for each day's production.

3.11.2.3 Asphalt Properties

One determination each for stability, flow, voids total mix, and voids

filled with bitumen for every 1000 tons of asphaltic concrete produced.

3.11.2.4 Asphalt Content

One determination of actual asphalt content per 1000 tons of asphaltic concrete produced.

3.11.2.5 Temperature

At least one measurement of asphaltic concrete temperature each hour, in which paving operations are being conducted. Additional tests may be taken as required by the Contracting Officer.

3.11.2.6 Density

At least three cores will be recovered and tested for every 1000 square yards of pavement, or one day's production, whichever is smaller. Additional tests may be taken as required by the Contracting Officer.

3.11.2.7 Thickness

At least three cores will be recovered and tested for every 1000 square meters of pavement, or one day's production, whichever is smaller. Additional tests may be taken as required by the Contracting Officer.

3.11.3 Action Required

3.11.3.1 Aggregate Gradation

When the amount passing any sieve is outside the specification limits, the aggregate shall be immediately resampled and retested. If there is another failure on any sieve, the fact shall immediately be reported to the Contracting Officer, and immediate steps shall be taken to rectify the situation.

3.11.3.2 Aggregate Moisture Content

When the moisture content of the aggregates is outside specification requirements the aggregates shall be immediately resampled and retested. If there is another failure, the fact shall immediately be reported to the Contracting Officer, and immediate steps shall be taken to rectify the situation.

3.11.3.3 Asphalt Properties

If there is a failure in any of the asphalt properties production will cease and the Contracting Officer will be immediately notified. No additional paving will occur until adjustments to the plant and test results confirm that the specified properties are being achieved.

3.11.3.4 Asphalt Content

If there is a failure to meet the specified asphalt content production will cease and the Contracting Officer will be immediately notified. No additional paving will occur until adjustments to the plant and test results confirm that the specified asphalt is being supplied.

3.11.3.5 Temperature

When the temperature of the bituminous mixture is outside specification requirements the mixture shall be immediately resampled and retested. If there is another failure, the fact shall immediately be reported to the Contracting Officer, and immediate steps shall be taken to rectify the situation. In no case will overheated or carbonized mixtures be allowed.

3.11.3.6 Density

When test results indicate lack of compaction additional specimens will be obtained as directed by the Contracting Officer. Based on the test results the Contractor will remove and replace the affected areas of pavement.

3.11.3.7 Thickness

When test results indicate that the finished pavement is 1/4-inch less than the thickness shown on the drawings, additional samples will be taken to determine the extent of defective thickness. The area determined will be removed and replaced or may be overlaid. The overlay will be a minimum of 1- inch thick and will be placed to duplicate slopes and drainages of the original pavement. No skin patching will be allowed.

3.11.4 Reports

All results of tests conducted at the project site shall be reported as required. During periods requiring protection from weather, reports of pertinent temperatures or other relevant values shall be made daily. These requirements do not relieve the contractor of the obligation to report certain failures immediately as required in preceding paragraphs. Such reports of failures and the action taken shall be confirmed in writing in the routine reports. The Contracting Officer has the right to examine all Contractor Quality Control records.

-- End of Section --

SECTION TABLE OF CONTENTS

DIVISION 02 - SITE WORK

SECTION 02600

STONE PROTECTION

-- End of Section Table of Contents --

SECTION 02600

STONE PROTECTION

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM C 33	(1997) Concrete Aggregates
ASTM C 88	(1990) Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulfate
ASTM C 127	(1988; R 1993) Specific Gravity and Absorption of Coarse Aggregate
ASTM C 131	(1996) Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine
ASTM C 136	(1996a) Sieve Analysis of Fine and Coarse Aggregates
ASTM C 295	(1990) Petrographic Examination of Aggregates for Concrete
ASTM C 535	(1989) Resistance to Degradation of Large-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine
ASTM D 1141	(1975; R 1980) Substitute Ocean Water
ASTM D 5519	(1994) Particle Size Analysis of Natural and Man-Made Riprap Materials
ASTM E 548	(1994) General Criteria Used for Evaluating Laboratory Competence

1.2 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-03 Product Data

Stone Sources

Name and location of quarry.

SD-05 Design Data

Method of placement; G

The following shall be submitted in accordance with Section 01330 if the source of riprap is not from the listed sources.

SD-06 Test Reports

Stone Quality Testing
Gradation Sampling and Testing

Quality compliance and gradation test results performed in accordance with 2.1.4 and 2.1.5.

SD-07 Certificates

Waybills and Delivery Tickets

Copies of waybills and delivery tickets shall be submitted as stated in paragraph: Waybills and Delivery Tickets.

PART 2 PRODUCTS

2.1 MATERIALS

2.1.1 Definitions

2.1.1.1 Rounded Stone

Stone which is obtained from alluvial deposits and is nearly spherical and well rounded.

2.1.1.2 Angular Stone

Stone which is obtained from bedrock deposits and is angular in shape.

2.1.2 General

The Contractor shall make all arrangements, pay all royalties, and secure all permits for the procurement, furnishing, and transporting of stone. The Contractor shall vary the quarrying, processing, loading, and placing operations, to produce the sizes and quality of stone specified. If the stone being furnished by the Contractor does not fully meet all the requirements of these specifications , the Contractor shall furnish, at no additional cost to the Government, other stone meeting the requirements of these specifications.

2.1.3 Stone Sources

2.1.3.1 Stone from Project Excavation

Stone conforming to these specifications will not be available from the required excavation(s). Except for salvaged stone, the required stone will

need to be obtained from offsite sources.

2.1.3.2 Salvaged Stone

The downstream gravel blanket and the existing upstream stone protection affected by the new construction shall be removed and salvaged as indicated on the plans. The existing stone protection will not meet the gradation specified for stone protection but does satisfy the requirements for grouted stone.

2.1.3.3 Source Authorization

Before any stone is produced from a source for completion of the work under this contract, the source of stone must be authorized by the Contracting Officer's Representative. Authorization of a stone source shall not be construed as a waiver of the right of the Government to require the Contractor to furnish stone which complies with these specifications. Materials produced from localized areas, intervals, or strata will be rejected, when such materials do not comply with the specifications.

2.1.3.4 Source Development

Before a proposed source or sources of stone will be considered for sampling and testing, the Contractor must demonstrate that the source has sufficient stone to fulfill the contract requirements. If sufficient amounts of stone conforming to these specifications are not available from a source or sources used in the work, the Contractor shall submit stone from another source for authorization.

2.1.3.5 Source Documentation

Authorization of a proposed stone source will be based on test results and/or service records. In general, current Corps of Engineers test results shall be required, as outlined in paragraph: Quality Compliance Testing, below. In special cases, however, the Contracting Officer's Representative may elect to use either past Corps of Engineers test results, test results from other agencies or private laboratories, or service records. A service record is considered to be acceptable if stone from the proposed source has remained sound and functional after at least 10 years of exposure on a project similar to the one to be constructed under these specifications.

2.1.3.6 Listed Stone Sources

The following are a few of the sources within the project area (and some that are farther away), which have either undergone recent quality compliance testing for use on Corps of Engineers projects or have acceptable service records:

Source Name	Nearest City
Harlow	Corona
Corona-Pacific	Corona
All-American Asphalt	Corona
3M	Corona
Eagle Valley	Corona
Pebbly Beach	Catalina
Pyrite Street	Riverside
Ormond (Atkinson)	Riverside

Source Name	Nearest City
Slover Mountain	Colton
Fish Canyon	Azusa
Gillibrand	Newhall

Listing of a stone source is not to be construed as to current or future availability of the source, authorization of all materials from the source, nor as a waiver of inspection and testing of the source. Stone produced from any listed source must meet all the requirements set forth in these specifications. Listing of a stone source is also not to be construed as an indication that the source can produce the total quantity of stone required for the project. Stone may be furnished from other sources designated by the Contractor and authorized by the Contracting Officer's Representative,
subject to the conditions stated herein.

2.1.4 Stone Quality

2.1.4.1 Quality Compliance Testing

If the Contractor proposes to furnish stone from an unlisted source, or a listed source which has not been tested in 5 years, the Contractor shall have evaluation tests performed on stone samples collected from the proposed source. The quarry investigation shall be performed by the Contracting Officer's Representative, a representative of the Contractor, a representative of the Quarry and an engineering geologist from the Geotechnical Branch of the Los Angeles District. The samples shall be submitted a minimum of 30 days in advance of the time when the stone will be required in the work. No work requiring testing shall be permitted until the laboratory has been inspected and approved. Samples of stone from a proposed source shall be taken at the quarry by the Contracting Officer's Representative, the Superintendent of the quarry, the Contractor and an engineering geologist from the Geotechnical Branch of the Los Angeles District. The samples shall consist of at least 300 pounds of stone. The quarry faces and the stockpiles to be used shall be examined and sampled. The Contractor will then ship the samples at the Contractor's expense to the approved Laboratory. The tests to which the stone shall be subjected and the required results are discussed below. All expenses of the testing shall be paid for by the Contractor. The laboratory to perform the required testing shall be approved based on compliance with ASTM E 548 and relevant paragraphs of ASTM D 3740. The laboratory will be under the direct supervision of a state licensed Civil Engineer, Geologist or Engineering Geologist. The results of the tests shall be delivered to the Contracting Officer's Representative as soon as they are received from the laboratory.

2.1.4.2 Stone Quality Testing Requirements

Stone shall be subjected to such tests as are necessary to demonstrate to the satisfaction of the Contracting Officer's Representative that the materials are acceptable for use in the work. At a minimum, the stone shall meet the following test requirements:

Test	Test Method	Requirement
Specific Gravity (Bulk SSD)	ASTM C 127	2.60 minimum
Absorption	ASTM C 127	2.0% maximum
Wetting and Drying	SPD Test Procedure(1)	No fracturing(3)
Sulfate Soundness	ASTM C 88(2)	10% max.loss(4)
Abrasion Loss	ASTM C 535	40% max. loss(4)

In addition to the above tests, the stone shall be subjected to a petrographic and X-ray diffraction analysis, in accordance with ASTM C 295(5). The stone must not contain any expansive clays. Stone for grouted stone protection shall not contain excessive amounts of deleterious minerals, associated with alkali-silica or alkali-carbonate reactions, as described in ASTM C 33.

NOTE: (1): Test procedure for wetting and drying test. The entire sample is carefully examined, and representative test specimens are selected. The sample should be large enough to produce two cut slabs, each 25 millimeters (1 inch) thick (+/-6 millimeters), with a minimum surface area of 0.019 square meters (28.8 square inches) on one side. Two chunks, approximately seventy-six by one-hundred two millimeters (3 by 4 inches), are also chosen. The slabs and chunks are carefully examined under a low-power microscope, and all visible surface features are noted and recorded. The specimens are then oven-dried at 60 degrees C., for eight hours, cooled, and weighed to the nearest tenth of a gram. The test specimens are photographed, to show all surface features, before the test. The chunks and slabs are then subjected to fifteen cycles of wetting and drying. One slab and one chunk are soaked in fresh tap water, the other slab and chunk are soaked in salt water, prepared in accordance with ASTM D 1141. Each cycle consists of soaking for sixteen hours, at room temperature and then drying in an oven for eight hours, at 60 degrees C. After each cycle, the specimens are examined with the low-power microscope, to check for opening or movement of fractures, flaking along edges, swelling of clays, softening of rock surfaces, heaving of micaceous minerals, breakdown of matrix material, and any other evidence of weakness developing in the rock. The cycle in which any of these actions occurs is recorded. After fifteen cycles, the slabs and chunks are again carefully examined, and all changes in the rocks are noted and recorded. The test specimens, together with all particles broken-off during the test, are oven-dried, weighed, and photographed.

NOTE: (2): The test shall be made on 50 particles, each weighing 100 grams (0.22 lbs.), +/-25 grams, in lieu of the gradation given in ASTM C 88.

NOTE: (3): Weakening and loss of individual surface particles is permissible, unless bonding of the surface grains softens and causes general disintegration of the surface material.

NOTE: (4): Stone which has a loss greater than the specified limit will be accepted, if the Contractor demonstrates that the stone has a satisfactory service record.

NOTE: (5): The test procedure for Petrographic and X-ray Diffraction is performed according to ASTM C 295, except for the following:

(a) A color, microscopic photograph shall be made of each stone type, and the individual minerals within the stone shall be identified by labels and arrows, upon the photograph.

(b) A very detailed macroscopic and microscopic description shall be made of the stone, to include all the mineral constituents, individual sizes, their approximate percentages, and mineralogical histories. A description of stone hardness, texture, weathering, and durability factors shall also be discussed.

(c) A written summary of the suitability of stone for use as riprap,

based on the Petrographic and X-ray tests and the results of ASTM C 535, shall be presented in the final laboratory report on stone quality.

2.1.4.3 Stone Acceptance Criteria

Prior to placement, all stone shall be subject to acceptance, by the Contracting Officer's Representative. Acceptance of any stone shall not constitute acceptance of all stone from a source. All accepted stone shall be as follows:

a. of the same lithology as the original stone from which test results or service records were taken, as a basis for authorization of the source;

b. sound, durable, hard, and free of laminations, weak cleavages, undesirable weathering, or blasting or handling-induced fractures (or fracture zones, which subtend more than 1/3 of the total circumference
of the stone, along the plane of fracturing);

c. of such character that the stone will not disintegrate from the action of air, water, or the conditions of handling and placing; and,

d. clean and free from earth, clay, refuse, or adherent coatings.

e. Ungrouted Stone: Ungrouted stone shall be angular quarried material, with a shape which assures interlocking with adjacent stone, and with the greatest dimension of each piece not greater than 3 times the least dimension.

f. Stone for Grouted Stone: Stone for grouted stone protection may be either rounded stone or angular quarried material, with a shape which assures reasonable adhesion with cement grout, yet allows flow of grout throughout the layer, to ensure adequate bonding. The greatest dimension of each piece shall be not greater than 3 times the least dimension.

g. Bedding Material or Filter Stone: Bedding material or filter stone obtained from an authorized source shall meet all the requirements specified herein, but shall have a percentage of wear not to exceed 45 percent, when tested in accordance with ASTM C 131.

2.1.5 Gradation

2.1.5.1 General

All points on individual grading curves shall be between the boundary limits, as defined by smooth curves, drawn through specified grading limits and plotted on a mechanical analysis diagram. The individual grading curves shall not exhibit abrupt changes in slope, denoting skip-grading or scalping of certain sizes. Specified grading of all material shall be met both at the source and as-delivered to the project. In addition, material not meeting the required grading, because of segregation or degradation during placement, shall be rejected. If test results show that stone does not meet the required grading, the hauling operation will be stopped immediately and will not resume, until processing procedures are adjusted, and a gradation test is completed, showing that gradation requirements are

met. All gradation tests shall be at the expense of the Contractor.

a. Rip-rap: Riprap shall be quarried, angular stone, reasonably well-graded, within the limits specified below, when tested in accordance with ASTM D 5519, Test Method A. In addition to riprap, this gradation will be used for 24-inch grouted stone.

Weight of Individual Pieces (pounds)	Percent Smaller (by weight)
1000	100
500	50-100
250	30-50
50	0-15
20	0-5

b. Stone for Grouted Stone: Stone for grouted stone shall be reasonably well-graded and within the limits specified above for 24-inch grouted stone and within the limits specified below for 15-inch grouted stone, when tested in accordance with ASTM D 5519, Test Method A. Salvaged stone shall be acceptable for grouted stone provided that not more than 5 percent is less than 5 pounds by weight.

Weight of Individual Pieces (pounds)	Percent Smaller (by weight)
200	100
100	75-100
50	40-75
20	10-40
5	0-5

b. Bedding Material and Downstream Gravel Blanket: Bedding material and the downstream gravel blanket shall be well-graded, between the limits specified below, when tested in accordance with ASTM C 136.

Sieve Size	Percent Finer (by weight)
4 inch	100
3 inch	90-100
1-1/2 inch	70-90
3/4 inch	45-70
3/8 inch	20-45
No. 4	0-15

2.1.5.2 Gradation Sampling and Testing

Testing shall be the responsibility of the Contractor and shall be performed at no additional cost to the Government. Tests shall be performed by an approved testing laboratory, on samples selected by the Contracting Officer's Representative. Testing may be done by the Contractor, subject to approval by the Contracting Officer's Representative. If the Contractor elects to establish testing facilities,

approval of such facilities shall be based on compliance with ASTM E 548, and no work requiring testing will be permitted, until the Contractor's facilities have been inspected and approved by the Contracting Officer's Representative. Testing shall be supervised by a registered Civil Engineer, experienced in rock-testing. The Government reserves the right to perform check-tests and to use the Contractor's sampling and testing facilities to make the tests. One gradation test shall be required at the beginning of production, prior to delivery of stone from the source to the project site. A minimum of one additional test shall be required for each 5000 tons of stone placed. Each sample shall consist of not less than 5 tons of stone, selected at random from the production run for the first test or from stone placed on grade or stockpiled on-site for required additional tests. All sampling and gradation tests performed by the Contractor shall be observed by the Contracting Officer's Representative.

2.1.6 Rejected Stone

Stone of unsuitable quality and/or size distribution, as required by these specifications, shall be rejected. Any rejected stone shall be promptly removed from the project, at no expense to the Government. Any portions of the work covered by these specifications containing rejected stone will be considered incomplete.

PART 3 EXECUTION

3.1 FOUNDATION PREPARATION

3.1.1 General

Subgrade preparation for material placement shall conform to the provisions of SECTION 02212 EMBANKMENT, and SECTION 02250 FILLS AND SUBGRADE PREPARATION. Areas on which bedding material or stone is to be placed shall be trimmed and dressed to conform to cross-sections, indicated or directed, within an allowable tolerance of plus or minus 1 inch from the theoretical slope-lines and grades. Where such areas are below the allowable minus tolerance limit, they shall be brought to grade by filling with earth, similar to the adjacent material and well-compacted, or by filling with approved material, and no additional payment will be made for any material thus required. Immediately prior to placing the bedding material, the prepared base shall be inspected by the Contracting Officer's Representative, and no material shall be placed thereon, until that area has been approved.

3.2 PLACEMENT

3.2.1 General

Except as otherwise specified, the limits of stone in place shall follow, with reasonable variation, the indicated lines and slopes, without continuous under- or overbuilding. Templates shall be placed at adequate intervals, as determined by the Contracting Officer's Representative, to accurately delineate the surface of the work being placed. For all stonework, the Contractor shall submit the method of placement to the Contracting Officer's Representative for approval, before placement begins.

3.2.2 Bedding Material and Downstream Gravel Blanket

Bedding material and the downstream gravel blanket shall be spread uniformly on the prepared base, in a satisfactory manner, to the neat lines

indicated or directed. Placing of material by methods which will tend to segregate particle sizes will not be permitted. Material shall not be dropped from a height of more than 18 inches. Any damage to the prepared surface of the base, during placing of the bedding material shall be repaired, before proceeding with the work. Compaction of the bedding material will not be required, but it shall be finished, to present a reasonably even surface, free from mounds or windrows. A tolerance of plus or minus 1 inch from the slope-lines and grades, when measured with a 10-foot straight edge, will be allowed in each finished course, except that either extreme of such tolerance shall not be continuous over an area greater than 200 square feet.

3.2.3 Riprap

Riprap shall be placed in a manner to produce a reasonably well-graded mass, with the minimum practicable percentage of voids, and shall be constructed to the lines and grades indicated or directed. Stone shall be placed to its full course thickness, in one operation, from the bottom of the slope or lowest portion requiring placement, to the top of the slope and in a manner to avoid displacing the underlying material. Material shall not be dropped from a height of more than 18 inches. Method of placement shall be submitted to the Contracting Officer's Representative, for approval, prior to commencement of placement operations. The Contractor shall maintain the stone protection until accepted, and any material displaced by any cause, shall be replaced, at his expense, to the lines and grades shown on the drawings. Self-propelled equipment shall not be used on the embankment slopes. Hand-placing, barring, or placing by crane will be required only to the extent necessary, to secure the results specified. Placing stone by dumping into chutes or by similar methods, likely to cause segregation, will not permitted. A tolerance of minus 2 to plus 2 inches from the indicated slope-lines and grades will be allowed in the finished surface, except that either extreme of such tolerance shall not be continuous over an area greater than 200 square feet.

3.2.4 Stone for Grouted Stone

Stone for grouted stone shall be placed in such a manner to produce a reasonably well-graded mass and to insure that all individual stones can be satisfactorily embedded in grout. Method of placement shall be submitted to Contracting Officer's Representative, for approval, prior to commencement of placement operations. Stone shall be placed to its full course thickness, in one operation, and in such a manner to avoid displacing the underlying material. Material shall not be dropped from a height of more than 18 inches. The Contractor shall maintain the stone protection until accepted, and any material displaced by any cause shall be replaced at his expense, to the lines and grades indicated. Self-propelled equipment shall not be used on the slopes. Hand-placing, barring, or placing by crane will be required only to the extent necessary, to secure the results specified. Placing stone by dumping into chutes or by similar methods, likely to cause segregation will not be permitted. A tolerance of minus 2 to plus 2 inches, from the indicated slope-lines and grades will be allowed in the finished surface, except that either extreme of such tolerance shall not be continuous over an area greater than 200 square feet. Use of thin, flat stones will not be permitted.

3.3 DEMONSTRATION SECTION

3.3.1 General

Prior to placement of riprap, the Contractor shall construct a section, to demonstrate his proposed operations for production placement. The section shall demonstrate procedure and capability of grading and placing stone protection within the tolerances specified. The demonstration section shall be 100 feet in length, placed in the area of stone protection at the downstream toe, and shall conform to all applicable specifications.

3.3.1.1 Methods and Equipment

Methods and equipment employed for placement shall demonstrate the adequacy for use in placement of rip-rap and shall conform with the requirements specified herein. The quantities of all materials placed within the section shall be accurately tabulated and provided immediately to the Contracting Officer's Representative, for comparison with the computed quantities.

3.3.2 Demonstration Section Evaluation

The Contractor shall not proceed in placing stonework, prior to the approval of the demonstration section. Within a period of 7 days after completion of the section, the Contracting Officer's Representative shall determine the adequacy of the section to function as part of the permanent construction. The Contractor shall be notified as to the acceptability of the section and may be directed to modify methods of construction, and remove the section, if necessary.

3.3.3 Removal of Demonstration Section

If removal of the demonstration section is required, it shall be conducted in such a manner as to maintain the integrity of the underlying subgrade. The Contractor shall make his own arrangements for disposal in areas not located on the site.

3.4 DELIVERY

All stone delivered by rail or truck shall be weighed, and the scale tickets shall be certified, by authorized weighers. All railroad cars and trucks used for delivering stone shall be plainly numbered.

3.4.1 Scales

Scales used for measurement shall, at the option of the Contractor, be either public scales or approved scales, provided by the Contractor. Weighing shall be at the point nearest the work at which the public scale is available or at which it is practicable for the Contractor to provide a scale. Scales shall be standard truck scales of the beam type. The scales shall be of sufficient size and capacity to accommodate all trucks used in hauling the material. Scales shall be tested, approved, and sealed by an inspector of the State Inspection Bureau, charged with scales inspection, within the state in which the project is located. Scales shall be calibrated and resealed as often as necessary, to insure continuous accuracy. The necessary number of standard weights for testing the scales shall be on hand at all times, and, if an official inspection bureau of the state is not available, the scales will be tested by the Contracting Officer's Representative.

3.4.2 Waybills and Delivery Tickets

Copies of waybills or delivery tickets shall be submitted to the

Contracting Officer's Representative, during the progress of the work. The Contractor shall furnish the Contracting Officer's Representative scale tickets for each load of material weighed; these tickets shall include tare weight, identification mark of each vehicle weighed, plus date, time, and location of the loading. Tickets shall be furnished at the point and time individual loads arrive at the work site. A master log of all vehicle loading shall be furnished for each day of loading operation. The Contractor shall file with the Contracting Officer's Representative the master log of loadings, certified waybills and/or certified tickets, within 24 hours of material delivery. Prior to the final payment, the Contractor shall furnish written certification that the material recorded on the submitted waybills and/or certified tickets was actually used in the construction covered by the contract. Weigh tickets will not be required for salvage stone. For bidding purposes the in-place weight of the salvaged stone shall be assumed to be 115 pounds per cubic foot.

-- End of Section --

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DIVISION 02 - SITE WORK

SECTION 02650

GROUTING STONE PROTECTION

-- End of Section Table of Contents --

SECTION 02650

GROUTING STONE PROTECTION

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM C 33	(1997) Concrete Aggregates
ASTM C 143	(1997) Slump of Hydraulic Cement Concrete
ASTM C 150	(1997) Portland Cement
ASTM C 309	(1995) Liquid Membrane-Forming Compounds for Curing Concrete
ASTM C 494	(1998) Chemical Admixtures for Concrete

1.2 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-05 Design Data

Grout Mix Design; G

Fifteen days prior to placement of grout, the contractor shall submit to the Contracting Officer the detailed mixture proportions for the specified grout.

SD-06 Test Reports

Aggregates; G

Thirty days prior to placement of grout, the contractor shall submit to the Contracting Officer the reports of aggregate quality tests.

SD-07 Certificates

Portland Cement; G

Certificates of compliance attesting that the concrete materials meet the requirements of the specifications shall be submitted in accordance with the Special Clause, CERTIFICATE OF COMPLIANCE. Cement will be accepted on the basis of a manufacturer's certificate of compliance, accompanied by mill test reports that the material meets the requirements of the specifications under which it is furnished.

Curing Compound; G

Certificates of compliance attesting that the curing materials meet the requirements of the specifications shall be submitted in accordance with the Special Clause, CERTIFICATE OF COMPLIANCE. Curing materials will be accepted on the basis of a manufacturer's certificate of compliance.

Waybills and Delivery Tickets; G.

Waybills and delivery tickets, during progress of the work.

1.3 PROTECTION OF COMPLETED WORK

After completion of any panel, no workman or other load shall be permitted on the grouted surface for a period of 24 hours. The grouted surface shall be protected from injurious action of the sun; shall be protected from rain, flowing water, and mechanical injury and shall be moist cured or membrane cured at the Contractor's option.

1.4 DELIVERY, STORAGE, AND HANDLING OF MATERIALS

1.4.1 Aggregates

Aggregates shall be delivered to the site of the grout batching and mixing plant and stockpiled in such manner as to preclude intermingling of different materials or the inclusion of foreign materials in the stockpiles or batching operations. Sufficient aggregates shall be maintained at the site at all times to permit continuous placement and completion of any lift or section of grout started.

1.4.2 Portland Cement

Cement may be supplied in bulk or in bags. When transported in a bulk form the carriers and systems for distribution of the cement will be accomplished in adequately designed weather-tight trucks, conveyors, or other means that will protect the material from exposure to moisture. All storage facilities shall permit easy access for inspection and identification. Sufficient materials shall be in storage to complete any lift or placement of grout started.

1.5 ACCESS TO PLANT AND EQUIPMENT

The Contracting Officer shall have access at all times to all parts of the placing operation and grout production plant for checking the adequacy of the equipment in use; inspecting operation of the plant; verifying weights, proportions, and character of materials; and installation of the grout and application of curing materials.

1.6 WAYBILLS AND DELIVERY TICKETS

Before the final statement is allowed, the Contractor shall file with the Contracting Officer certified waybills and certified delivery tickets for all cement and grout actually used in the construction.

PART 2 PRODUCTS

2.1 GROUT

2.1.1 Aggregates

Aggregates shall meet the quality requirements of ASTM C 33. Aggregates shall conform to the gradation requirements of ASTM C 33 for Fine Aggregate.

2.1.2 Portland Cement

Portland cement shall conform to the requirements of ASTM C 150, Type II, low alkali.

2.2 CURING COMPOUND

Membrane curing compound shall conform to ASTM C 309 Type 2.

2.3 GROUT MIX DESIGN

The grout shall be composed of cement, sand, and water mixed in the proportions as directed. The estimated cement content requirement per cubic yard of grout shall be 7-1/2 sacks. The water content of the mix shall not exceed 8-1/2 gallons per sack of cement. In calculating total water content of the mix, the amount of moisture carried on the surfaces of aggregate particles shall be included.

PART 3 EXECUTION

3.1 CONDITIONING OF UNDERLYING MATERIALS

Prior to grouting, the stone shall be thoroughly washed with water to wash down the fines and to prevent absorption of water from the grout. The stone shall be kept wet just ahead for the actual placing of grout.

3.2 PREPARATION OF GROUT

The consistency of the grout shall be such as to permit gravity flow into the interstices of the stones with the help of spading, rodding, and brooming. Grout batches in the same course shall be uniform in mix, size, and consistency. Slump of grout mix shall be between 9 and 10 inches for the first course and between 7 and 8 inches for the second course or where one course is placed.

3.3 PLACING

3.3.1 Mixing Time

The grout shall be mixed in a concrete mixer in the manner specified for concrete, except that time of mixing shall be as long as is required to produce a satisfactory mixture, and the grout shall be used in the work within a period of 30 minutes after mixing. Retempering of grout will not be permitted.

3.3.2 Weather Limitations

3.3.2.1 Hot Weather Placing

The temperature of the grout when deposited in the proper location shall not exceed 85 degrees F except as directed by the Contracting Officer.

3.3.2.2 Cold Weather Placing

No grout shall be prepared except when the air temperature is at least 40 degrees F. in the shade and rising. Materials entering the mixer shall be free from ice, snow, and frozen lumps. A non-chloride based accelerating admixture, conforming to the requirements of ASTM C 494, may be used when approved in advance, by the Contracting Officer.

3.3.3 Deposition of Grout

The grout shall be placed in one course on the invert and two courses on slopes. Each course shall be placed fully, starting at the toe of the slope and working upward to top of the slope. In conditions where the stone is not placed on the slope in a continuous operation due to slope length, the grout shall be placed in two operations. The first operation shall begin at the toe and continue to approximately two feet above the placed stone section. The second operation shall continue from the end of the first to the top of the slope. Grout placing at each operation shall be a continuous process. The grout shall be brought to the place of final deposit by approved means and discharged directly on the stone. The use of a concrete shoot in placing grout will not be allowed. A splash plate of metal or wood shall be used where necessary to prevent displacement of stone directly under discharge. The flow of grout shall be directed with brooms or other approved baffles to cover the entire area and to assure that all crevices are filled. Sufficient barring shall be done to loosen tight pockets of stone and otherwise aid the penetration of grout. The first course shall fully penetrate the stone blanket. The second course shall be placed as soon as the first course has sufficiently stiffened so that it will not flow when additional grout is added. On slopes, all brooming shall be uphill.

3.4 FINISHING

Placement and brooming of the grouted surface shall be such that the outer layer of rock projects 1/3 to 1/4 their diameter above the grouted surface except on the access ramps where grout is to be finished flush with the tops of the stones to create a smooth surface suitable for vehicular traffic. After the top course has stiffened the entire surface shall be re-broomed to eliminate runs in the top course and to fill voids caused by sloughing of the layers of grout.

3.5 CURING AND PROTECTION

Curing of the grouted surface shall be accomplished by one of the following methods.

3.5.1 Moist Curing

Moist curing shall consist of covering the grout with a uniform thickness of 2 inches of sand which shall be kept continuously saturated for a period of 14 days.

3.5.2 Curing Compound

Curing compounds shall be applied as soon as the free water disappears and shall be applied in a 2-coat continuous operation by approved power-spraying equipment at a rate not to exceed 200 square feet per gallon for the combined coats. The second coat shall be applied to overlap the first coat in a direction approximately at right angle to the direction of the first application.

3.6 CONTRACTOR QUALITY CONTROL

3.6.1 General

The individuals who sample and test grout as required in this specification shall have demonstrated a knowledge and ability to perform the necessary test procedures equivalent to the ACI minimum guidelines for certification of Concrete Field Testing Technicians, Grade I.

3.6.2 Inspection Details and Frequency of Testing

3.6.2.1 Preparations for Placing

Stone, foundation, forms, and embedded items shall be inspected in sufficient time prior to each grout placement by the Contractor to certify to the Contracting Officer that is ready to receive grout.

3.6.2.2 Slump

Slump shall be checked once during each shift that grout is produced. Samples shall be obtained in accordance with ASTM C 172 and tested in accordance with ASTM C 143.

3.6.2.3 Consolidation and Protection

The Contractor shall ensure that the grout is properly installed, finished, protected, and cured.

3.6.3 Action Required

3.6.3.1 Placing

The placing foreman shall not permit placing to begin until he has verified that there is an adequate number of men with appropriate bars and other such tools are available for the necessary barring and adjustment of stone as required above.

3.6.3.2 Slump

Whenever a test is outside the specification limits, the results of the test shall be reported to the Contracting Officer and another test shall be immediately taken. If the results of the subsequent test indicates that the slump is not being met. The placement will cease and the contractor will readjust the mix design to achieve the proper slump. The adjusted mix will continue to meet the requirements specified above.

3.6.4 Reports

The results of all tests and inspections conducted at the project site shall be reported informally at the end of each shift and in writing weekly and shall be delivered to the Contracting Officer within 3 days after the

end of each weekly reporting period. See Section 01451 CONTRACTOR QUALITY CONTROL.

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DIVISION 02 - SITE WORK

SECTION 02720

STORM-DRAIN SYSTEM AND CULVERTS

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SECTION 02720

STORM-DRAIN SYSTEM AND CULVERTS

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS (AASHTO)

AASHTO M 198	(1994) Joints for Circular Concrete Sewer and Culvert Pipe Using Flexible Watertight Gaskets
AASHTO M 304	(1994) Poly(Vinyl Chloride) (PVC) Profile Wall Drain Pipe and Fittings Based on Controlled Inside Diameter

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A 36	(1997ael) Carbon Structural Steel
ASTM A 48	(1994a) Gray Iron Castings
ASTM A 123	(2000) Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
ASTM A 126	(1995) Gray Iron Castings for Valves, Flanges, and Pipe Fittings
ASTM A 444	(1989) Steel Sheet, Zinc-Coated (Galvanized) by the Hot-Dip Process for Storm Sewer and Drainage Pipe
ASTM A 536	(1999el) Ductile Iron Castings
ASTM A 760	(1995a) Corrugated Steel Pipe, Metallic-Coated for Sewers and Drains
ASTM A 798	(1997a) Installing Factory-Made Corrugated Steel Pipe for Sewers and Other Applications
ASTM B 26	(1996) Aluminum-Alloy Sand Castings
ASTM C 76	(1997) Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe

ASTM C 231	(1997) Air Content of Freshly Mixed Concrete by the Pressure Method
ASTM C 270	(1997ae1) Mortar for Unit Masonry
ASTM C 443	(1994) Joints for Circular Concrete Sewer and Culvert Pipe, Using Rubber Gaskets
ASTM C 478	(1997) Precast Reinforced Concrete Manhole Sections
ASTM C 877	(1994) External Sealing Bands for Noncircular Concrete Sewer, Storm Drain, and Culvert Pipe
ASTM D 1056	(1991) Flexible Cellular Materials - Sponge or Expanded Rubber
ASTM D 1171	(1994) Rubber Deterioration - Surface Ozone Cracking Outdoors or Chamber (Triangular Specimens)
ASTM D 1751	(1983; R 1991) Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Nonextruding and Resilient Bituminous Types)
ASTM D 1752	(1984; R 1996) Preformed Sponge Rubber and Cork Expansion Joint Fillers for Concrete Paving and Structural Construction

1.2 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-07 Certificates

Pipe for Culverts and Storm Drains; G
Frame and Cover for Gratings; G

Certified copies of test reports demonstrating conformance to applicable pipe specifications, before pipe is installed. Certification on the ability of frame and cover or gratings to carry the imposed live load.

SD-08 Manufacturer's Instructions

Placing Pipe

Printed copies of the manufacturer's recommendations for installation procedures of the material being placed, prior to installation.

1.3 DELIVERY, STORAGE, AND HANDLING

1.3.1 Delivery and Storage

Materials delivered to site shall be inspected for damage, unloaded, and stored with a minimum of handling. Materials shall not be stored directly on the ground. The inside of pipes and fittings shall be kept free of dirt and debris. Gasket materials and plastic materials shall be protected from exposure to the direct sunlight over extended periods.

1.3.2 Handling

Materials shall be handled in such a manner as to ensure delivery to the trench in sound, undamaged condition. Pipe shall be carried to the trench, not dragged.

PART 2 PRODUCTS

2.1 PIPE FOR CULVERTS AND STORM DRAINS

Pipe for culverts and storm drains shall be of the sizes indicated and shall conform to the requirements specified.

2.1.1 Concrete Pipe

ASTM C 76, Class IV.

2.1.2 Corrugated Steel Pipe

ASTM A 760, zinc coated, Type I pipe with annular or helical corrugations. Sheet thickness shall be as indicated with 0.5 inch corrugation depth.

2.1.3 PVC Pipe

The pipe manufacturer's resin certification, indicating the cell classification of PVC used to manufacture the pipe in accordance with AASHTO M 304, shall be submitted prior to installation of the pipe.

2.2 DRAINAGE STRUCTURES

2.2.1 Flared End Sections

Sections shall be of a standard design fabricated from zinc coated steel sheets meeting requirements of ASTM A 444.

2.3 AUTOMATIC DRAINAGE GATES

Automatic drainage gates shall be of the size required by the plans, and shall be designed to allow free outflow and prevent backflow for maximum seating heads up to 20 feet. Frame and cover shall be cast-iron conforming to the requirements of ASTM A 126, Class B. Pivot lug shall be ductile iron conforming to the requirements of ASTM A 536. Hinge link shall be structural steel conforming to ASTM A 36, and galvanized in accordance ASTM A 123. Bushings and washers shall be commercial bronze. Assembly hardware and pin shall be 18-8 stainless steel.

2.4 MISCELLANEOUS MATERIALS

2.4.1 Reinforced Concrete

Unless otherwise specified, concrete and reinforced concrete shall conform

to the requirements for 3000 psi concrete under Section 03305 CONCRETE. The concrete mixture shall have air content by volume of concrete, based on measurements made immediately after discharge from the mixer, of 5 to 7 percent when maximum size of coarse aggregate exceeds 1-1/2 inches. Air content shall be determined in accordance with ASTM C 231. The concrete covering over steel reinforcing shall not be less than 1 inch thick for covers and not less than 1-1/2 inchesthick for walls and flooring. Concrete covering deposited directly against the ground shall have a thickness of at least 3 inchesbetween steel and ground. Expansion-joint filler material shall conform to ASTM D 1751, or ASTM D 1752, or shall be resin-impregnated fiberboard conforming to the physical requirements of ASTM D 1752.

2.4.2 Mortar

Mortar for pipe joints, connections to other drainage structures, and brick or block construction shall conform to ASTM C 270, Type M, except the maximum placement time shall be 1 hour. The quantity of water in the mixture shall be sufficient to produce a stiff workable mortar. Water shall be clean and free of harmful acids, alkalies, and organic impurities. The mortar shall be used within 30 minutes after the ingredients are mixed with water. The inside of the joint shall be wiped clean and finished smooth. The mortar head on the outside shall be protected from air and sun with a proper covering until satisfactorily cured.

2.4.3 Precast Reinforced Concrete Manholes

Precast reinforced concrete manholes shall conform to ASTM C 478. Joints between precast concrete risers and tops shall be full-bedded in cement mortar and shall be smoothed to a uniform surface on both interior and exterior of the structure.

2.4.4 Frame and Cover for Gratings

Frame and cover for gratings shall be cast gray iron, ASTM A 48, Class 35B; cast ductile iron, ASTM A 536, Grade 65-45-12; or cast aluminum, ASTM B 26, Alloy 356.OT6. Weight, shape, size, and waterway openings for grates and curb inlets shall be as indicated on the plans.

2.4.5 Joints

2.4.5.1 External Sealing Bands

Requirements for external sealing bands shall conform to ASTM C 877.

2.4.5.2 Flexible Watertight, Gasketed Joints

a. Gaskets: When infiltration or exfiltration is a concern for pipe lines, the couplings may be required to have gaskets. The closed-cell expanded rubber gaskets shall be a continuous band approximately 7 inches wide and approximately 3/8 inch thick, meeting the requirements of ASTM D 1056, Grade RE43, and shall have a quality retention rating of not less than 70 percent when tested for weather resistance by ozone chamber exposure, Method B of ASTM D 1171. Rubber O-ring gaskets shall be 13/16 inch in diameter for pipe diameters of 36 inches or smaller and 7/8 inch in diameter for larger pipe having 1/2 inch deep end corrugation. Rubber O-ring gaskets shall be 1-3/8 inches in diameter for pipe having 1 inch deep end corrugations. O-rings shall meet the

requirements of AASHTO M 198 or ASTM C 443. Flexible plastic gaskets shall conform to requirements of AASHTO M 198, Type B.

b. Connecting Bands: Connecting bands shall be of the type, size and sheet thickness of band, and the size of angles, bolts, rods and lugs as indicated or where not indicated as specified in the applicable standards or specifications for the pipe. Exterior rivet heads in the longitudinal seam under the connecting band shall be countersunk or the rivets shall be omitted and the seam welded.

2.4.5.3 PVC Plastic Pipes

Joints shall be solvent cement or elastomeric gasket type in accordance with the specification for the pipe and as recommended by the pipe manufacturer.

PART 3 EXECUTION

3.1 EXCAVATION FOR PIPE CULVERTS, STORM DRAINS, AND DRAINAGE STRUCTURES

Excavation of trenches and for appurtenances and backfilling for culverts and storm drains shall be in accordance with the applicable portions of Section 02316 EXCAVATION, TRENCHING, AND BACKFILLING FOR UTILITIES SYSTEMS and Section 02250 FILLS AND SUBGRADE PREPARATION and the requirements specified below.

3.2 PLACING PIPE

Each pipe shall be carefully examined before being laid, and defective or damaged pipe shall not be used. Plastic pipe shall be protected from exposure to the direct sunlight prior to laying as needed to maintain adequate pipe stiffness and meet installation deflection requirements. Pipelines shall be laid to the grades and alignment indicated. Proper facilities shall be provided for lowering sections of pipe into trenches. Under no circumstances shall pipe be laid in water, and no pipe shall be laid when trench conditions or weather are unsuitable for such work. Diversion of drainage or dewatering of trenches during construction shall be provided as necessary. Deflection of installed plastic pipe shall not exceed 4.5 percent of the nominal inside diameter. After backfilling has been completed, the Government may perform a deflection test on the entire length of installed plastic pipeline using a mandrel or other suitable device. Any plastic pipe showing deflections in excess of 4.5 percent shall be removed and replaced at the Contractor's expense. All pipe in place shall be inspected before backfilling, and those pipes damaged during placement shall be removed and replaced.

3.2.1 Concrete and PVC Pipe

Laying shall proceed upgrade with spigot ends of bell-and-spigot pipe and tongue ends of tongue-and-groove pipe pointing in the direction of the flow.

3.2.2 Corrugated Metal Pipe

Laying shall be with the separate sections joined firmly together, with the outside laps of circumferential joints pointing upstream, and with longitudinal laps on the sides. Pipe on which bituminous coating has been damaged to such an extent that satisfactory field repairs cannot be made shall be removed and replaced.

3.2.3 Multiple Culverts

Where multiple lines of pipe are installed, adjacent sides of pipe shall be at least half the nominal pipe diameter or 3 feet apart, whichever is less.

3.3 JOINTS

3.3.1 Concrete Pipe

3.3.1.1 Cement-Mortar Tongue-and-Groove Joint

The first pipe shall be bedded carefully to the established gradeline with the groove upstream. A shallow excavation shall be made underneath the pipe at the joint and filled with mortar to provide a bed for the pipe. The grooved end of the first pipe shall be carefully cleaned with a wet brush, and a layer of soft mortar applied to the lower half of the groove. The tongue of the second pipe shall be cleaned carefully with a wet brush; while in horizontal position, a layer of soft mortar shall be applied to the upper half of the tongue. The tongue end of the second pipe then shall be inserted in the grooved end of the first pipe until mortar is squeezed out on interior and exterior surfaces. Sufficient mortar shall be used to fill the joint completely and to form a bead on the outside.

3.3.1.2 Cement-Mortar Diaper Joint for Tongue-and-Groove Pipe

The joint shall be of the type described for cement-mortar tongue-and-groove joint in this paragraph, except that the shallow excavation directly beneath the joint shall not be filled with mortar until after a gauze or cheesecloth band dipped in cement mortar has been wrapped around the outside of the joint. The cement-mortar bead at the joint shall be at least 1/2 inch, thick and the width of the diaper band shall be at least 8 inches. The diaper shall be left in place. Placing of this type of joint shall be kept at least five joints behind the actual laying of the pipe. No backfilling around the joints shall be done until the joints have been fully inspected and approved.

3.3.2 Corrugated Metal Pipe

3.3.2.1 Field Joints

Transverse field joints shall be of such design that the successive connection of pipe sections will form a continuous line free of appreciable irregularities in the flow line. In addition, the joints shall meet the general performance requirements described in ASTM A 798. Suitable transverse field joints which satisfy the requirements for one or more of the joint performance categories can be obtained with the following types of connecting bands furnished with suitable band-end fastening devices: corrugated bands, bands with projections, flat bands, and bands of special design that engage factory reformed ends of corrugated pipe. The space between the pipe and connecting bands shall be kept free from dirt and grit so that corrugations fit snugly. The connecting band, while being tightened, shall be tapped with a soft-head mallet of wood, rubber or plastic, to take up slack and ensure a tight joint. Field joints for each type of corrugated metal pipe shall maintain pipe alignment during construction and prevent infiltration of fill material during the life of the installations. The type, size, and sheet thickness of the band and the size of angles or lugs and bolts shall be as indicated or where not indicated, shall be as specified in the applicable standards or

specifications for the pipe.

3.3.2.2 Flexible Watertight, Gasketed Joints

Installation shall be as recommended by the gasket manufacturer for use of lubricants and cements and other special installation requirements. The gasket shall be placed over one end of a section of pipe for half the width of the gasket. The other half shall be doubled over the end of the same pipe. When the adjoining section of pipe is in place, the doubled-over half of the gasket shall then be rolled over the adjoining section. Any unevenness in overlap shall be corrected so that the gasket covers the end of pipe sections equally. Connecting bands shall then be centered over adjoining sections of pipe, and rods or bolts placed in position and nuts tightened. Band Tightening: The band shall be tightened evenly, even tension being kept on the rods or bolts, and the gasket shall be closely observed to see that it is seating properly in the corrugations. Watertight joints shall remain uncovered for a period of time designated, and before being covered, tightness of the nuts shall be measured with a torque wrench. If the nut has tended to loosen its grip on the bolts or rods, the nut shall be retightened with a torque wrench and remain uncovered until a tight, permanent joint is assured.

3.4 DRAINAGE STRUCTURES

3.4.1 Manholes and Inlets

Construction shall be of reinforced concrete, precast reinforced concrete, precast concrete segmental blocks, complete with frames and covers or gratings and with fixed galvanized steel ladders where indicated.

3.4.2 Walls and Headwalls

Construction shall be as indicated.

3.5 STEEL LADDER INSTALLATION

Ladder shall be adequately anchored to the wall by means of steel inserts spaced not more than 6 feet vertically, and shall be so installed as to provide at least 6 inchesof space between the wall and the rungs. The wall along the line of the ladder shall be vertical for its entire length.

3.6 BACKFILLING

Backfilling of trenches and for appurtenances and backfilling for culverts and storm drains shall be in accordance with the applicable portions of Section 02316 EXCAVATION, TRENCHING, AND BACKFILLING FOR UTILITIES SYSTEMS and Section 02250 FILLS AND SUBGRADE PREPARATION.

3.7 AUTOMATIC DRAINAGE GATES

Automatic drainage gates shall be installed in accordance with the manufacturers recommendations.

-- End of Section --

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DIVISION 02 - SITE WORK

SECTION 02722

AGGREGATE AND/OR GRADED-CRUSHED AGGREGATE BASE COURSE

SECTION 02722

AGGREGATE AND/OR GRADED-CRUSHED AGGREGATE BASE COURSE

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM C 117	(1995) Materials Finer Than 75 micrometer (No. 200) Sieve in Mineral Aggregates by Washing
ASTM C 131	(1996) Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine
ASTM C 136	(1996a) Sieve Analysis of Fine and Coarse Aggregates
ASTM D 75	(1987; R 1992) Sampling Aggregates
ASTM D 1556	(1990; R 1996) Density and Unit Weight of Soil in Place by the Sand-Cone Method
ASTM D 1557	(1991) Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/cu. ft. (2,700 kN-m/cu. m.))
ASTM D 2167	(1994) Density and Unit Weight of Soil in Place by the Rubber Balloon Method
ASTM D 2487	(1998) Classification of Soils for Engineering Purposes (Unified Soil Classification System)
ASTM D 4318	(1995a) Liquid Limit, Plastic Limit, and Plasticity Index of Soils
ASTM E 11	(1995) Wire Cloth Sieves for Testing Purposes

1.2 DEFINITIONS

For the purposes of this specification, the following definitions apply.

1.2.1 Aggregate Base Course

Aggregate base course (ABC) is well graded, durable aggregate uniformly moistened and mechanically stabilized by compaction.

1.2.2 Degree of Compaction

Degree of compaction shall be expressed as a percentage of the maximum density obtained by the test procedure presented in ASTM D 1557.

1.3 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-03 Product Data

Plant, Equipment, and Tools

List of proposed equipment to be used in performance of construction work, including descriptive data.

Waybills and Delivery Tickets

Copies of waybills and delivery tickets during the progress of the work.

SD-06 Test Reports

Sampling and testing; G
Density Tests; G

Calibration curves and related test results prior to using the device or equipment being calibrated. Copies of field test results within 24 hours after the tests are performed. Certified copies of test results for approval not less than 15 days before material is required for the work.

1.4 SAMPLING AND TESTING

Sampling and testing shall be the responsibility of the Contractor. Sampling and testing shall be performed by a testing laboratory approved in accordance with Section 01451 CONTRACTOR QUALITY CONTROL. Work requiring testing will not be permitted until the testing laboratory has been inspected and approved. The materials shall be tested to establish compliance with the specified requirements; testing shall be performed at the specified frequency. The Contracting Officer may specify the time and location of the tests. Copies of test results shall be furnished to the Contracting Officer within 24 hours of completion of the tests.

1.4.1 Sampling

Samples for laboratory testing shall be taken in conformance with ASTM D 75. When deemed necessary, the sampling will be observed by the Contracting Officer.

1.4.2 Tests

The following tests shall be performed in conformance with the applicable standards listed.

1.4.2.1 Sieve Analysis

Sieve analysis shall be made in conformance with ASTM C 117 and ASTM C 136. Sieves shall conform to ASTM E 11.

1.4.2.2 Liquid Limit and Plasticity Index

Liquid limit and plasticity index shall be determined in accordance with ASTM D 4318.

1.4.2.3 Moisture-Density Determinations

The maximum density and optimum moisture content shall be determined in accordance with ASTM D 1557.

1.4.2.4 Field Density Tests

Density shall be field measured in accordance with ASTM D 1556 or ASTM D 2167. For the method presented in ASTM D 1556 the base plate as shown in the drawing shall be used.

1.4.2.5 Wear Test

Wear tests shall be in conformance with ASTM C 131.

1.4.2.6 R-Value

R-Value shall be in accordance with CAL-301.

1.4.2.7 Sand Equivalent

The Sand Equivalent shall be in conformance with CAL-217.

1.4.3 Testing Frequency

1.4.3.1 Initial Tests

One of each of the following tests shall be performed on the proposed material prior to commencing construction to demonstrate that the proposed material meets all specified requirements when furnished. If materials from more than one source are going to be utilized, this testing shall be completed for each source.

a. Sieve Analysis.

b. Liquid limit and plasticity index.

c. R-Value.

d. Sand Equivalent.

e. Wear.

1.4.3.2 In Place Tests

One of each of the following tests shall be performed on samples taken from

the placed and compacted ABC. Samples shall be taken and tested at the rates indicated.

a. Density tests shall be performed on every lift of material placed and at a frequency of one set of tests for every 250 square yards, or portion thereof, of completed area.

b. Sieve Analysis shall be performed for every 500 tons, or portion thereof, of material placed.

c. Liquid limit and plasticity index tests shall be performed at the same frequency as the sieve analysis.

1.4.4 Approval of Material

The source of the material shall be selected 30 days prior to the time the material will be required in the work. Tentative approval of material will be based on initial test results. Final approval of the materials will be based on sieve analysis, liquid limit, and plasticity index tests performed on samples taken from the completed and fully compacted ABC.

1.5 WEATHER LIMITATIONS

Construction shall be done when the atmospheric temperature is above 35 degrees F. When the temperature falls below 35 degrees F, the Contractor shall protect all completed areas by approved methods against detrimental effects of freezing. Completed areas damaged by freezing, rainfall, or other weather conditions shall be corrected to meet specified requirements.

1.6 PLANT, EQUIPMENT, AND TOOLS

All plant, equipment, and tools used in the performance of the work will be subject to approval before the work is started and shall be maintained in satisfactory working condition at all times. The equipment shall be adequate and shall have the capability of producing the required compaction, meeting grade controls, thickness control, and smoothness requirements as set forth herein.

1.7 WAYBILLS AND DELIVERY TICKETS

Before the final statement is allowed, the Contractor shall file with the Contracting Officer certified waybills and certified delivery tickets for all aggregate materials actually used in construction.

PART 2 PRODUCTS

2.1 AGGREGATE PROPERTIES

The ABC shall consist of clean, sound, durable particles of gravel, stone, crushed stone, crushed gravel, angular sand, or other approved material. ABC shall be free of lumps of clay, organic matter, and other objectionable materials or coatings. The portion retained on the No. 4 sieve shall be known as coarse aggregate; that portion passing the No. 4 sieve shall be known as fine aggregate. Aggregates shall be of uniform density. Fifty percent of the material retained on the 3/8-inch screen shall have three or more freshly fractured faces. No more than five percent of the material retained on the 3/8-inch screen shall show no such faces resulting from crushing. The amount of flat and elongated particles shall not exceed 30 percent. A flat particle is one having a ratio of width to thickness

greater than 3; an elongated particle is one having a ratio of length to width greater than 3. Additionally, the aggregates when tested will conform to the following requirements.

Test Name	Ref Standard	Test Requirement	
R-Value	CAL-301		80 min
Sand Equivalent	CAL-217		50 min
Percentage Wear	ASTM C-131		-
		100 Revs	15 max
		500 Revs	52 max
Specific Gravity	ASTM C-127		2.58 min

2.2 GRADATION REQUIREMENTS

The specified gradation requirements shall apply to the completed base course. The aggregates shall have a maximum size of 1-1/2 inches and shall be continuously well graded within the limits specified in the table below. Sieves shall conform to ASTM E 11.

GRADATION OF AGGREGATES

Sieve Designation	Percentage by Weight Passing Square-Mesh Sieve
1-1/2 inch	100
3/4 inch	90-100
3/8 inch	50-80
No. 4	35-55
No. 30	10-30
No. 200	2-9

NOTE 1: Particles having diameters less than 0.0008 inch shall not be in excess of 3 percent by weight of the total sample tested.

NOTE 2: The values are based on aggregates of uniform specific gravity. If materials from different sources are used for the coarse and fine aggregates, they shall be tested in accordance with ASTM C 127 and ASTM C 128 to determine their specific gravities. If the specific gravities vary by more than 10 percent, the percentages passing the various sieves shall be corrected as directed by the Contracting Officer.

2.3 LIQUID LIMIT AND PLASTICITY INDEX

Liquid limit and plasticity index requirements shall apply to the completed course and shall also apply to any component that is blended to meet the required gradation. The portion of any component or of the completed course passing the No. 40 sieve shall be either nonplastic or have a liquid limit not greater than 25 and a plasticity index not greater than 5.

PART 3 EXECUTION

3.1 GENERAL REQUIREMENTS

When the ABC is constructed in more than one layer, the previously constructed layer shall be cleaned of loose and foreign matter by sweeping with power sweepers or power brooms, except that hand brooms may be used in

areas where power cleaning is not practicable. Adequate drainage shall be provided during the entire period of construction to prevent water from collecting or standing on the working area. Line and grade stakes shall be provided as necessary for control. Grade stakes shall be in lines parallel to the centerline of the area under construction and suitably spaced for string lining.

3.2 OPERATION OF AGGREGATE SOURCES

Aggregates shall be obtained from offsite sources.

3.3 STOCKPILING MATERIAL

Prior to stockpiling of material, storage sites shall be cleared and leveled by the Contractor. Aggregates shall be stockpiled on the cleared and leveled areas designated by the Contracting Officer to prevent segregation. Materials obtained from different sources shall be stockpiled separately.

3.4 PREPARATION OF UNDERLYING COURSE

Prior to constructing the ABC, the underlying course or subgrade shall be cleaned of all foreign substances. At the time of construction of the ABC, the underlying course shall contain no frozen material. The surface of the underlying course or subgrade shall meet specified compaction and surface tolerances. The underlying course shall conform to Section 02212 EMBANKMENT or Section 02250 FILLS AND SUBGRADE PREPARATION as applicable. Ruts or soft yielding spots in the underlying courses, areas having inadequate compaction, and deviations of the surface from the requirements set forth herein shall be corrected by loosening and removing soft or unsatisfactory material and by adding approved material, reshaping to line and grade, and recompacting to specified density requirements. For cohesionless underlying courses containing sands or gravels, as defined in ASTM D 2487, the surface shall be stabilized prior to placement of the ABC. Stabilization shall be accomplished by mixing ABC into the underlying course and compacting by approved methods. The stabilized material shall be considered as part of the underlying course and shall meet all requirements of the underlying course. The finished underlying course shall not be disturbed by traffic or other operations and shall be maintained by the Contractor in a satisfactory condition until the ABC is placed.

3.5 INSTALLATION

3.5.1 Mixing the Materials

The coarse and fine aggregates shall be mixed in a stationary plant. The Contractor shall make adjustments in mixing procedures or in equipment as directed to obtain true grades, to minimize segregation or degradation, to obtain the required water content, and to insure a satisfactory ABC meeting all requirements of this specification.

3.5.2 Placing

The mixed material shall be placed on the prepared subgrade or subbase in layers of uniform thickness. When a compacted layer 6 inches or less in thickness is required, the material shall be placed in a single layer. When a compacted layer in excess of 6 inches is required, the material shall be placed in layers of equal thickness. No layer shall exceed 6

inches or be less than 3 inches when compacted. The layers shall be so placed that when compacted they will be true to the grades or levels required with the least possible surface disturbance. Where the ABC is placed in more than one layer, the previously constructed layers shall be cleaned of loose and foreign matter by sweeping with power sweepers, power brooms, or hand brooms, as directed. Such adjustments in placing procedures or equipment shall be made as may be directed to obtain true grades, to minimize segregation and degradation, to adjust the water content, and to insure an acceptable ABC.

3.5.3 Grade Control

The finished and completed ABC shall conform to the lines, grades, and cross sections shown. Underlying material(s) shall be excavated and prepared at sufficient depth for the required ABC thickness so that the finished ABC with the subsequent surface course will meet the designated grades.

3.5.4 Edges of Base Course

Approved fill material shall be placed along the outer edges of ABC in sufficient quantities to compact to the thickness of the course being constructed, or to the thickness of each layer in a multiple layer course, allowing in each operation at least a 2 foot width of this material to be rolled and compacted simultaneously with rolling and compacting of each layer of ABC. If this base course material is to be placed adjacent to another pavement section, then the layers for both of these sections shall be placed and compacted along this edge at the same time.

3.5.5 Compaction

Each layer of the ABC shall be compacted as specified with approved compaction equipment. Water content shall be maintained during the compaction procedure to within plus or minus two percent of the optimum water content determined from laboratory tests as specified in paragraph: SAMPLING AND TESTING. Rolling shall begin at the outside edge of the surface and proceed to the center, overlapping on successive trips at least one-half the width of the roller. Alternate trips of the roller shall be slightly different lengths. Speed of the roller shall be such that displacement of the aggregate does not occur. In all places not accessible to the rollers, the mixture shall be compacted with hand-operated power tampers. Compaction shall continue until each layer has a degree of compaction that is at least 98 percent of laboratory maximum density through the full depth of the layer. The Contractor shall make such adjustments in compacting or finishing procedures as may be directed to obtain true grades, to minimize segregation and degradation, to reduce or increase water content, and to ensure a satisfactory ABC. Any materials that are found to be unsatisfactory shall be removed and replaced with satisfactory material or reworked, as directed, to meet the requirements of this specification.

3.5.6 Thickness

Compacted thickness of the aggregate course shall be as indicated on the drawings. No individual layer shall exceed 8 inches nor be less than 3 inches in compacted thickness. The total compacted thickness of the ABC course shall be within 1/4 inch of the thickness indicated. Where the measured thickness is more than 1/4 inch deficient, such areas shall be corrected by scarifying, adding new material of proper gradation,

reblading, and recompacting as directed. Where the measured thickness is more than 1/4 inch thicker than indicated, the course shall be considered as conforming to the specified thickness requirements. Average job thickness shall be the average of all thickness measurements taken for the job, but shall be within 1/4 inch of the thickness indicated. The total thickness of the ABC course shall be measured at intervals in such a manner as to ensure one measurement for each 500 square yards of base course. Measurements shall be made in 3 inch diameter test holes penetrating the base course.

3.5.7 Finishing

The surface of the top layer of ABC shall be finished after final compaction by cutting any overbuild to grade and rolling with a steel-wheeled roller. Thin layers of material shall not be added to the top layer of base course to meet grade. If the elevation of the top layer of ABC is ½ inch or more below grade, then the top layer should be scarified to a depth of at least 3 inches and new material shall be blended in and compacted to bring to grade. Adjustments to rolling and finishing procedures shall be made as directed to minimize segregation and degradation, obtain grades, maintain moisture content, and insure an acceptable base course. Should the surface become rough, corrugated, uneven in texture, or traffic marked prior to completion, the unsatisfactory portion shall be scarified, reworked and recompacted or it shall be replaced as directed.

3.5.8 Smoothness

The surface of the top layer shall show no deviations in excess of 3/8 inch when tested with a 10 foot straightedge. Measurements shall be taken in successive positions parallel to the centerline of the area to be paved. Measurements shall also be taken perpendicular to the centerline at 50 foot intervals. Deviations exceeding this amount shall be corrected by removing material and replacing with new material, or by reworking existing material and compacting it to meet these specifications.

3.6 TRAFFIC

Traffic shall not be allowed on the completed ABC course.

3.7 MAINTENANCE

The ABC shall be maintained in a satisfactory condition until the full pavement section is completed and accepted. Maintenance shall include immediate repairs to any defects and shall be repeated as often as necessary to keep the area intact. Any ABC that is not paved over prior to the onset of winter, shall be retested to verify that it still complies with the requirements of this specification. Any area of ABC that is damaged shall be reworked or replaced as necessary to comply with this specification.

3.8 DISPOSAL OF UNSATISFACTORY MATERIALS

Any unsuitable materials that must be removed shall be disposed of waste disposal areas indicated. No additional payments will be made for materials wasted or that must be replaced.

-- End of Section --

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DIVISION 02 - SITE WORK

SECTION 02821

FENCING

-- End of Section Table of Contents --

SECTION 02821

FENCING

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A 121	(1992a) Zinc-Coated (Galvanized) Steel Barbed Wire
ASTM A 153/A 153M	(1998) Zinc-Coating (Hot-Dip) on Iron and Steel Hardware
ASTM A 392	(1996) Zinc-Coated Steel Chain-Link Fence Fabric
ASTM A 491	(1996) Aluminum-Coated Steel Chain-Link Fence Fabric
ASTM A 585	(1997) Aluminum-Coated Steel Barbed Wire
ASTM A 702	(1989; R 1994) Steel Fence Posts and Assemblies, Hot Wrought
ASTM A 780	(1993a) Repair of Damaged and Uncoated Areas of Hot-Dipped Galvanized Coatings
ASTM A 824	(1995) Metallic-Coated Steel Marcelled Tension Wire for Use With Chain Link Fence
ASTM C 94	(1998c) Ready-Mixed Concrete
ASTM F 567	Standard Practice for Installation of Chain Link Fence
ASTM F 626	(1996) Fence Fittings
ASTM F 883	(1997) Padlocks
ASTM F 900	(1994) Industrial and Commercial Swing Gates
ASTM F 1043	(1998a) Strength and Protective Coatings on Metal Industrial Chain-Link Fence Framework
ASTM F 1083	(1997) Specification for Pipe, Steel,

	Hot-Dipped Zinc-Coated (Galvanized) Welded, for Fence Structures
ASTM F 1184	(1994) Industrial and Commercial Horizontal Slide Gates

1.2 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-07 Certificates

Chain Link Fence; G

Statement, signed by an official authorized to certify on behalf of the manufacturer, attesting that the chain link fence and component materials meet the specified requirements.

PART 2 PRODUCTS

2.1 FENCE FABRIC

Fence fabric shall conform to the following:

2.1.1 Chain Link Fence Fabric

ASTM A 392, Class 1, zinc-coated steel wire with minimum coating weight of 1.2 ounces of zinc per square foot of coated surface, or ASTM A 491, Type I, aluminum-coated steel wire. Fabric shall be fabricated of 9 gauge wire woven in 2 inch mesh. Fabric height shall be as shown. Fabric shall be twisted and barbed on the top selvage and knuckled on the bottom selvage.

2.1.2 Fencing Slats

The fencing slats shall be either (1) pre-inserted at the time of manufacture, or (2) inserted at the time of installation; and shall be double wall, self locking and approximately 1-1/8" wide, flaring out to 1-1/2" wide for the top 10" (min.) of the slat to provide a tight fit in the fence fabric. The slats shall be manufactured from virgin, high density, polyethylene and shall be gray in color. Minimum privacy screening shall be 75 percent coverage. Slats shall be secured in a manner such that they may not be readily removed or blown out of the fence.

2.2 GATES

ASTM F 900 and/or ASTM F 1184. Gate shall be the type and swing shown. Gate frames shall conform to strength and coating requirements of ASTM F 1083 for Group IA, steel pipe, with external coating Type A, nominal pipe size (NPS) 1-1/2. Gate frames shall conform to strength and coating requirements of ASTM F 1043, for Group IC, steel pipe with external coating Type A or Type B, nominal pipe size (NPS) 1-1/2. Gate fabric shall be as specified for chain link fabric. Gate leaves more than 8 feet wide shall have either intermediate members and diagonal truss rods or shall have tubular members as necessary to provide rigid construction, free from sag or twist. Gate leaves less than 8 feet wide shall have truss rods or

intermediate braces. Intermediate braces shall be provided on all gate frames with an electro-mechanical lock. Gate fabric shall be attached to the gate frame by method standard with the manufacturer except that welding will not be permitted. Latches, hinges, stops, keepers, rollers, and other hardware items shall be furnished as required for the operation of the gate. Latches shall be arranged for padlocking so that the padlock will be accessible from both sides of the gate. Stops shall be provided for holding the gates in the open position.

2.3 POSTS

2.3.1 Metal Posts for Chain Link Fence

ASTM F 1083, zinc-coated. Group IA, with external coating Type A steel pipe. Group IC steel pipe, zinc-coated with external coating Type A or Type B and Group II , formed steel sections, shall meet the strength and coating requirements of ASTM F 1043. Group III, ASTM F 1043 steel H-section may be used for line posts in lieu of line post shapes specified for the other classes. Sizes shall be as shown on the drawings. Line posts and terminal (corner, gate, and pull) posts selected shall be of the same designation throughout the fence. Gate post shall be for the gate type specified subject to the limitation specified in ASTM F 900 and/or ASTM F 1184.

2.3.2 Metal Posts for Farm Style Fence

Metal posts shall conform to ASTM A 702 zinc-coated, T-section; length as indicated. Accessories shall conform to ASTM A 702.

2.4 BRACES AND RAILS

ASTM F 1083, zinc-coated, Group IA, steel pipe, size NPS 1-1/4. Group IC steel pipe, zinc-coated, shall meet the strength and coating requirements of ASTM F 1043. Group II , formed steel sections, size 1-21/32 inch, conforming to ASTM F 1043, may be used as braces and rails if Group II line posts are furnished.

2.5 WIRE

2.5.1 Tension Wire

Tension wire shall be Type I or Type II, Class 2 coating, in accordance with ASTM A 824.

2.5.2 Barbed Wire for Farm Style Fence

Barbed wire shall conform to ASTM A 121 zinc-coated, class 1, 13 gauge wire with 13-1/2 gauge 4-point barbs spaced no more than 6 inches apart.

2.6 ACCESSORIES

ASTM F 626. Ferrous accessories shall be zinc or aluminum coated. Truss rods shall be furnished for each terminal post. Truss rods shall be provided with turnbuckles or other equivalent provisions for adjustment. Barbed wire shall be 2 strand, 12-1/2 gauge wire, zinc-coated, Class 3 in accordance with ASTM A 121 or aluminum coated Type I in accordance with ASTM A 585. Barbed wire shall be four-point barbed type steel wire. Tie wire for attaching fabric to rails, braces, and posts shall be 9 gauge steel wire and match the coating of the fence fabric. Miscellaneous

hardware coatings shall conform to ASTM A 153/A 153M unless modified.

2.7 CONCRETE

ASTM C 94, using 3/4 inch maximum size aggregate, and having minimum compressive strength of 3000 psi at 28 days. Grout shall consist of one part portland cement to three parts clean, well-graded sand and the minimum amount of water to produce a workable mix.

2.8 PADLOCKS

Padlocks shall conform to ASTM F 883, Type PO1, Options A, B, and G, size 1-3/4 inch. All padlocks shall be keyed alike.

PART 3 EXECUTION

3.1 INSTALLATION

Fence shall be installed to the lines and grades indicated. The area on either side of the fence line shall be cleared to the extent indicated. Line posts shall be spaced equidistant at intervals not exceeding 10 feet. Terminal (corner, gate, and pull) posts shall be set at abrupt changes in vertical and horizontal alignment. Fabric shall be continuous between terminal posts; however, runs between terminal posts shall not exceed 500 feet. Any damage to galvanized surfaces, including welding, shall be repaired with paint containing zinc dust in accordance with ASTM A 780.

3.2 EXCAVATION

Post holes shall be cleared of loose material. Waste material shall be spread where directed. The ground surface irregularities along the fence line shall be eliminated to the extent necessary to maintain a 2 inch clearance between the bottom of the fabric and finish grade.

3.3 POST INSTALLATION

3.3.1 Posts for Chain Link Fence

Posts shall be set plumb and in alignment. Except where solid rock is encountered, posts shall be set in concrete to the depth indicated on the drawings. Where solid rock is encountered with no overburden, posts shall be set to a minimum depth of 18 inches in rock. Where solid rock is covered with an overburden of soil or loose rock, posts shall be set to the minimum depth indicated on the drawing unless a penetration of 18 inches in solid rock is achieved before reaching the indicated depth, in which case depth of penetration shall terminate. All portions of posts set in rock shall be grouted. Portions of posts not set in rock shall be set in concrete from the rock to ground level. Posts set in concrete shall be set in holes not less than the diameter shown on the drawings. Diameters of holes in solid rock shall be at least 1 inch greater than the largest cross section of the post. Concrete and grout shall be thoroughly consolidated around each post, shall be free of voids and finished to form a dome. Concrete and grout shall be allowed to cure for 72 hours prior to attachment of any item to the posts. Group II line posts may be mechanically driven, for temporary fence construction only, if rock is not encountered. Driven posts shall be set to a minimum depth of 3 feet and shall be protected with drive caps when being set. For high security fences, fence post rigidity shall be tested by applying a 50 pound force on the post, perpendicular to the fabric, at 5 feet above ground; post

movement measured at the point where the force is applied shall be less than or equal to 3/4 inch from the relaxed position; every tenth post shall be tested for rigidity; when a post fails this test, further tests on the next four posts on either side of the failed post shall be made; all failed posts shall be removed, replaced, and retested at the Contractor's expense.

3.3.2 Posts for Farm Style Fence

Posts shall be set plumb and in proper alignment. Metal posts shall be driven or set in concrete as indicated.

3.4 RAILS

3.4.1 Top Rail

Top rail shall be supported at each post to form a continuous brace between terminal posts. Where required, sections of top rail shall be joined using sleeves or couplings that will allow expansion or contraction of the rail. Top rail, if required for high security fence, shall be installed as indicated on the drawings.

3.4.2 Bottom Rail

The bottom rail shall be bolted to double rail ends and double rail ends shall be securely fastened to the posts. Bolts shall be peened to prevent easy removal. Bottom rail shall be installed before chain link fabric.

3.5 BRACES AND TRUSS RODS

Braces and truss rods shall be installed as indicated and in conformance with the standard practice for the fence furnished. Horizontal (compression) braces and diagonal truss (tension) rods shall be installed on fences over 6 feet in height. A center brace or 2 diagonal truss rods shall be installed on 12 foot fences. Braces and truss rods shall extend from terminal posts to line posts. Diagonal braces shall form an angle of approximately 40 to 50 degrees with the horizontal. No bracing is required on fences 6 feet high or less if a top rail is installed.

3.6 TENSION WIRES

Tension wires shall be installed along the top and bottom of the fence line and attached to the terminal posts of each stretch of the fence. Top tension wires shall be installed within the top 1 foot of the installed fabric. Bottom tension wire shall be installed within the bottom 6 inches of the installed fabric. Tension wire shall be pulled taut and shall be free of sag.

3.7 CHAIN LINK FABRIC

Chain link fabric shall be installed on the side of the post indicated. Fabric shall be attached to terminal posts with stretcher bars and tension bands. Bands shall be spaced at approximately 15 inch intervals. The fabric shall be installed and pulled taut to provide a smooth and uniform appearance free from sag, without permanently distorting the fabric diamond or reducing the fabric height. Fabric shall be fastened to line posts at approximately 15 inch intervals and fastened to all rails and tension wires at approximately 24 inch intervals. Fabric shall be cut by untwisting and removing pickets. Splicing shall be accomplished by weaving a single picket into the ends of the rolls to be joined. The bottom of the

installed fabric shall be 2 plus or minus 1/2 inch above the ground. For high security fence, after the fabric installation is complete, the fabric shall be exercised by applying a 50 pound push-pull force at the center of the fabric between posts; the use of a 30 pound pull at the center of the panel shall cause fabric deflection of not more than 2-1/2 inches when pulling fabric from the post side of the fence; every second fence panel shall meet this requirement; all failed panels shall be resecured and retested at the Contractor's expense.

3.7.1 Fencing Slats

Installation shall be in accordance with ASTM F 567, "Standard Practice for Installation of Chain Link Fence," and manufacturer's recommendations.

3.8 BARBED WIRE

3.8.1 General Requirements

Barbed wire shall be installed as indicated and as recommended by the manufacturer.

3.8.2 Barbed Wire for Farm Style Fence

Wire shall be installed on the side of the post indicated. Wire shall be pulled taut to provide a smooth uniform appearance, free from sag. Wire shall be fastened to line posts at approximately 15 inch intervals unless indicated otherwise.

3.9 GATE INSTALLATION

Gates shall be installed at the locations shown. Hinged gates shall be mounted to swing as indicated. Latches, stops, and keepers shall be installed as required. Padlocks shall be attached to gates or gate posts with chains. Hinge pins, and hardware shall be welded or otherwise secured to prevent removal.

3.10 GROUNDING

Fences crossed by powerlines of 600 volts or more shall be grounded at or near the point of crossing and at distances not exceeding 150 feet on each side of crossing. Ground conductor shall consist of No. 8 AWG solid copper wire. Grounding electrodes shall be 3/4 inch by 10 foot long copper-clad steel rod. Electrodes shall be driven into the earth so that the top of the electrode is at least 6 inches below the grade. Where driving is impracticable, electrodes shall be buried a minimum of 12 inches deep and radially from the fence. The top of the electrode shall be not less than 2 feet or more than 8 feet from the fence. Ground conductor shall be clamped to the fence and electrodes with bronze grounding clamps to create electrical continuity between fence posts, fence fabric, and ground rods. After installation the total resistance of fence to ground shall not be greater than 25 ohms.

3.11 TEMPORARY FENCE

Temporary fence will meet the requirements of this section and may be new or used material. Posts do not have to be embedded in concrete. However temporary fence shall be maintained to provide secure barrier. Temporary fence shall be removed at the end of the contract period.

-- End of Section --

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DIVISION 02 - SITE WORK

SECTION 02900

HYDROSEEDING

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SECTION 02900

HYDROSEEDING

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

U.S. DEPARTMENT OF AGRICULTURE (USDA)

AMS Seed Act	(1995) Federal Seed Act Regulations Part 201

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM D 4972	(1995a) pH of Soils
ASTM D 5268	(1992; R 1996) Topsoil Used for Landscaping Purposes

1.2 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-03 Product Data

Equipment

Manufacturer's literature including physical characteristics, application and installation instructions for equipment, surface erosion control material and chemical treatment material.

A listing of equipment to be used for the seeding operation.

Delivery

Delivery schedule.

Topsoil; G

Topsoil from the stripping and stock piling operation.

Quantity Check; G

Bag count or bulk weight measurements of material used compared with area covered to determine the application rate and quantity installed.

Seed Establishment Period; G

Calendar time period for the seed establishment period. When there is more than one seed establishment period, the boundaries of the seeded area covered for each period shall be described.

Maintenance Record; G

Maintenance work performed, area repaired or reinstalled, diagnosis for unsatisfactory stand of seeded plants.

Maintenance Plan; G

Plant watering and maintenance plan indicating the Contractor's method(s) to establish a healthy stand of native plants. Provide a temporary irrigation system layout plan and or indicate method(s) of water application and maintenance required to meet specification. The watering and maintenance plan shall cover one year of plant establishment and shall include a watering and maintenance schedule.

Application of Pesticide; G

Pesticide treatment plan with sequence of treatment work with dates and times. The pesticide trade name, EPA registration number, chemical composition, formulation, concentration of original and diluted material, application rate of active ingredients, method of application, area treated, amount applied; and the name and state license number of the state certified applicator shall be included.

Wood cellulose fiber mulch and tackifier; G

Application rates recommended by the manufacture.

SD-04 Samples

Delivered Topsoil; G

Samples taken from several locations at the source.

Soil Amendments; G

A 5 pound sample.

Mulch; G

A 5 pound sample.

SD-06 Test Reports

Equipment Calibration; G

Certification of calibration tests conducted on the equipment used in the seeding operation.

Soil Test; G

Certified reports of inspections and laboratory tests, prepared by an independent testing agency, including analysis and interpretation of test results. Each report shall be properly identified. Test methods used and compliance with recognized test standards shall be described.

SD-07 Certificates

Seed; G
Topsoil; G
pH Adjuster
Fertilizer
Organic Material
Soil Conditioner
Mulch
Pesticide; G

Prior to the delivery of materials, certificates of compliance attesting that materials meet the specified requirements. Certified copies of the material certificates shall include the following:

a. Seed. Classification, botanical name, common name, percent pure live seed, minimum percent germination and hard seed, maximum percent weed seed content, and date tested.

b. Topsoil. Particle size, pH, organic matter content, textural class, soluble salts, chemical, mechanical and plant growth analyses.

c. pH Adjuster. Calcium carbonate equivalent and sieve analysis.

d. Fertilizer. Chemical analysis and composition percent.

e. Organic Material: Composition and source.

f. Soil Conditioner: Composition and source.

g. Mulch: Composition and source.

h. Pesticide. EPA registration number and registered uses.

1.3 SOURCE INSPECTION

The source of delivered topsoil shall be subject to inspection.

1.4 DELIVERY, INSPECTION, STORAGE, AND HANDLING

1.4.1 Delivery

A delivery schedule shall be provided at least 10 calendar days prior to the first day of delivery.

1.4.1.1 Delivered Topsoil

Prior to the delivery of any topsoil, its availability shall be verified in paragraph TOPSOIL. A soil test shall be provided for topsoil delivered to the site.

1.4.1.2 Soil Amendments

Soil amendments shall be delivered to the site in the original, unopened containers bearing the manufacturer's chemical analysis. In lieu of containers, soil amendments may be furnished in bulk. A chemical analysis shall be provided for bulk deliveries.

1.4.1.3 Pesticides

Pesticide material shall be delivered to the site in the original, unopened containers bearing legible labels indicating the EPA registration number and the manufacturer's registered uses.

1.4.2 Inspection

Seed shall be inspected upon arrival at the job site for conformity to species and quality. Seed that is wet, moldy, or bears a test date five months or older, shall be rejected. Other materials shall be inspected for compliance with specified requirements. The following shall be rejected: open soil amendment containers or wet soil amendments; topsoil that contains slag, cinders, stones, lumps of soil, sticks, roots, trash or other material over a minimum 1-1/2 inch diameter; and topsoil that contains viable plants and plant parts. Unacceptable materials shall be removed from the job site.

1.4.3 Storage

Materials shall be stored in designated areas. Seed and fertilizer shall be stored in cool, dry locations away from contaminants. Chemical treatment material shall be stored according to manufacturer's instructions and not with seeding operation materials.

1.4.4 Handling

Except for bulk deliveries, materials shall not be dropped or dumped from vehicles.

1.4.5 Time Limitation

Hydroseeding time limitation for holding seed in the slurry shall be a maximum 10 hours.

PART 2 PRODUCTS

2.1 SEED

2.1.1 Seed Classification

State-certified seed of the latest season's crop shall be provided in original sealed packages bearing the producer's guaranteed analysis for percentages of mixture, purity, germination, hard seed, weed seed content, and inert material. Labels shall be in conformance with AMS Seed Act and applicable state seed laws.

2.1.2 Native Seed Species and Mixtures

Native seed species and mixtures shall be as follows:

Botanical Name	Common Name	Pure Live Seed (PLS) lbs Per Acre
Buchloe dactyloides	Buffalo Grass	2.5
Eragrostis curvula	Weeping Lovegrass	1.0
Encelia californica	Bush Sunflower	0.2
Encelia farinosa	Desert Encelia	0.5
Erigonum fasciculatum	California Buckwheat	1.5
Eschscholtzia californica	California Poppy	3.0
Festuca megalura	Zorro Grass	1.5
Festuca rubra molate	Native Red Fescue	4.0
Layia platyglossa	Tidy Tips	1.5
Lupinus succulentus	Arroyo Lupin	1.5
Orvzopsis hynenoides	Indian Rice Grass	1.5
Salvia apiana	White Sage	0.3
Total (PLS)lbs per Acre		19.0

2.1.3 Quality

Weed seed shall be a maximum 1 percent by weight of the total mixture.

2.1.4 Seed Mixing

The mixing of seed may be done by the seed supplier prior to delivery, or on site as verified by the Contracting Officer.

2.1.5 Substitutions

Substitutions will not be allowed without written request and approval from the Contracting Officer. The Contractor shall make all arrangements with the seed vendor(s)to hold the required amount of seeds needed for the project. The Contractor shall verify and secure from the seed vendor(s)the required native seed species and quantity no later than 160 days or sooner prior to seeding operations.

2.2 TOPSOIL

Topsoil shall be as defined in ASTM D 5268. The topsoil shall be the top 6 inch of existing surface soil stripped and stockpiled onsite in accordance with Section 02100 CLEAR SITE AND REMOVE OBSTRUCTIONS. When additional topsoil is required beyond the available topsoil from the stripping operation, topsoil shall be delivered and amended as recommended by the soil test(s) for the seed specified. The Contractor shall pay for all soils tests as directed by the Contracting Officer. Topsoil shall be free

from slag, cinders, stones, lumps of soil, sticks, roots, trash or other material over a minimum 3 inches in diameter. Topsoil shall be free from viable plants and plant parts.

2.3 SOIL AMENDMENTS

Soil amendments shall consist of pH adjuster, fertilizer, organic material and soil conditioners meeting the following requirements. Vermiculite shall not be used.

2.3.1 pH Adjuster

The pH adjuster shall not be less than 99 percent elemental sulfur. The pH adjuster shall be used to create a favorable soil pH for the plant material specified.

2.3.2 Fertilizer

Fertilizer shall be commercial grade, free flowing, uniform in composition, and consist of a nitrogen-phosphorus-potassium ratio. The fertilizer shall conform to applicable State and Federal regulations and shall bear the manufacturer's guaranteed statement of analysis.

Nitrogen	5%
Phosphoric Acid	3%
Water Soluble Potash	1%
Humus (composted organic and mineral matter)	50%
Humic Acids (derived from compost)	15%
Soluble Metallic Iron	1%

2.3.3 Organic Material

Organic material shall consist of rotted manure and decomposed wood derivatives.

2.3.3 Rotted Manure

Rotted manure shall be unleached manure containing a maximum 25 percent by volume of sawdust, or other bedding materials. It shall contain no chemicals or ingredients harmful to plants. The manure shall be heat treated to kill weed seeds and be free of stones, sticks, and soil.

2.3.3.2 Decomposed Wood Derivatives

Decomposed wood derivatives shall be rotted sawdust that is free of stones, sticks, soil, and toxic substances harmful to plants, and is fully composted. Rotted sawdust shall be stabilized with 7.5 pounds of nitrogen added uniformly to each cubic yard of material.

2.3.4 Wood Cellulose Fiber

Wood cellulose fiber shall not contain any growth or germination-inhibiting factors and shall be dyed an appropriate color to facilitate placement during application. Composition on air-dry weight basis: 9 to 15 percent moisture, pH range from 4.5 to 6.0

2.4 WATER

Water for native seeding and plant establishment shall be the

responsibility of the Contractor, unless otherwise noted. The Contractor shall pay all water cost. Water shall not contain elements toxic to plant life.

2.5 PESTICIDE

Pesticide shall be insecticide, herbicide, fungicide, nematocide, rodenticide or miticide. For the purpose of this specification, a soil fumigant shall have the same requirements as a pesticide. The pesticide material shall be EPA registered and approved.

PART 3 EXECUTION

3.1 INSTALLING SEED TIME AND CONDITIONS

3.1.1 Seeding Time

Seed shall be installed from 1 October to 31 December.

3.1.2 Seeding Conditions

Seeding operations shall be performed only during periods when beneficial results can be obtained. When drought, excessive moisture, or other unsatisfactory conditions prevail, the work shall be stopped when directed. A time variance to the seeding operations will not be allowed, unless approved by the Contracting Officer.

3.1.3 Equipment Calibration

Immediately prior to the commencement of seeding operations, calibration tests shall be conducted on the equipment to be used. These tests shall confirm that the equipment is operating within the manufacturer's specifications and will meet the specified criteria. The equipment shall be calibrated a minimum of once every day during the operation. The calibration test results shall be provided within 1 week of testing.

3.1.4 Soil Test

Delivered topsoil, existing soil in smooth graded areas, and stockpiled topsoil shall be tested in accordance with ASTM D 5268 and ASTM D 4972 for determining the particle size, pH, organic matter content, textural class, chemical analysis, soluble salts analysis, mechanical and plant growth analysis. Sample collections on site shall be random over the entire site. Sample collections for stockpiled topsoil shall be at different levels in the stockpile. Six (6) samples shall be tested and the locations shall be determined by the Contracting Officer. The planting soil shall be free from debris, noxious weeds, toxic substances, or other materials harmful to plant growth. The test of stockpiled topsoil shall determine if addition quantities of soil amendments and soil conditioners are required to meet local growing conditions for the seed species specified.

3.2 SITE PREPARATION

3.2.1 Finished Grade and Topsoil

The Contractor shall verify that finished grades are as indicated on drawings, and the placing of topsoil, smooth grading, and compaction requirements have been completed in accordance with Section 02200 EXCAVATION and Section 02250 FILLS AND SUBGRADE PREPARATION, prior to the

commencement of the seeding operation.

3.2.2 Application of Soil Amendments

3.2.2.1 Applying pH Adjuster

The pH adjuster shall not be less than 99 percent elemental sulfur applied at the rate of 15 lbs per 1,000 square feet. The pH adjuster shall be incorporated into the soil to a maximum 6 inch depth as part of the tillage operation.

3.2.2.2 Applying Fertilizer

The application rate shall be 150 lbs per 1,000 square feet. Fertilizer shall be incorporated into the soil to a maximum 6 inch depth part of the tillage operation.

3.2.2.3 Rotted Manure

The application rate shall be 200 lbs per 1,000 square feet. The soil conditioner shall be spread uniformly over the soil and thoroughly incorporated by tillage into the soil to a maximum 6 inch depth.

3.2.2.4 Decomposed Wood Derivatives

The application rate shall be 2 cubic yards per 1,000 square feet. The soil conditioner shall be spread uniformly over the soil and thoroughly incorporated by tillage into the soil to a maximum 6 inch depth.

3.2.3 Tillage

Soil on slopes up to a maximum 2-horizontal-to-1-vertical shall be tilled to a minimum 6 inch depth. On slopes between 2-horizontal-to-1-vertical and 1-horizontal-to-1 vertical, the soil shall be tilled to a minimum 2 inch depth by scarifying with heavy rakes, or other approved methods. On slopes between 2-horizontal-to-1-vertical and 1-horizontal-to-1 vertical, fertilizer, soil amendments and soil conditioners shall be reduced by one-half. Rototillers shall be used where soil conditions and length of slope permit. Drainage patterns shall be maintained as indicated on drawings. Areas compacted by construction operations shall be completely pulverized by tillage. Soil used for repair of surface erosion or grade deficiencies shall conform to topsoil requirements. The pH adjuster, fertilizer, and soil conditioner may be applied during this procedure.

3.2.4 Prepared Surface

3.2.4.1 Preparation

The prepared surface shall be a maximum 2 inch below the adjoining grade of any surfaced area. New surfaces shall be blended to existing areas. The prepared surface shall be completed with a light raking to remove debris.

3.2.4.2 Debris

Debris over a minimum 3 inch in any dimension shall be removed from the surface. Rocks and stones may remain in the surface soil at the discretion of the Contracting Officer.

3.2.4.3 Protection

Areas with the prepared surface shall be protected from compaction or damage by vehicular or pedestrian traffic and surface erosion.

3.3 INSTALLATION

Prior to installing seed, any previously prepared surface compacted or damaged shall be reworked to meet the requirements of paragraph SITE PREPARATION. Seeding operations shall not take place when the wind velocity will prevent uniform seed distribution.

3.3.1 Installing Seed

Seeding method shall be by Hydroseeding. Seeding procedure shall ensure even coverage.

3.3.1.1 Broadcast Seeding

Broadcast Seeding shall be for seed re-establishment. Seed shall be uniformly broadcast at the rate of 19 lbs (pls) per acre using broadcast seeders. Half the total rate of seed application shall be broadcast in 1 direction, with the remainder of the seed rate broadcast at 90 degrees from the first direction. Seed shall be covered a maximum 1-1/2 inch by raking, or other approved device. After the seed have been covered the area shall be mulch with 2 inch of decomposed wood derivatives.

3.3.1.2 Hydroseeding

Seed shall be mixed to ensure broadcast at the rate of 19 lbs (pls) per acre. Seed and wood cellulose fiber shall be added to water and thoroughly mixed to meet the rates specified. The time period for the seed to be held in the slurry shall be a maximum 10 hours. Wood cellulose fiber mulch and tackifier rates recommended by the manufacture shall be submitted to the Contracting Officer for approval. Wood cellulose fiber mulch and tackifier shall be added at the rates recommended by the manufacturer after the seed, wood cellulose fiber, and water have been thoroughly mixed to produce a homogeneous slurry. Slurry shall be uniformly applied under pressure over the entire area. The hydroseeded area shall not be rolled.

3.3.2 Wood cellulose fiber mulch and tackifier

Wood cellulose fiber, paper fiber, or recycled paper shall be applied as part of the hydroseeding operation. The mulch and tackifier shall be mixed and applied in accordance with the manufacturer's recommendations.

3.3.3 Watering Seed

Watering shall be started immediately after completing the seeding of an area. Water shall be applied to supplement rainfall at a rate sufficient to ensure moist soil conditions to a minimum 1-1/2 inch depth. Run-off and puddling shall be prevented. Watering trucks shall not be driven over seeded areas, unless otherwise approved by the Contracting Officer. Truck route shall be as shown on the maintenance plan. Watering of other adjacent areas or plant material shall be prevented.

3.4 QUANTITY CHECK

For materials provided in bags, the empty bags shall be retained for recording the amount used. For materials provided in bulk, the weight

certificates shall be retained as a record of the amount used. The amount of material used shall be compared with the total area covered to determine the rate of application used. Differences between the quantity applied and the quantity specified shall be adjusted as directed.

3.5 APPLICATION OF PESTICIDE

When application of a pesticide becomes necessary to remove a pest or disease, a pesticide treatment plan shall be submitted and coordinated with the installation pest management program.

3.5.1 Technical Representative

The certified installation pest management coordinator shall be the technical representative, and shall be present at all meetings concerning treatment measures for pest or disease control. They may be present during treatment application.

3.5.2 Application

A state certified applicator shall apply required pesticides in accordance with EPA label restrictions and recommendations. Clothing and personal protective equipment shall be used as specified on the pesticide label. A closed system is recommended as it prevents the pesticide from coming into contact with the applicator or other persons. Water for formulating shall only come from designated locations. Filling hoses shall be fitted with a backflow preventer meeting local plumbing codes or standards. Overflow shall be prevented during the filling operation. Prior to each day of use, the equipment used for applying pesticide shall be inspected for leaks, clogging, wear, or damage. Any repairs are to be performed immediately. A pesticide plan shall be submitted.

3.6 RESTORATION AND CLEAN UP

3.6.1 Restoration

Seeded areas, pavements, and facilities that have been damaged from the seeding operation shall be restored to original condition at Contractor's expense.

3.6.2 Clean Up

Excess and waste material shall be removed from the seeded areas and shall be disposed offsite on a daily basis. Adjacent paved areas shall be cleaned

3.7 PROTECTION OF INSTALLED AREAS

Immediately upon completion of the seeding operation in an area, the area shall be protected against traffic or other use by erecting barricades and providing signage as required, or as directed. Signage shall be in accordance with this specifications.

3.8 SEED ESTABLISHMENT PERIOD

3.8.1 Commencement

The plant establishment period to obtain a healthy stand of plants shall begin after seeding operation have been completed and approved by the Contracting Officer. The seed establishment period shall be 1 year from

the date of Contracting Officer's approval. Written calendar time period shall be furnished for the seed establishment period. When there is more than 1 seed establishment period, the boundaries of the seeded area covered for each period shall be described. The seed establishment period shall be modified for inclement weather, shut down periods, or for separate completion dates of areas.

3.8.2 Proper Stand of Hydroseed

The seeded area shall have a solid soil surface growth ground covering with bare spots no larger than 4 inches square and with bare areas not to exceed 2 percent of the total seeded area.

3.8.3 Maintenance During Establishment Period

Maintenance of the seeded areas shall include eradicating weeds, insects and diseases; protecting seeded areas from surface erosion; maintaining slopes to design conditions; protecting installed areas from traffic; trash removal; watering; and post-fertilization. Weeds shall be removed as soon as possible and as directed by the Contracting Officer. The Contractor shall provide sufficient work force to remove all weeds from all seeded areas within a 2-week period.

3.8.3.1 Maintenance Plan

The Contractor shall submit a plan, subject to appproval by the Contracting Officer, for watering and maintenance requirements to establish a healthy stand of native plants. The plan shall include watering layouts, procedures and schedules, including but not limited to the temporary irrigation system plan with irrigation lines, valves and equipment layout, maintenance procedures and labor. Other method(s) of water application shall be submitted to the Contracting Officer for approval. Watering trucks shall not be driven over seeded areas, unless an approved route is establish with the least amount of disturbance to the planted areas. The Contractor shall not vary from the plan route once approved by the Contracting Officer. After the plant establish period is over the Contractor shall seed the area disturbed by the watering truck in accordance with paragraph BROADCAST SEEDING.

3.8.3.2 Post-Fertilization

Forty-five (45) days after commencement of plant establishment, fertilizer shall be broadcast over all seeded areas. The application rate shall be 25 lbs per 1,000 square feet.

3.8.3.3 Pesticide Treatment

Treatment for disease or pest shall be in accordance with paragraph: APPLICATION OF PESTICIDE.

3.8.3.4 Repair or Reinstall

Unsatisfactory stand of grass plants and mulch shall be repaired or reinstalled, and eroded areas shall be repaired in accordance with paragraph: SITE PREPARATION.

3.8.3.5 Maintenance Record

A written record shall be furnished to the Contracting Officer describing

the maintenance work performed; day and amount of water applied, areas weeded, areas repaired or reinstalled; and diagnosis for unsatisfactory stand of grass plants.

3.9 FINAL ACCEPTANCE

3.9.1 Preliminary Inspection

Prior to the completion of the establish period, a preliminary inspection shall be held by the Contracting Officer. Time for the inspection shall be establish in writing. The acceptability of the seeded areas in accordance with the specification shall be determined. An unacceptable stand of hydroseeded area shall be replanted in accordance with paragraph BROADCAST SEEDING and as directed by the Contracting Officer as soon as seeding conditions permit.

3.9.2 Final Inspection

A final inspection shall be held by the Contracting Officer to determined that the deficiencies noted in the preliminary inspection have been corrected. Time for the final inspection shall be in writing.

-- End of Section --