LOS OSOS COMMUNITY SERVICES DISTRICT

CONSTRUCTION OF
LOS OSOS WASTEWATER PROJECT
AREA A, AREA B, AREA C, & AREA D

STATE REVOLVING FUND LOAN PROGRAM
PROJECT NO. C – 06 – 4014 - 110

VOLUME IIA:

TECHNICAL SPECIFICATIONS

DIVISION 02 THROUGH DIVISION 10

MWH
MONTGOMERY WATSON HARZA

Bids will be received at the office of the Los Osos Community Services District located at 2122 9th Street, Los Osos, CA 93402 on April 14, 2004.

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DIVISION 02 THROUGH DIVISION 10

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SECTION 02100 - SITE PREPARATION

PART 1 -- GENERAL

1.1 THE REQUIREMENT

A. The WORK of this Section includes measures required during the CONTRACTOR's initial move onto the pump station, disposal system and well facilities sites to protect existing fences, houses and associated improvements, streets, and utilities adjacent to construction areas from damage due to erosion, boulders, trees or other objects dislodged during the construction process; clearing, grubbing and stripping; and regrading of certain areas to receive embankment fill.

1.2 SITE INSPECTION AND SURVEYING

A. Prior to moving onto the Site, the CONTRACTOR shall inspect the Site conditions and review maps of the project area and facilities delineating the OWNER's property and right-of-way lines.

B. The CONTRACTOR shall retain a California Licensed Surveyor (this can be the same individual or firm retained by the CONTRACTOR to perform it's construction staking) to stake the site property corners in order to positively identify the boundaries within which construction must be contained. The site boundaries (adding temporary/construction easement, if any) shall be marked with orange snow fencing or similar method to provide a clear indication to construction personnel.

PART 2 -- PRODUCTS (NOT USED)

PART 3 -- EXECUTION

3.1 SITE ACCESS

A. The CONTRACTOR shall develop any necessary access to the pump station, disposal system and well sites, including access barriers (e.g. temporary chain link fencing) to prohibit entry of unauthorized persons.

B. **Utility Interference:** Where existing utilities interfere with the WORK, notify the utility owner and the ENGINEER before proceeding in accordance with the General Conditions.

3.2 CLEARING, GRUBBING, AND STRIPPING

A. Construction areas shall be cleared of grass and weeds to a minimum depth of 9 inches and cleared of structures, pavement, sidewalks, concrete or masonry debris, trees, logs, upturned stumps, loose boulders, and any other objectionable material of any kind which would interfere with the performance or completion of the WORK, create a hazard to safety, or impair the subsequent usefulness of the WORK, or obstruct its operation. Loose boulders within 10-feet of the top of cut lines shall be incorporated in landscaping or removed from the Site. Trees and other natural vegetation either shown to be retained or outside the actual lines of construction shall be protected from damage during construction. All materials removed shall be hauled from the job site and disposed of at an approved landfill, all at the CONTRACTOR's cost.

B. Within the limits of clearing, the areas below the natural ground surface shall be grubbed to a depth necessary to remove, stumps, roots, buried logs, all vegetation and organic matter and all other objectionable material. Inactive septic tanks, drain fields, and connection lines and any other underground structures, debris or waste shall be removed if found on the Site. All objectionable material from the clearing and grubbing process shall be removed from the Site and wasted in approved locations, all at the CONTRACTOR's cost.

C. Unless otherwise indicated, native trees larger than 3 inches in diameter at the base shall not be removed without the ENGINEER's approval. The removal of any trees, shrubs, fences, or other improvements outside of rights-of-way, if necessary for the CONTRACTOR's choice of means and methods, shall be arranged with the owner of the property, and shall be removed and replaced, at no additional cost to the OWNER.

3.3 OVEREXCAVATION, REGRADING, AND BACKFILL UNDER FILL AREAS

A. After the fill areas have been cleared, grubbed, and excavated, the areas to receive fill will require regrading, and backfill and compaction with suitable materials. The ground surface shall be recontoured for keying the fill and removing severe or abrupt changes in the topography of the Site. Unsuitable materials shall be hauled off site and disposed of at an approved landfill, all at the CONTRACTOR's cost

- END OF SECTION -

SECTION 02120 - SHORING

PART 1 - GENERAL

1.1 SUMMARY

A. The CONTRACTOR shall design, furnish, install, and maintain a system of temporary supports, including all bracing and associated items, to retain excavations in a safe manner, to control ground movements, and prevent detrimental settlement and lateral movement of existing facilities, adjacent property, and completed Work. Upon completion of the required excavation and pipe installation, the CONTRACTOR shall remove the support system, as specified, and backfill the excavations.

B. The CONTRACTOR shall be solely responsible for design, structural strength, integrity, and safety of all shoring, sheeting, bracing, and sloping, and shall repair, at the CONTRACTOR's expense, all damage resulting from inadequate protection. All shoring, sheeting, bracing, and sloping shall conform to the applicable government regulations.

C. The CONTRACTOR shall have sole responsibility for sizing the excavations to accommodate shoring, bracing, pipe and pipe installation to the specified lines, grades and tolerances.

D. The CONTRACTOR's attention is directed to the provisions for "Shoring and Bracing Drawings" in Section 6705 of the California Labor Code. The CONTRACTOR, prior to beginning any trench or structure excavation 5 feet deep or over shall submit to the OWNER and shall be in receipt of the OWNER's written acceptance of the CONTRACTOR's detailed plan showing design of all shoring, bracing, sloping of the sides of excavation, or other provisions for worker protection against the hazard of caving ground during the excavation of such trenches or structure excavation. If such plan varies from the shoring system standards established in the Construction Safety Orders of the State of California, such alternative systems plans shall be prepared by a civil or structural engineer licensed in the State of California. The CONTRACTOR shall submit a copy of the excavation permit issued by the California Department of Industrial Safety.

E. Shoring and dewatering systems shall be designed by the CONTRACTOR, compatibly. See Section 01240.

F. The CONTRACTOR shall thoroughly review the Project Geotechnical Report.

G. **Due to the generally sandy conditions and the presence of groundwater at certain site locations, the CONTRACTOR is hereby advised that shoring will present an appreciable construction consideration. The CONTRACTOR shall plan, include all costs in its bid and execute the WORK accordingly.**

H. Existing roads and underground utilities are in fragile condition. The CONTRACTOR shall design and use shoring systems to prevent sloughing and cave-ins and to otherwise protect these improvements.

I. CONTRACTOR's electing to use trench shields or trench boxes shall prevent sloughing and cave-ins and shall prevent shield movement from affecting the

installed pipeline. The CONTRACTOR should consider use of trench shields or boxes having struts that can be jacked out against the trench wall and then retracted when the box is advanced. Also see Paragraph 3.3.C.

J. All boring and receiving pits and pump station excavations shall be provided with continuous solid shoring. Also see Paragraph 1.1.K below.

K. Pump Stations will likely be installed in sandy conditions below the groundwater table. Dewatering or wet construction techniques will likely be needed to allow for pump station construction. Installation methods can likely consist of shoring and dewatering the pump station excavation or sinking the wetwell and potentially valve vault using caisson type construction where material is excavated from the center of the structure allowing it to sink into the ground. Selection and use of these means and methods are strictly at the CONTRACTOR's option and responsibility.

1.2 RELATED WORK SPECIFIED ELSEWHERE

A. SECTION 01535, SETTLEMENT MONITORING

B. SECTION 02100, SITE PREPARATION.

B. SECTION 02200, EARTHWORK.

C. SECTION 02140, DEWATERING.

1.3 (NOT USED)

1.4 SUBMITTALS

A. Submittals shall be made in accordance with Section 01300 – Submittals.

B. Shop drawings shall be submitted for excavation support systems and other related information as requested by the ENGINEER and in accordance with the California Labor Code. As a minimum, the following information shall be submitted:

1. Name and qualifications of person responsible for excavation support system design.

2. Details of shoring and bracing or other provisions for worker protection from hazards of caving ground.

3. Details of shoring and bracing or other provisions for protection of adjacent pavements, utilities, structures and other improvements from hazards of caving ground and/or settlement.

4. Design assumptions and calculations.

5. Methods and sequencing of excavation and installation of staged excavation support.

6. Proposed locations of stockpiled excavated material.

7. Minimum lateral distance from the crest of slopes for vehicles and stockpiled excavated materials.

8. Anticipated difficulties and proposed resolutions.

9. Backfilling of voids as required to minimize ground movement and protect adjacent property.

10. Control of water, method of maintaining bottom stability, and protection of subgrade.

11. Settlement monitoring facilities and procedures.

C. Reports and Records: The CONTRACTOR shall submit the following to the ENGINEER on each day that measurements are made:

1. Excavation monitoring data of horizontal and vertical deflections of supports.

2. Settlement and deformation monitoring data.

1.5 DESIGN CRITERIA

A. The size type and design of shoring and protection methods are the CONTRACTOR's responsibility, and are subject to review and approval by the ENGINEER.

B. In all areas, excavation support systems shall be designed by the CONTRACTOR to support earth pressure, unrelieved hydrostatic pressures, bottom heave, utility loads, equipment, applicable traffic loads, and other surcharge loads in such manner as will allow safe construction and will prevent damage to adjacent improvements and structures (including roads, existing pipelines and utilities) and injury to workers and the public. In addition, the installation of excavation support systems shall not cause a disruption to public convenience or access.

C. Excavation support systems shall be designed to be compatible with the geologic conditions described in the Geotechnical Report including any adjacent slope support structures.

D. The support system shall be designed to minimize horizontal and vertical movements and to protect adjacent utilities from damage. Also see Section 01535 - Settlement Monitoring.

E. Excavation support systems shall be designed to be compatible with and not interfere with the dewatering systems for control of water, maintaining bottom stability and protection of subgrade.

F. Excavation support systems shall be designed by a Civil or Structural Engineer registered in the State of California who has a minimum of five years experience in the design of soil retaining structures.

G. The ENGINEER's approval of the CONTRACTOR's shoring submittals does not relieve the CONTRACTOR of the full responsibility for the adequacy of the design, installation and removal or serviceability of it's shoring systems.

1.6 WARRANTY

A. The CONTRACTOR shall be solely responsible for, and bear the sole burden of cost for any and all damages resulting from improper shoring or failure to shore.

B. The safety of workmen, the protection of adjacent structures, property and utilities, and the installation of adequate supports for all excavations shall be the sole responsibility of the CONTRACTOR.

C. The design, planning, installation and removal of all shoring shall be accomplished in such a manner as to maintain stability of the required excavation and to prevent the movement of soil that may cause damage to adjacent shoring systems, structures, pavements and utilities, damage or delay the work, or endanger life and health.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.1 GENERAL

A. Excavations shall commence only after receiving a favorable review of applicable submittals by the ENGINEER. Install excavation support systems in accordance with submittals which have been reviewed by the ENGINEER.

B. Before beginning construction, adequately protect existing structures, utilities, trees, shrubs, and other existing facilities. The repair of or compensation for damage to existing facilities shall be at no cost to the OWNER.

D. Excavation shall be performed in accordance with the requirements of Section 02200, EARTHWORK and in sequence with installation of shoring and bracing in a manner that limits settlement of surrounding ground and adjacent conduits, structures, or roads and so as to offer no hazard to structures or train, truck or automobile operations.

E. Shoring shall be performed in accordance with the approved shoring submittal, a copy of which shall be maintained at each excavation site.

F. The CONTRACTOR shall notify the ENGINEER not less than 15 days before beginning any excavation. Excavations and construction for site development shall not extend beyond the property lines and limits of disturbance shown on the Plans.

G. The CONTRACTOR shall conduct all excavation, shoring, temporary facilities, materials storage, and construction traffic within construction easements established for this project. All work shall be in accordance with the applicable permit.

H. All welding shall conform to the applicable provisions of ANSI/AWS D1.1.

I. The CONTRACTOR shall provide temporary Type K safety railing and, excepting for pipeline work, fencing around all excavations. Provide "Danger, Keep Out" signs at each side of the excavation. Also see the Contract Documents traffic control requirements.

J. The maximum height of unsupported sidewall span shall be in accordance with OSHA regulations, 29 CFR Part 1926 – Excavation Standards.

K. Tolerances: Unless more stringent tolerances are noted or required on shop drawings, the location of the excavation supports shall be within 3 inches of that shown on the shop drawings.

L. Trench and excavation spoils shall be stockpiled away from the trench or excavation to avoid imposing surcharge loads. Alternatively, the shoring system should be designed for the additional surcharge.

3.2 INSTRUMENTATION AND SETTLEMENT MONITORING

A. Performance of excavation support system shall be monitored by the CONTRACTOR for both horizontal and vertical deflections. Also see Section 01535 - Settlement Monitoring.

B. If excessive settlement or deflections of supports occur that exceed those values predicted by the CONTRACTOR's shoring designer modifications to the excavation and shoring approach will be required. Revised shop drawings and calculations shall be submitted to the ENGINEER. Changes to excavation sequence and shoring shall be implemented as may be necessary at no additional cost to the OWNER.

3.3 REMOVAL OR MOVEMENT OF SUPPORT SYSTEM

A. Excavation support shall not be removed until support can be removed without damage to completed work existing facilities, or adjacent property.

B. Excavation support shall be removed in a manner that will maintain support as excavation is backfilled and will not leave voids in backfill. Removal of the support system shall be performed in a manner that will not disturb the pipeline or structure, the compacted backfill, or adjacent construction or facilities.

C. Trench shoring boxes/shields shall be moved in a manner that prevents pipe movement off grade or horizontally or pipe disjointing and prevents disturbing the pipezone backfill material and geotextile and prevents creation of voids.

C. Any void left by shoring system or voids created by the removal of the shoring system shall be filled with CLSM or as approved by the ENGINEER to provide soil support between backfill zone and the native soil.

D. Sheet piling removal shall be performed in a manner that will avoid "vibro-consolidation" of sandy or granular material below the excavation that could lead to settlement of the pipeline, structures or other works of construction or existing structures and other improvements.

E. The support system removed from the excavation shall remain the property of the CONTRACTOR and shall be removed from the site.

- END OF SECTION -

SECTION 02140 - DEWATERING

PART 1 -- GENERAL

1.1 THE REQUIREMENT

A. The CONTRACTOR shall dewater trench and structure excavations, in accordance with the Contract Documents. The CONTRACTOR shall secure all necessary permits to complete the requirements of this Section of the Specifications.

B. **The CONTRACTOR is hereby advised that due to the presence of sands and other permeable materials and extensive and shallow groundwater at the project site, that dewatering presents an appreciable construction challenge. The CONTRACTOR shall plan, include all costs in its bid and execute the project construction accordingly**. Also see Paragraph 3.1.K, below.

C. Dewatering and shoring systems shall be designed to be compatible with each other thereby ensuring dry and stable excavations.

D. The CONTRACTOR shall obtain and abide by all permits necessary for dewatering including from the RWQCB. Also see Section 01060 - Regulatory Agency and Utility requirements.

E. An NPDES Construction Activity Storm Water Permit shall be obtained by the CONTRACTOR prior to beginning construction activities. (See SWPPP requirements in Section 01562). The CONTRACTOR'S dewatering water disposal activities shall be in compliance with the requirements of same.

1.2 CONTRACTOR SUBMITTALS

A. Prior to commencement of excavation, the CONTRACTOR shall submit a detailed plan and operation schedule for dewatering of excavations. At the time of the first excavation, The CONTRACTOR shall be required to demonstrate the system proposed and to verify that adequate equipment, personnel, and materials are provided to dewater the excavations at all locations and times. The CONTRACTOR's dewatering plan shall be reviewed by the ENGINEER.

B. **The CONTRACTOR shall thoroughly review the project Geotechnical Report prior to developing its dewatering approach and plan.**

1.3 QUALITY CONTROL

A. It shall be the sole responsibility of the CONTRACTOR to control the rate and effect of the dewatering in such a manner as to avoid all objectionable settlement and subsidence.

B. All dewatering operations shall be adequate to assure the integrity of the finished project and shall be the responsibility of the CONTRACTOR.

C. Where critical structures or facilities exist immediately adjacent to areas of proposed dewatering, reference points shall be established and observed at frequent intervals to detect any settlement that may develop. The responsibility for conducting the dewatering operation in a manner which will protect adjacent structures and facilities

rests solely with the CONTRACTOR. The cost of repairing any damage to adjacent structures and restoration of facilities shall be the responsibility of the CONTRACTOR. Also see Section 01535 – Settlement Monitoring.

PART 2 -- PRODUCTS

2.1 EQUIPMENT

A. Dewatering, where required, may include the use of wells, well points, sump pumps, temporary pipelines for water disposal, rock or gravel placement, and other means. Standby pumping equipment including standby generators shall be maintained on the Site at all times

B. The CONTRACTOR shall provide a dewatering system failure alarm with auto dialer or a person to monitor the system during working and non-working hours.

PART 3 -- EXECUTION

3.1 GENERAL REQUIREMENTS

A. The CONTRACTOR shall provide all manpower, equipment and materials necessary for dewatering. It shall have on hand, at all times, sufficient pumping and generator equipment and other machinery in good working condition and shall have available, at all times, competent workmen for the operation of the pumping equipment. Adequate standby equipment shall be kept available at all times to insure efficient dewatering and maintenance of dewatering operation during power failure.

B. Dewatering for structures and pipelines shall commence when groundwater is first encountered, and shall be continuous until such times as water can be allowed to rise in accordance with the provisions of this Section or other requirements.

C. At all times, site grading shall promote drainage. Surface runoff shall be diverted from excavations. Water entering the excavation from surface runoff shall be collected in shallow ditches around the perimeter of the excavation, drained to sumps, and be pumped or drained by gravity from the excavation to maintain a bottom free from standing water.

D. Dewatering shall at all times be conducted in such a manner as to preserve the undisturbed bearing capacity of the subgrade soils at proposed bottom of excavation to prevent softening, boils, quick and other undesirable conditions.

E. If foundation soils are disturbed or loosened by the upward seepage of water or an uncontrolled flow of water, the affected areas shall be excavated and replaced with drain rock wrapped in geotextile, or other method approved by the ENGINEER. All of the foregoing shall be at the CONTRACTOR'S cost.

F. The CONTRACTOR shall maintain the water level a minimum of one (1) foot below the bottom of excavation in all work areas where groundwater occurs during excavation construction, pipeline or structure installation and backfilling/compaction.

G. Flotation shall be prevented by the CONTRACTOR by maintaining a positive and continuous removal of water. The CONTRACTOR shall be fully responsible and liable for all damages that may result from failure to adequately keep excavations dewatered.

H. If well points or wells are used, they shall be adequately spaced to provide the necessary dewatering and shall be sand-packed and/or other means used to prevent pumping of fine sands or silts from the subsurface. A continual check by the CONTRACTOR shall be maintained to ensure that the subsurface soil is not being removed by the dewatering operation.

I. The CONTRACTOR shall dispose of water from the WORK in a suitable manner without damage to adjacent property. CONTRACTOR shall be responsible for obtaining any permits that may be necessary to dispose of water. No water shall be drained into work built or under construction without prior consent of the ENGINEER. If the new sanitary sewer or other pipeline is used for dewatering water disposal, the CONTRACTOR shall thoroughly desilt the water prior to discharge then clean the pipeline in accordance with Sections 01655 and 01656. Water shall be settled and/or filtered using an approved method to remove sand and fine-sized soil particles before disposal into any drainage system. The CONTRACTOR shall bear the cost for cleaning solids that escape the removal system and enter drainage facilities.

J. Existing storm drainage facilities within the project area are very limited and are owned and operated by San Luis Obispo County, the OWNER and others including private facilities. In addition, few streets have curb and gutter. The CONTRACTOR shall not discharge dewatering water to the street that may result in erosion and/or property damage or create traffic impacts.

K. **Because existing storm drainage facilities are very limited and due to the potentially high flow rates and volumes anticipated, the CONTRACTOR is hereby advised that dewatering water disposal will represent an appreciable construction challenge and the CONTRACTOR shall plan, include all costs in its bid and execute the work accordingly. Temporary pumps and pipelines to convey dewatering water to a suitable disposal location may be required. Construction of temporary dry wells may also be required. Storm water detention and percolation basins exist in certain locations only and the CONTRACTOR shall obtain permission from the owner of said facility prior to use for dewatering water disposal. Certain basins are privately owned. The CONTRACTOR shall be responsible to clean and restore all basins after use. The CONTRACTOR shall not discharge any dewatering water to streams or to bodies of water that discharge to Morro Bay or to the Bay itself.**

L. The release of groundwater to its static level shall be performed in such a manner as to maintain the undisturbed state of the natural foundation soils, prevent disturbance of compacted backfill and prevent flotation or movement of structures, pipelines, and sewers.

M. Groundwater conditions are shallow in many areas of the project site. In some areas of the project site groundwater daylights on the surface resulting in areas of ponding, springs and seeps. Certain project areas are also prone to flooding. The CONTRACTOR shall plan, include all costs in its bid and execute the work accordingly.

N. Groundwater and surface conditions along the coastal areas of the project site (southern shore of Morro Bay) are likely influenced by tidal fluctuations. Groundwater level will also fluctuate seasonally and with variations in storm water runoff, irrigation schedules, rainfall and other factors. The CONTRACTOR shall plan, include all costs in its bid and execute the work accordingly.

O. Dewatering facilities shall be designed with filters such that sand and fine grained materials are not removed from the soil during dewatering. All dewatering water shall be desilted prior to discharge.

P. Although the soil conditions encountered generally consist of sandy materials, layers of moderately cemented, dense sand and clay were encountered in some of the geotechnical investigation explorations at depth. These types of conditions can perch groundwater and subsequently reduce the effectiveness of dewatering wells constructed at depth to drawdown the water table. The CONTRACTOR shall plan, include all costs in its bid and execute the work accordingly.

Q. Dewatering of trenches and other excavations shall be considered as incidental to the construction of the WORK and all costs thereof shall be included in the various contract prices in the Bid Forms.

- END OF SECTION -

SECTION 02181 – TEMPORARY SHAFTS (RECEIVING SHAFTS) CONSTRUCTION

PART 1 -- GENERAL

1.1 THE REQUIREMENT

A. This Section specifies minimum construction requirements for the temporary microtunneling receiving shaft.

B. The construction method for the receiving shafts shall form a continuous and closed wall system and may be constructed of: (1) sheet piling; (2) a combination of soldier piles and lagging with sheet piling; or (3) a reinforced concrete caisson constructed using the sunken caisson method. The CONTRACTOR shall select the construction method used for the receiving shafts subject to the requirements herein and the requirements of Section 02160 – Excavation Support Systems. The size, shape, and bottom elevation of the receiving shafts shall be as determined by the CONTRACTOR. These shafts shall be used to receive the microtunneling machine. The CONTRACTOR may propose alternative construction methods for the receiving shafts, subject to review and approval by the ENGINEER.

C. This Section includes requirements for designing, furnishing, installing, maintaining, leaving in-place, and removing excavation support systems as indicated and required.

1.2 REFERENCE CODES, REGULATIONS, SPECIFICATIONS, AND STANDARDS

A. Reference codes, regulations, specification and standards include, but are not limited to:

1. California Labor Code.

2. Occupational Safety and Health Administrative Code.

3. Caltrans Trenching and Shoring Manual.

1.3 QUALITY CONTROL

A. Designs shall be prepared, stamped, sealed and signed by a Civil or Structural Engineer licensed in the State of California.

B. Support of excavations shall be designed in accordance with the criteria specified an/or shown on the Drawings.

1.4 CONTRACTOR SUBMITTALS

A. In accordance with Section 01300 – Contractor Submittals, the CONTRACTOR shall submit the following information on the construction of each temporary shaft for review by the ENGINEER prior to commencing construction of the shafts. This information shall be prepared, stamped and signed by Professional civil or Structural Engineer currently licensed in the State of California.

1. Overall sequence of construction for each shaft.

2. Description and schedule of equipment and procedures proposed to be utilized to construct the receiving shafts; to execute the associated excavation, dewatering,

and vertical and horizontal deformation monitoring; and to protect existing structures and utilities.

3. Scaled drawings (plan and section views with dimensions and sizes) showing the proposed receiving shaft elements (Including bracing); adjacent and nearby existing structures and utilities; details of microtunneling pipe penetrations; and details of pipe penetrations.

4. Design calculations and details of thrust blocks for microtunneling.

5. Description of contingency plans for excessive movement of receiving shaft elements.

6. Method and details of excavation including method of hoisting excavated material and methods for hauling and disposal of the excavated materials.

7. Details of the microtunneling receiving seals at the temporary shafts for the microtunneling operations.

8. Procedures for checking and ensuring proper elevation of the shaft placement.

9. Details for dewatering the inside of the shafts.

10. Details for removal of the microtunneling machine at the receiving shafts.

11. Information on materials and strength of materials used to stabilize any weak or running soils at the receiving shaft faces where pipe penetrations occur.

1.5 DESIGN CRITERIA

A. Design receiving shafts to support earth and groundwater pressures (in accordance with the Geotechnical Report and the other requirements described in these specifications), utility loads, equipment, applicable traffic and construction loads, and other surcharge loads in a manner which will allow the safe and expeditious construction of permanent facilities without excessive movement or settlement of the ground and in a manner which will prevent damage to, or movement of, adjacent structures, utilities, or other facilities without excessive movement or settlement of the ground and in a manner which will prevent damage to, or movement of, adjacent structures, utilities, or other facilities. Include evaluation of the effects of dewatering where dewatering activities are necessary.

B. Design each support member to support the maximum loads which may occur during construction.

C. Install bottom of support systems to a sufficient depth below the main excavation to prevent excessive lateral and vertical movement of ground both inside and outside of the excavation and to prevent excessive inflow of water.

D. Design the receiving shafts to allow the required free excavated space for workers and groundwater control systems and to accommodate indicated permanent facilities.

E. Design the receiving shafts for staged installation and removal to accommodate construction and backfill sequences.

1.6 CONTINGENCIES

A. The CONTRACTOR shall monitor performance of components of receiving shafts, both for vertical and horizontal movement, at regular intervals.

B. The CONTRACTOR shall provide and secure approval for a contingency plan, or alternative procedures, to be implemented in the event of an unfavorable performance of the system.

C. The CONTRACTOR shall have materials and equipment available to implement the approved contingency plan.

1.7 REVIEW

A. Review of the CONTRACTOR's plans and methods of construction of the temporary shafts shall not relieve the CONTRACTOR o its sole responsibility to provide adequate receiving shafts to support all load configurations encountered to complete the required work.

PART 2 -- PRODUCTS

2.1 GENERAL

A. Products shall be in accordance with the requirements of Section 02160 – Excavation Support Systems.

PART 3 -- EXECUTION

3.1 GENERAL

A. Execution shall be in accordance with the requirements of Section 02160 – Excavation Support Systems.

- END OF SECTION -

SECTION 02200 - EARTHWORK

PART 1 -- GENERAL

1.1 THE REQUIREMENT

A. The CONTRACTOR shall perform all earthwork indicated and required for construction of the WORK, complete and in place, in accordance with the Contract Documents.

B. **The CONTRACTOR shall review and become thoroughly familiar with the Project Geotechnical Report. The generally sandy soils and areas of shallow groundwater represent appreciable construction challenges. The CONTRACTOR shall plan, include all costs in its bid and execute the WORK accordingly. Also see Section 02140 – Dewatering and Section 02120 - Shoring.**

C. In groundwater areas the CONTRATOR may consider, though is not required to employ, use of caisson-type construction for the pump stations. See Section 1255 – Caissons. Selection of construction means and methods is strictly the CONTRACTOR's responsibility.

1.2 CONTRACTOR SUBMITTALS

A. The CONTRACTOR's attention is directed to the provisions for "Shoring and Bracing Drawings" in Section 6705 of the California Labor Code. The CONTRACTOR, prior to beginning any trench or structure excavation 5 feet deep or over shall submit to the OWNER and shall be in receipt of the OWNER's written acceptance of the CONTRACTOR's detailed plan showing design of all shoring, bracing, sloping of the sides of excavation, or other provisions for worker protection against the hazard of caving ground during the excavation of such trenches or structure excavation. If such plan varies from the shoring system standards established in the Construction Safety Orders of the State of California, such alternative systems plans shall be prepared by a civil or structural engineer licensed in the State of California.

B. The CONTRACTOR shall submit a copy of the excavation permit issued by the California Department of Industrial Safety.

C. The CONTRACTOR shall submit samples of all materials proposed to be used in the work in accordance with the requirements in Section 01300 - Contractor Submittals. Sample sizes shall be as determined by the testing laboratory.

PART 2 -- PRODUCTS

2.1 SUITABLE FILL AND BACKFILL MATERIAL REQUIREMENTS

A. **General:** Fill, backfill, and embankment materials shall be selected or processed clean, fine earth, rock, or sand, free from grass, roots, brush, or other vegetation.

B. Fill and backfill materials to be placed within 6 inches of any structure or pipe shall be free of rocks or unbroken masses of earth materials having a maximum dimension larger than 3 inches.

C. **Suitable Materials:** Materials not defined as unsuitable below are defined as suitable materials and may be used in fills, backfilling, and embankment construction subject to

the indicated limitations. In addition, when acceptable to the ENGINEER, some of the material listed as unsuitable may be used when thoroughly mixed with suitable material to form a stable composite.

D. Suitable materials may be obtained from on-site excavations, may be processed on-site materials, or may be imported. If imported materials are required by this Section or to meet the quantity requirements of the project, the CONTRACTOR shall provide the imported materials at no additional expense to the OWNER.

E. The following types of suitable materials are defined:

1. Type A (three-quarters inch minus granular backfill): Crushed rock or gravel, and sand with the gradation requirements below. The material shall have a minimum sand equivalent value of 28 and a minimum R-value of 78. If the sand equivalent value exceeds 35 the R-value requirement is waived.

Sieve Size	Percentage Passing
3/4-inch	100
No. 4	30 - 50
No. 200	0 - 12

2. Type B (Class I crushed stone): Manufactured angular, crushed stone, crushed rock, or crushed slag with the following gradation requirements. The material shall have a minimum sand equivalent value of 75.

Sieve Size	Percentage Passing
3/4-inch	100
No. 4	30 - 50
No. 200	0 - 5

3. Type C (sand backfill): Sand with 100 percent passing a 3/8-inch sieve, at least 90 percent passing a Number 4 sieve, and a sand equivalent value not less than 30.

4. Type D: (sand): Native sand or import material having a sand equivalent (SE per ASTM 2419) of at least 30 and conforming to Section 19-3.025B, Sand Bedding of the Caltrans Standard Specifications.

5. Type E (backfill): Crushed rock or gravel the size gradation for Size Number 8 in ASTM C 33 – Concrete Aggregates.

Sieve Size	Percentage Passing
½"	100
3/8"	85-100
No. 4	10-30
No. 8	0-10
No. 16	0-5

6. Type F (coarse drainrock): Crushed rock or gravel with the size gradation for Size Number 4 in ASTM C 33.

7. Type G (aggregate base): Aggregate base material of such nature that it can be compacted readily by watering and rolling to form a firm, stable base for pavements. . Aggregate may include material processed from reclaimed asphalt concrete, Portland cement concrete, lean concrete base, cement treated base or a combination of any of these materials. The amount of reclaimed material shall not exceed 50 percent of the total volume of the aggregate used.

   At the option of the CONTRACTOR, the grading for either the 1-1/2-inch maximum size or 3/4-inch maximum size gradation shall be used. The sand equivalent value shall be not less than 22, and the material shall meet the following gradation requirements:

	Percentage Passing	
Sieve Size	1-1/2-inch Max. Gradation	3/4-inch Max. Gradation
2-inch	100	-
1-1/2-inch	90 - 100	-
1-inch	-	100
3/4-inch	50 - 85	90 - 100
No. 4	25 - 45	35 - 55
No. 30	10 - 25	10 - 30
No. 200	2 - 9	2 – 9

QUALITY REQUIREMENTS

Test	Test Method	Contract Compliance
Resistance (R-value)	Calif. 301	78 Min.
Sand Equivalent	Calif. 217	35Min.
Durability Index	Calif. 229	35 Min.

8. Type H (graded drainrock): Drainrock shall be crushed rock or gravel, durable and free from slaking or decomposition under the action of alternate wetting or drying. The material shall be uniformly graded and shall meet the gradation requirements for Size Number 57 in ASTM C 33:

   The drainrock shall have a sand equivalent value not less than 75. The finish graded surface of the drainrock immediately beneath hydraulic structures shall be stabilized to provide a firm, smooth surface upon which to construct reinforced concrete floor slabs. The CONTRACTOR shall use, at its option, one of the asphalt types listed below:

	Type 1	Type 2	Type 3
Designation	SC-800	SC-250	RS-1
Spray Temperature (°F)	175-255	165-200	70-120
Coverage (gal/sq yd)	0.50	0.50	0.50

If the surface remains tacky, sufficient sand shall be applied to absorb the excess asphalt.

Type I: Trench Backfill, Retaining Wall Backfill, Embankment Fill, and General Fill.Suitable on-site or imported material that is free of organics, debris, oversized material greater than 3 inches, or other deleterious materials and meets the requirements of Paragraph 2.3

9. Type J (cement-treated backfill): Material which consists of Type H material, or any mixture of Types B, C, G, and H materials which has been cement-treated so that the cement content of the material is not less than 5 percent by weight when tested in accordance with ASTM D 2901 - Standard Test Method for Cement Content of Freshly Mixed Soil Cement. The ultimate compressive strength at 28 days shall be not less than 400 psi when tested in accordance with ASTM D 1633 - Standard Test Method for Compressive Strength of Molded Soil - Cement Cylinders.

10. Type K (topsoil): Stockpiled topsoil material which has been obtained at the site by removing soil to a depth not exceeding 2 feet. Removal of the topsoil shall be done after the area has been stripped of vegetation and debris.

11. Type L (controlled low strength material): Controlled low strength material shall be in accordance with Section 02210 - Controlled Low Strength Material.

12. Type M (Aggregate Subbase): Aggregate subbase material that can be compacted readily by watering and rolling to form a firm stable base. Aggregate shall conform to the grading and quality requirements shown in the following tables for Class 4 AS:

CLASS 4 AGGREGATE SUBBASE GRADING REQUIREMENTS
(PERCENTAGE PASSING)

Sieve Size	Operating Range	Contract Compliance
75 mm	100	100
63 mm	--	---
No. 4 (4.75 mm)	35 to 100	30 to 100
No. 200 (0.075 mm)	0 to 20	0 to 23

(Quality Requirements)

Test	Method	Contract Compliance
Sand Equivalent	Calif. 217	20 min.
R-value	Calif. 301	50 min.

13. Type N (trench plug): Low permeable fill material, a non-dispersible clay material having a minimum plasticity index of 10. Alternatively, Controlled Low Strength Material (CLSM) may be used for trench plug construction.

14. Type O (coarse aggregate): Coarse aggregate as per Section 90-3.02 of the Caltrans Standard Specifications.

2.2 UNSUITABLE MATERIAL

A. Unsuitable materials include the materials listed below.

1. Soils which, when classified under ASTM D 2487 - Standard Classification of Soils for Engineering Purposes (Unified Soil Classification System), fall in the classifications of Pt, OH, CH, MH, or OL.

2. Soils which cannot be compacted sufficiently to achieve the density specified for the intended use. Also see Paragraph 2.2.A.6.

3. Materials that contain hazardous or designated waste materials including petroleum hydrocarbons, pesticides, heavy metals, and any material which may be classified as hazardous or toxic according to applicable regulations.

4. Soils that contain greater concentrations of chloride or sulfate ions, or have a soil resistively or pH less than the existing on-site soils.

5. Topsoil, except as allowed below.

6. **Soils that cannot be compacted because they are at greater than optimum moisture content are not unsuitable. The CONTRACTOR shall blade, aerate and/or mix with dry material such that optimum moisture is achieved.**

2.3 USE OF FILL, BACKFILL, AND EMBANKMENT MATERIAL TYPES

A. The CONTRACTOR shall use the types of materials as designated herein for all required fill, backfill, and embankment construction hereunder.

B. Where these Specifications conflict with the requirements of any local agency having jurisdiction or with the requirements of a pipe material manufacturer, the ENGINEER shall be immediately notified. In case of conflict between types of pipe embedment backfills, the CONTRACTOR shall use the agency-specified backfill material if that material provides a greater degree of structural support to the pipe, as determined by the ENGINEER. In case of conflict between types of trench or final backfill types, the CONTRACTOR shall use the agency-specified backfill material if that material provides the greater in-place density after compaction.

C. Fill and backfill types shall be used in accordance with the following provisions:

1. Embankment fills and General Fill shall be constructed of Type I material, as defined herein.

   Fill materials to be placed within 3 feet of finished grade in pavement areas shall have an R-Value of at least 50 as determined by California Test 301.

   Imported fill materials used in building areas shall have an Expansion Index of less than 20. Imported fill materials shall be reviewed by the ENGINEER prior to being brought to the site; however, imported fill materials shall comply with all specifications for those materials as placed at the site.

2. Pipe zone backfill, as defined under "Pipe and Utility Trench Backfill" below, shall consist of the following materials.

   a. For dry trench conditions (i.e. non-groundwater areas) for pipelines up to 12 inches in diameter, the pipe zone material shall be Type D material obtained on-site. At the CONTRACTOR's option and cost imported materials may be used. Suitable imported materials are Types D,E and G . If Type E is used, the CONTRACTOR shall wrap the bedding in geotextile, also at its cost.

   b. For pipelines 12 inches and greater in diameter and for **all** pipelines in wet trench conditions (i.e. in groundwater areas with proper dewatering) the pipe zonefrom below the pipe to the pipe springline.

3. Trench zone backfill for pipelines as defined under "Pipe and Utility Trench Backfill" shall be Type I backfill material Trench zone backfill material shall have at least 85 percent of the material passing the No. 4 sieve. Type K material may be used for trench zone backfill in agricultural areas unless otherwise shown or specified.

4. Final backfill material for pipelines under paved areas, as defined under "Pipe and Utility Trench Backfill" shall be Type G backfill material. Final backfill under areas not paved shall be the same material as that used for trench backfill, except that Type K material shall be used for final backfill in agricultural areas unless otherwise indicated.

5. Trench backfill and final backfill for pipelines under structures shall be the same material as used in the pipe zone, except where concrete encasement is required by the Contract Documents.

6. Aggregate base materials under pavements shall be Type G material constructed to the thicknesses indicated. Aggregate subbase shall be Type M material. Trench backfill materials placed within 3 feet of finished grade in pavement areas shall have an R-value of at least 50 as determined by Caltrans Test 301.

7. Backfill around structures shall be Type I material, except as shown.

8. Backfill materials beneath structures shall be as follows:

   a. Drainrock materials under hydraulic structures or other water retaining structures with underdrain systems shall be Type H material.

   b. Under concrete hydraulic structures or other water retaining structures without underdrain systems, Types G or H materials shall be used.

   c. Under structures where groundwater must be removed to allow placement of concrete, Type F material wrapped in geotextile shall be used.

   d. Under all other structures, Type G or H material shall be used.

9. Backfill for disposal system vertical well and horizontal french drain type systems shall be Type E gravel.

10. Gravel backfill for the retaining wall chimney and collection drains shall be a Type H material.

11. Retaining wall backfill material shall consist of a Type I native or imported material conforming to Caltrans Standard Specifications for Structural Backfill, Section 19-3.06, and having a sand equivalent (SE) of at least 30.

12. The top 6 inches of fill on reservoir roofs, embankment fills around hydraulic structures, and all other embankment fills shall consist of Type K material, topsoil.

13. Geotextile for separation (filter fabric) shall consist of nonwoven geotextile that conforms to the requirements outlined in the Caltrans Standard Specifications for Filter Fabric-underdrains, Section 88-1.03.

14. Geotextile for Subgrade Stabilization: Geotextile to be used for subgrade stabilization in building areas shall conform to the requirements outlined in Caltrans Standard Specifications for Rock Slope Protection Fabric - Type B, Section 88-1.04.

2.4 MATERIALS TESTING

A. All soils testing of samples submitted by the CONTRACTOR will be done by a testing laboratory of the OWNER'S choice and at the OWNER'S expense. At its discretion, the ENGINEER may request that the CONTRACTOR supply samples for testing of any material used in the work. All materials shall comply with the specifications as-placed at the job site.

B. Particle size analysis of soils and aggregates will be performed using ASTM D 422 - Standard Test Method for Particle-Size Analysis of Soils.

C. Determination of sand equivalent value will be performed using ASTM D 2419 - Standard Test Method for Sand Equivalent Value of Soils and Fine Aggregate.

D. **Unified Soil Classification System:** References in this Section to soil classification types and standards shall have the meanings and definitions indicated in ASTM D 2487. The CONTRACTOR shall be bound by all applicable provisions of said ASTM D 2487 in the interpretation of soil classifications.

E. The testing for chloride, sulfate, resistively, and pH will be done in accordance with California Test Methods 532 and 643 of the California Department of Transportation.

2.5 TRACER WIRE

A. A.Unless indicated otherwise, ten (10) gauge tracer wire shall be placed above all buried pipelines which are not comprised at least in part of magnetic components.

B. B. If purple pipe is not used for disposal main pipelines, a purple warning tape stating "Warning: Reclaimed Water Pipeline Below" shall be provided in addition to the tracer wire.

PART 3 -- EXECUTION

3.1 EXCAVATION - GENERAL

A. **General:** Except when specifically provided to the contrary, excavation shall include the removal of all materials of whatever nature encountered, including all obstructions of any nature that would interfere with the proper execution and completion of the WORK. The removal of said materials shall conform to the lines and grades indicated or ordered.

Unless otherwise indicated, the entire construction site shall be stripped of all vegetation and debris, and such material shall be removed from the site prior to performing any excavation or placing any fill. The CONTRACTOR shall furnish, place, and maintain all supports and shoring that may be required for the sides of the excavations. Excavations shall be sloped or otherwise supported in a safe manner in accordance with applicable State safety requirements and the requirements of OSHA Safety and Health Standards for Construction (29CFR1926).

B. Removal and Exclusion of Water: The CONTRACTOR shall remove and exclude water, including stormwater, groundwater, irrigation water, and wastewater, from all excavations. Dewatering wells, wellpoints, sump pumps, or other means shall be used to remove water and continuously maintain groundwater at a level at least one (1) foot below the bottom of excavations before the excavation work begins at each location. Water shall be removed and excluded until backfilling and compaction is complete and all field soils testing has been completed. Also see Section 02140 – Dewatering.

3.2 SETTLEMENT MONITORING AND CONTINGENCY PLANNING

A. Prior to excavation, the CONTRACTOR shall implement and maintain monitoring and contingency plans until completion of backfill and compaction operations.

B. The CONTRACTOR shall develop a settlement monitoring and contingency program for any permanent structure, any buried utilities larger than 12 inches in diameter, all natural gas pipelines, and any additional structures which are within a horizontal distance 1.5 times the depth of any excavation deeper than the structure or natural gas pipeline. This Section does not limit the CONTRACTOR's choice of construction methods based on the site conditions. It establishes minimum requirements for the CONTRACTOR to monitor the effects of construction on existing site features and to demonstrate a reasonable preparedness to meet potential contingencies and protect existing site features.

C. The CONTRACTOR shall establish a settlement monitoring program and perform all survey and inspections necessary for monitoring existing site features. All surveys shall be performed under the direction of a licensed land surveyor.

1. The CONTRACTOR shall set a minimum of two survey monuments on each permanent structure, a minimum of one survey monument within 10 feet of the excavation in the immediate vicinity of existing buried utilities, and a minimum of one survey target on sheet piling or sheeting in the immediate vicinity of existing structures, utilities or gas lines. The survey monuments and targets shall be spaced at least 50 feet apart on structures and 100 feet apart for all other conditions, when excavations parallel structures, utilities or gas pipes.

3.3 STRUCTURE, ROADWAY, AND EMBANKMENT EXCAVATION

A. **Excavation Beneath Structures and Embankments:** Except where otherwise indicated for a particular structure or ordered by the ENGINEER, excavation shall be carried to the grade of the bottom of the footing or slab. Where indicated or ordered, areas beneath structures or fills shall be over-excavated. The subgrade areas beneath embankments shall be excavated to remove not less than the top 6 inches of native material and where such subgrade is sloped, the native material shall be benched.

When such over-excavation is indicated, both over-excavation and subsequent backfill to the required grade shall be performed by the CONTRACTOR. When such over-excavation is not indicated but is ordered by the ENGINEER, such over-excavation and any resulting backfill will be paid for under a separate unit price bid item if such bid item has been established; otherwise payment will be made in accordance with a negotiated price. After the required excavation or over-excavation has been completed, the exposed surface shall be scarified to a depth of 6 inches, brought to optimum moisture content, and rolled with heavy compaction equipment to obtain 95 percent of maximum density.

B. **Excavation Beneath Concrete Reservoirs:** Excavation under reservoirs shall extend to the bottom of the drainrock layer. After such excavation has been completed, the exposed surface shall be rolled with heavy compaction equipment to 95 percent of maximum density and then graded to provide a reasonably smooth surface for placement of the drainrock. Areas under the reservoir upon which fill is to be placed shall be scarified to a depth of 6 inches, brought to optimum moisture content, and compacted to obtain 95 percent of maximum density.

C. **Excavation Beneath Paved Areas:** Excavation under areas to be paved shall extend to the bottom of the aggregate base or subbase, if such base is called for; otherwise it shall extend to the paving thickness. After the required excavation has been completed, the top 12 inches of exposed surface shall be scarified, brought to optimum moisture content, and rolled with heavy compaction equipment to obtain 95 percent of maximum density. The finished subgrade shall be even, self-draining, and in conformance with the slope of the finished pavement. Areas that could accumulate standing water shall be regraded to provide a self-draining subgrade.

D. **Notification of ENGINEER:** The CONTRACTOR shall notify the ENGINEER at least 3 days in advance of completion of any structure excavation and shall allow the ENGINEER a review period of at least one day before the exposed foundation is scarified and compacted or is covered with backfill or with any construction materials.

3.4 PIPELINE AND UTILITY TRENCH EXCAVATION

A. Exploratory Excavation (Potholing)

1. The CONTRACTOR shall excavate and expose buried points of connection to existing utilities and other underground utilities that will be crossed during new pipeline construction. Excavation shall be performed prior to constructing in a given area, prior to preparation of Shop Drawings for connections and before fabrication of pipe, and the data obtained shall be used in preparing Shop Drawings.

2. The CONTRACTOR shall contact Dig Alert (1-800-642-2444) a minimum of two days prior to any excavation to enable underground utilities to move their facilities in the field.

3. Data, including dates, locations excavated, and sketches, shall be submitted to the ENGINEER within one week of excavation.

4. Damage to utilities from excavation activities shall be repaired by the CONTRACTOR at its cost/time.

B. **General:** Unless otherwise indicated or ordered, excavation for pipelines and utilities shall be open-cut trenches with widths as indicated. See trench sections included in the details in the Contract Drawings.

C. **Trench Bottom:** Except when pipe bedding is required, the bottom of the trench shall be excavated uniformly to the grade of the bottom of the pipe bedding. Excavations made to below the bottom of the pipe bedding shall be re-compacted to a minimum of 90 percent relative compaction at the CONTRACTOR's cost. Excavations for pipe bells and welding shall be made as required.

D. **Open Trench:** The maximum amount of open trench permitted in any one location shall be 500 feet, or the length necessary to accommodate the amount of pipe installed in a single day, whichever is greater. All trenches shall be fully backfilled at the end of each day or, in lieu thereof, shall be covered by heavy steel plates adequately braced and capable of supporting vehicular traffic in those locations where it is impractical to backfill at the end of each day. Traffic plates shall be provided with non-skid coating and shall be wedged to prevent movement.

E. **Indicated Trench Over-Excavation:** Where trenches are indicated to be over-excavated, excavation shall be to the depth indicated, and backfill shall be installed to the grade of the bottom of the pipe bedding.

F. Over-Excavation (Not Indicated)

1. When ordered by the OWNER to over-excavate trenches deeper and/or wider than required by the Contract Documents, the CONTRACTOR shall over-excavate to the dimensions ordered and backfill to the indicated grade of the bottom of the pipe bedding.

2. Payment

a. Additional payment will be based on unit price bid items for over-excavation if such bid items were established; otherwise payment will be based on a negotiated price. Volumes of material will be based on neat line survey measurements of the over-excavated area.

G. Where pipelines are to be installed in embankments, fills, or structure backfills, the fill shall be constructed to a level at least one foot above the top of the pipe before the trench is excavated.

H. If a moveable trench shield is used during excavation operations, the trench width shall be wider than the shield so that the shield is free to be lifted and then moved horizontally without binding against the trench sidewalls. If the trench walls cave in or slough, the trench shall be excavated as an open excavation with sloped sidewalls or with trench shoring, as indicated and as required by the pipe structural design. Also see Section 02120 – Shoring.

3.5 OVER-EXCAVATION NOT ORDERED OR INDICATED

A. Any over-excavation carried below the grade ordered or indicated, shall be backfilled and compacted to a minimum of 90 percent R.C. to the required grade with the indicated material. The foregoing shall be at the CONTRACTOR's cost.

3.6 EXCAVATION IN LAWN AREAS

A. Where excavation occurs in lawn areas, the sod shall be carefully removed, dampened, and stockpiled to preserve it for replacement. Excavated material may be placed on the lawn; provided, that a drop cloth or other suitable method is employed to protect the lawn from damage. The lawn shall not remain covered for more than 72 hours. Immediately after completion of backfilling and testing of the pipeline, the sod shall be replaced and lightly rolled in a manner so as to restore the lawn as near as possible to its original condition. CONTRACTOR shall provide new sod if stockpiled sod has not been replaced within 72 hours.

3.7 EXCAVATION IN VICINITY OF TREES

A. Except where trees are indicated to be removed, trees shall be protected from injury during construction operations. No tree roots over 2 inches in diameter shall be cut without express permission of the ENGINEER. Trees shall be supported during excavation by any means previously reviewed by the ENGINEER.

3.8 ROCK EXCAVATION (NOT USED)

3.9 DISPOSAL OF EXCESS EXCAVATED MATERIAL

A. The CONTRATOR shall dispose of all excavated spoil and other waste material at a legal disposal site. The CONTRACTOR shall provide copies of fill and grading permits for all private properties that one used for Spoil disposal and a signed release upon completion of site usage.

B. The CONTRACTOR shall abide by all SWPPP requirements for all spoil disposal or storage sites.

C. The CONTRACTOR shall obtain all required permits, landowner, and agency approvals for disposal of excess excavated material and shall pay all costs associated with the removal and disposal.

3.10 BACKFILL - GENERAL

A. Backfill shall not be dropped directly upon any structure or pipe. Backfill shall not be placed around or upon any structure until the concrete has attained sufficient strength to withstand the loads imposed. Backfill around water retaining structures shall not be placed until the structures have been tested, and the structures shall be full of water while backfill is being placed.

B. Except for drainrock materials being placed in over-excavated areas or trenches, backfill shall be placed after all water is removed from the excavation, and the trench sidewalls and bottom have been dried to a moisture content suitable for compaction.

C. If a moveable trench shield is used during excavation, pipe installation, and backfill operations, the shield shall be moved by lifting the shield free of the trench bottom or backfill and then moving the shield horizontally, The CONTRACTOR shall not drag trench shields along the trench causing damage or displacement to the trench sidewalls, the pipe, or the bedding and backfill.

D. Immediately prior to placement of backfill materials, the bottoms and sidewalls of trenches and structure excavations shall have all loose sloughing, or caving soil and

rock materials removed. Trench sidewalls shall consist of excavated surfaces that are in a relatively undisturbed condition before placement of backfill materials.

3.11 PLACING AND SPREADING OF BACKFILL MATERIALS

A. Backfill materials shall be placed and spread evenly in layers. When compaction is achieved using mechanical equipment, the layers shall be evenly spread so that when compacted each layer shall not exceed 8 inches in thickness.

When compaction is achieved using flooding and jetting methods, each layer shall not exceed 3 feet in thickness after compaction. The jet pipe shall be capable of penetrating to within 2 feet of the bottom of the lift being compacted. Compaction shall be provided in the pipeline bedding and pipe zone prior to placing the trench backfill above the pipe. **Flooding or jetting compaction methods shall not be permitted in the upper 3 feet of the pipeline trench.**

B. During spreading, each layer shall be thoroughly mixed as necessary to promote uniformity of material in each layer. Pipe zone backfill materials shall be manually spread around the pipe so that when compacted the pipe zone backfill will provide uniform bearing and side support.

C. The moisture content of the backfill shall be between two (2) percent below to two (2) percent above the optimum moisture content.

D. Where the backfill material moisture content is below the optimum moisture content, water shall be added before or during spreading until the proper moisture content is achieved.

E. Where the backfill material moisture content is too high to permit the specified degree of compaction the material shall be dried bladed, aerated, dried or blended with dryer material until the moisture content is satisfactory.

3.12 COMPACTION OF FILL, BACKFILL, AND EMBANKMENT MATERIALS

A. Each layer of Types A, B, C, D, G, H, I, K, M, and N backfill materials as defined herein, where the material is graded such that 10 percent or more passes a No. 4 sieve, shall be mechanically compacted to the indicated percentage of density. Equipment that is consistently capable of achieving the required degree of compaction shall be used and each layer shall be compacted over its entire area while the material is at the required moisture content. Use of impact type compaction equipment such as Hydrohammers is prohibited due to their potentially adverse effects on new and existing improvements.

B. Each layer of Type E, F, J and O backfill materials shall be compacted by means of at least 2 passes from a flat plate vibratory compactor. When such materials are used for pipe zone backfill, vibratory compaction shall be used at vertical intervals of 24-inches, measured in the uncompacted state. In addition, these materials shall be subjected to vibratory compaction at the springline of the pipe and the top of the pipe zone backfill, regardless of whether that dimension is less than 24-inches or not.

C. Fill on reservoir and structure roofs shall be deposited at least 30 days after the concrete roof slab has been placed. Equipment weighing more than 10,000 pounds when loaded shall not be used on a roof. A roller weighing not more than 8,000 pounds shall be used to compact fill on a roof.

D. Flooding, ponding, or jetting shall not be used for fill on roofs, backfill around structures, backfill around reservoir walls, for final backfill materials, or aggregate base materials.

E. Pipe zone backfill materials that are granular, may be compacted by a combination of flooding and vibration using concrete vibrators or by jetting, when acceptable to the ENGINEER. Jetting shall always be supplemented by mechanical compaction to achieve specified requirements.

F. Pipeline trench zone backfill materials, having a minimum sand equivalent of 30 and a coefficient of permeability faster than 1×10^{-3} cm/sec , may be compacted using flooding and jetting or vibration if the CONTRACTOR uses effective procedures that yield the specified compaction test results. Flooding and jetting shall not be done in such a manner that the pipe or nearby utilities are damaged, in areas of poorly draining or expansive soils, or where the use of the procedure is prohibited by any agency having jurisdiction over the street or right-of-way. Approved jet pipes or immersible vibrators shall be used so that each backfill layer is saturated and consolidated to its full depth before the next layer is placed. Flooding or jetting compaction methods shall not be permitted in the upper 3 feet of the pipeline trench. Jet pipes shall be kept at least 6 inches away from the pipe where the backfill is being consolidated and 2 feet away from other pipes or utilities. Jetting shall always be supplemented by mechanical compaction to achieve specified requirements

G. Equipment weighing more than 10,000 pounds shall not be used closer to walls than a horizontal distance equal to the depth of the fill at that time. Hand operated power compaction equipment shall be used where use of heavier equipment is impractical or restricted due to weight limitations.

H. Backfill around and over pipelines that is mechanically compacted shall be compacted using light, hand operated, vibratory compactors and rollers. After completion of at least two feet of compacted backfill over the top of pipeline, compaction equipment weighing no more than 8,000 pounds may be used to complete the trench backfill.

Recommended Minimum Location	Relative Compaction
General	90% U.O.N.*
Bedding and Pipe Zone	90% U.O.N.
Trench Zone Backfill	90% U.O.N.
Trench Backfill Placed within 3 feet Of Finished Grade in Pavement Areas	95%
Aggregate Base or Subbase	95%
Asphalt Concrete	95%
Building Areas	95%

*Unless otherwise noted

I. It is understood and agreed that proper pipe zone compaction is critical to addressing the side support necessary for flexible pipelines to provide a proper installation and to achieve passing deflection tests. The CONTRACTOR shall plan, include all costs in its bid and execute the work accordingly.

3.13 PIPE AND UTILITY TRENCH BACKFILL

A. Pipe Zone Backfill

1. The pipe zone is defined as that portion of the vertical trench cross-section lying between a plane below the bottom surface of the pipe and a plane at a point 12 inches above the top surface of the pipe as indicated. The bedding is defined as that portion of pipe zone backfill material between the trench subgrade and the bottom of the pipe. The embedment is defined as that portion of the pipe zone backfill material between the bedding and a level line as indicated.

2. After compacting the bedding the CONTRACTOR shall perform a final trim using a stringline for establishing grade, such that each pipe section when first laid will be continually in contact with the bedding along the extreme bottom of the pipe. Excavation for pipe bells and welding shall be made as required.

3. The pipe zone shall be backfilled with the indicated backfill material. The CONTRACTOR shall exercise care to prevent damage to the pipeline coating, cathodic bonds, and the pipe itself during the installation and backfill operations.

4. The CONTRACTOR shall hand shovel slice the pipe bedding beneath the pipe haunches to ensure absence of voids and uniform pipe support.

5. If a moveable trench shield is used during backfill operations the shield shall be lifted to a location above each layer of backfill material prior to compaction of the layer. The CONTRACTOR shall not displace the pipe or backfill while the shield is being moved.

B. **Trench Zone Backfill:** After the pipe zone backfills have been placed, backfilling of the trench zone may proceed. The trench zone is defined as that portion of the vertical trench cross-section lying as indicated between a plane 12 inches above the top surface of the pipe and the finished surface grade, or if the trench is under pavement, 36 inches below finished grade. If flooding, ponding, or jetting is used the pipe shall be filled with water to prevent flotation.

C. **Final Backfill:** Final backfill is all backfill in the trench cross-sectional area within 36 inches of finished grade, if the trench is under pavement.

D. Tracer Wire: Install tracer wire as indicated.

3.14 FILL AND EMBANKMENT CONSTRUCTION

A. The area where a fill or embankment is to be constructed shall be cleared of all vegetation, roots and foreign material. Following this, the surface shall be moistened, scarified to a depth of 6 inches, and rolled or otherwise mechanically compacted. Embankment and fill material shall be placed and spread evenly in approximately horizontal layers. Each layer shall be moistened or aerated, as necessary. Unless otherwise approved by the ENGINEER, each layer shall not exceed 6 inches of compacted thickness. The embankment, fill, and the scarified layer of underlying ground shall be compacted to 95 percent of maximum density under structures and paved areas, and 90 percent of maximum density elsewhere.

B. When an embankment or fill is to be made and compacted against hillsides or fill slopes steeper than 4:1, the slopes of hillsides or fills shall be horizontally benched to key the embankment or fill to the underlying ground. Unless otherwise noted on the Contract

Drawings, the base of the fill shall initiate from a base key centered at the toe of the slope. The base key shall be excavated at least two feet below the existing ground surface, or into relatively firm material. The width of the base key shall be at least 10 feet, and extend at least 5 feet beyond the toe of slope A minimum of 12-inches normal to the slope of the hillside or fill shall be removed and re-compacted as the embankment or fill is brought up in layers. Material thus cut shall be re-compacted along with the new material. Hillside or fill slopes 4:1 or flatter shall be prepared in accordance with Paragraph A, above.

C. Where embankment or structure fills are constructed over pipelines, the first 4 feet of fill over the pipe shall be constructed using light placement and compaction equipment that does not damage the pipe. Heavy construction equipment shall maintain a minimum distance from the edge of the trench equal to the depth of the trench until at least 4 feet of fill over the pipe has been completed.

3.15 SOIL COMPACTION TESTING

A. **General:** All soil compaction testing will be done by a testing laboratory of the OWNER's choice at the OWNER's expense except as indicated below. The foregoing shall be to aid the DISTRICT and ENGINEER in determining if the CONTRACTOR is meeting the specified compaction requirements.

B. The CONTRACTOR shall retain a geotechnical engineer and/or materials testing firm to aid it in developing and refining its compaction methodolgy as necessary to achieve specified compaction requirements. Only the DISTRICT's compaction testing results shall be used to confirm Contract compliance.

C. Where soil material is required to be compacted to a percentage of maximum density, the maximum density at optimum moisture content will be determined in accordance with Method C of ASTM D 1557. Where cohesionless, free draining soil material is required to be compacted to a percentage of relative density, the calculation of relative density will be determined in accordance with ASTM D 4253 and D 4254. Field density in-place tests will be performed in accordance with ASTM D 1556 - Standard Test Method for Density and Unit Weight of Soil in Place by the Sand-Cone Method, ASTM D 2922 - Standard Test Methods for Density of Soil and Soil-Aggregate in Place By Nuclear Methods (Shallow Depth), or by such other means acceptable to the ENGINEER.

D. In case the test of the fill or backfill show non-compliance with the required density, the CONTRACTOR shall accomplish such remedy as may be required to insure compliance. Subsequent testing to show compliance shall be by a testing laboratory selected by the OWNER and paid by the CONTRACTOR.

E. The CONTRACTOR shall provide test trenches and excavations including excavation, trench support, and groundwater removal for the OWNER'S field soils testing operations. The trenches and excavations shall be provided at the locations and to the depths required by the OWNER. Lawn areas destroyed by test trenching and excavation shall be regraded and relandscaped with sod.

F. Where agency or utility company requirements govern, the highest compaction standards shall apply. Also see trench sections in the Contract Drawings details.

- END OF SECTION -

SECTION 02210 - CONTROLLED LOW STRENGTH MATERIAL

PART 1 -- GENERAL

1.1 THE REQUIREMENT

A. The CONTRACTOR shall provide Controlled Low Strength Material (CLSM), complete and in place, in accordance with the Contract Documents.

B. CLSM shall be placed where indicated and may be used, if the ENGINEER approves, for the following purposes:

1. Normal CLSM with high slump, non-segregating consistency that readily flows and fills voids and difficult to reach places: pipe zone fill, trench zone fill, pipe abandonment, structure backfill, and structure cavity fill.

2. Foundation CLSM is used where higher early strengths are required and future excavation is not likely to be required.

1.2 CONTRACTOR SUBMITTALS

A. Submittals shall be furnished in accordance with Section 01300 - Contractor Submittals.

B. Shop Drawings:

1. CLSM mix designs which show the proportions and gradations of all materials proposed for each type of CLSM indicated. Each mix design shall be accompanied by independent laboratory test results of the indicated properties.

2. If the CONTRACTOR proposes to provide lower strength CLSM with aggregates that do not conform to ASTM C 33 - Concrete Aggregate, Shop Drawings shall include a testing program that will be used to control the variability of the aggregates. The testing program shall be acceptable to the Engineer.

1.3 QUALITY ASSURANCE

A. All testing will be done by a testing laboratory selected by the OWNER at the OWNER's expense, except as otherwise indicated.

B. If tests of the CLSM show non-compliance with the specifications, the CONTRACTOR shall make changes as may be required to achieve compliance. Performing and paying for subsequent testing to show compliance shall be the CONTRACTOR's responsibility.

C. Correlation Tests

1. The CONTRACTOR shall perform a field correlation test for each mix of CLSM used in pipe zone, trench zone, or backfill used in amounts greater than 100 cubic yards or when CLSM is required to support traffic or other live loads on the fill less than 7 days after placing CLSM.

2. Field correlation tests shall be performed in a test pit similar in cross section to the WORK and at least 10-feet long at a location near the WORK. The proposed location shall be acceptable to the ENGINEER.

3. Laboratory and field tests shall be performed on samples taken from the same CLSM batch mix. All tests shall be performed by a laboratory at the CONTRACTOR'S expense.

4. Testing shall be performed once each 2 hours during the first 8 hours, once each 8 hours during the first week, and once each 24 hours until the CLSM mix reaches the maximum design strength.

   a. Compression testing shall be in accordance with ASTM D 4832 - Preparation and Testing of Soil-Cement Slurry Test Cylinders.

   b. Setting test shall be in accordance with ASTM C 403 - Time of Setting of Concrete Mixtures by Penetration Resistance

   c. Density tests shall be in accordance with ASTM C 138 - Unit Weight, Yield and Air Content (Gravimetric) of Concrete.

PART 2 -- PRODUCTS

2.1 CONTROLLED LOW STRENGTH MATERIAL

A. CLSM shall be a mixture of cement, pozzolan, coarse and fine aggregate, admixtures, and water, mixed in accordance with ASTM C 94 - Ready Mixed Concrete.

B. **Composition:** The following parameters shall be within the indicated limits and as necessary to produce the indicated compressive strengths.

   1. Mix proportions as necessary

   2. Entrained air content shall be between 0 to 20 percent minimum and 6 to 30 percent maximum.

   3. Water reducing agent content as necessary

C. Properties

   1. Density shall be between 120 PCF minimum and 145 PCF maximum

   2. Slump shall be as required by the CONTRACTOR's methods, but shall not promote segregation nor shall slump exceed 9 inches.

   3. Compressive strength at 28 days:

      a. Normal CLSM: Between 100 psi minimum and 300 psi maximum. Unless specifically indicated otherwise, all CLSM shall be Normal CLSM.

      b. Foundation CLSM: 1,000 psi minimum.

2.2 CEMENT

A. Cement shall be Type I or II in accordance with ASTM C 150 - Portland Cement.

2.3 POZZOLAN

A. Pozzolan shall be Type F or C in accordance with ASTM C 618 - Flyash and Raw or Calcined Natural Pozzolan for Use as a Mineral Admixture in Portland Cement Concrete. Pozzolan content, by weight, in Normal CLSM shall not be greater than cement content.

2.4 AGGREGATE

A. Aggregate shall consist of a well graded mixture of crushed rock, soil, or sand, with a nominal maximum size of 3/8-inch. One hundred percent shall pass the 1/2-inch sieve; no more than 30 percent shall be retained on the 3/8-inch sieve; and no more than 12 percent shall pass the number 200 sieve. If more than 5 percent of the aggregate passes the number 200 sieve, the material passing the number 200 sieve shall have a plasticity index of less than 0.73 (liquid limit-20), when tested in accordance with ASTM D 4318 - Liquid Limit, Plastic Limit, and Plasticity Index of Soils. All aggregate shall be free from organic matter and shall not contain more alkali, sulfates, or salts than the native materials at the Site.

2.5 ADMIXTURES

A. Air entraining admixtures shall be in accordance with ASTM C 260 - Air-Entraining Admixtures for Concrete.

B. Water reducing admixtures shall be in accordance with ASTM C 494 - Chemical Admixtures for Concrete.

2.6 WATER

A. Water shall be potable, clean, free from objectionable quantities of silt, organic matter, alkali, salt, and other impurities.

PART 3 -- EXECUTION

3.1 PREPARATION

A. Subgrade and compacted fill to receive CLSM shall be prepared according to Section 02200 - Earthwork.

3.2 BATCHING, MIXING AND DELIVERY

A. Batching, mixing, and delivery of CLSM shall conform to ASTM C 94. CLSM shall be mixed at a batch plant acceptable to the ENGINEER and shall be delivered in standard transit mix trucks.

3.3 PLACEMENT

A. CLSM shall be placed by tailgate discharge, conveyor belts, pumped, or other means acceptable to the ENGINEER. CLSM shall be directed in place by vibrator, shovel, or rod to fill all crevices and pockets. Avoid over-consolidation which causes separation of aggregate sizes.

B. CLSM shall be continuously placed against fresh material unless otherwise approved by the ENGINEER. When new material is placed against existing CLSM, the placement area shall be free from all loose and foreign material. The surface of the existing

material shall be soaked a minimum of one hour before placement of fresh material but no standing water shall be allowed when placement begins.

C. Temperature of the CLSM shall be between 50 and 90 degrees F, when placed. CLSM shall not be placed when the air temperature is below 40 degrees F. No CLSM shall be placed against frozen subgrade or other materials having temperature less than 32 degrees F.

3.4 FINISHING

A. The finish surface shall be smooth and to the grade indicated or directed by the ENGINEER. Surfaces shall be free from fins, bulges, ridges, offsets, and honeycombing. Finishing by wood float, steel trowel, or similar methods is not required.

3.5 CURING

A. CLSM shall be kept damp for a minimum of 7 days or until final backfill is placed.

3.6 PROTECTION

A. CLSM shall be protected from freezing for 72 hours after placement.

B. No fill or loading shall be placed on CLSM until probe penetration resistance, as measured in accordance with ASTM C 803 - Standard Test Method for Penetration Resistance of Hardened Concrete, exceeds 650 psi.

C. CLSM shall be protected from running water, rain, and other damage until the material has been accepted and final fill completed.

- END OF SECTION -

SECTION 02240 - SOIL STABILIZATION

PART 1 -- GENERAL

1.1 THE REQUIREMENT

A. The CONTRACTOR shall stablize the soil utilizing chemical grout for open-cut excavation and the application of air-placed concrete to the face of the excavation without shoring.

1.2 CONTRACTOR SUBMITTALS

A. Submittals shall be made in accordance with Section 01300 - Contractor Submittals.

B. The CONTRACTOR shall submit, for approval by the ENGINEER, detailed sketches of the intended injection techniques and patterns, including necessary data to prove that the chemicals contemplated will meet in all respects the requirements as to properties and qualities required by these Specifications. Any test data furnished by the CONTRACTOR substantiating the adequacy of the grout shall be from a certified testing lab, as directed by the ENGINEER.

1.3 QUALIFICATIONS

A. Work required under this Section shall be performed by a CONTRACTOR having at least 5 years' experience in the field of chemical grout soil stabilization and underpinning and having successfully completed at least 5 projects of a similar nature.

B. The CONTRACTOR shall submit satisfactory documentation that project personnel have the appropriate qualifications.

1.4 WORK COORDINATION

A. The CONTRACTOR shall fully coordinate the work operations of this Section with that of other trades involved and with the ENGINEER to ensure proper sequence of work, limitation, methods, and time of work so as to minimize or avoid interferences as well as performance of work by other trades.

PART 2 -- PRODUCTS

2.1 MATERIALS

A. "Chemical Grout," as referred to herein, shall be a relatively nonviscous solution, not a slurry, that may be injected into a permeable soil mass, undergo chemical reactions that lead to metathetical precipitation or polymerization, and result in solidification of that injected soil by binding together the soil grains for the purpose of increasing the load bearing capacity of the soil. The solidified soil shall have an unconfined compressive strength of 50 psi at 28 days.

B. The CONTRACTOR shall be responsible for formulation of the grout. Chemicals used shall be sodium silicate based with catalyst that will provide the required chemical grout. Water used shall be compatible with the chemical system to be used.

C. Considering the chemistry of the gel and the conditions known at the site, the chemical system used shall produce a stable gel. The chemical system used shall stabilize soil to permit open-cut excavation and the application of air-placed concrete to the face of the excavation without use of any shoring, and shall have a proven record of stability.

D. The chemicals used shall be so proportioned and mixed as to produce a chemical grout that contains no solids in suspension, may be pumped without difficulty, will penetrate and fill the voids in the soil mass, and will form a gel of the required strength and stability.

E. Chemicals mixed into primary solutions before final batching may be held only in accordance with the Manufacturer's recommendations and must not be injected if limiting factors imposed by the Manufacturer are exceeded. Any solutions not to be used for injection shall be immediately disposed of to the satisfaction of the ENGINEER. The chemical system shall not be detrimental to the environment. The injected solution and its components shall be nontoxic.

2.2 SITE PREPARATION

A. The project site consists primarily of sands and silty sands. See the project Geotechnical Report.

B. The site clearing, grubbing, and removal shall be in accordance with Section 02100 - Site Preparation. After site preparation work is complete, the CONTRACTOR shall commence soil stabilization.

2.3 MIXING

A. All materials shall be accurately measured by weight or volume for mixing. If a variable proportioning pump system is used, positive controls shall be incorporated to ensure accurate proportioning. Care shall be taken not to contaminate mixing vessels with reactive chemical by spillage, splash, etc.

B. A fast check reaction shall be made with each new primary chemical batch. A test sample shall be made of every injection batch. The CONTRACTOR shall keep records to establish the point of injection for each sample. These data shall be submitted to the ENGINEER on a daily basis.

C. If any sample fails to show the proper gelation, the potential area of failure shall be reinjected. The CONTRACTOR shall propose method of correction.

PART 3 -- EXECUTION

3.1 APPLICATION

A. The CONTRACTOR shall determine the extent of the soil stabilization required, subject to approval by the ENGINEER.

B. Care shall be taken in the placing of injection points to secure accurate injection and the proper overlapping of injection cylinders.

C. Injection rates and pressures shall be closely controlled to prevent blowout, localized "quick" conditions, and to ensure the proper filling of voids to attain the desired stabilized section.

D. Quantities of chemical grout injected at each point shall be governed by calculated volume, back pressure, or a combination of these two factors. If it appears, at any point, that a large void exists, proper steps shall be taken to ensure permeation of the desired soil section as directed by the ENGINEER.

3.2 CLEANUP

A. Upon completion of soil stabilization and work specified herein, the CONTRACTOR shall dispose of all excess materials off the jobsite and the jobsite shall be left in a clean and orderly condition ready for subsequent work operations.

- END OF SECTION -

SECTION 02268 - EROSION CONTROL BARRIER

PART 1 -- GENERAL

1.1 THE REQUIREMENT

A. The CONTRACTOR shall provide erosion control barriers, complete and in place, in accordance with the Contract Documents.

B. Use of erosion control barriers and other erosion control materials shall be in accordance with the requirements herein and with Section _____ Storm Water Pollution Prevention Plan.

1.2 CONTRACTOR SUBMITTALS

A. Submittals shall be in accordance with Section 01300 - Contractor Submittals.

B. **Product Data:** Manufacturer's catalog sheets on geotextile fabrics.

PART 2 -- PRODUCTS

2.1 FABRIC

A. Fabric may be woven or non-woven, made from polypropylene, polyethylene, or polyamid, and shall contain sufficient UV inhibitors so that it will last for 2 years in outdoor exposure.

B. Fabric shall have the following properties:

Parameter	Standard Method	Value
Grab tensile strength	ASTM D 4632	100 lb
Burst strength	ASTM D 3786	200 psi
Apparent opening size	ASTM D 4751	Between 200 and 70 sieve size

C. Fabric Manufacturer, or equal

1. **Mirafi.**

2.2 POSTS

A. Posts shall be wood, at least 2 inches by 2 inches, at least 6 feet long.

2.3 FENCING

A. Woven wire fabric fencing shall be galvanized, mesh spacing of 6 inches, maximum 14-gauge, at least 30 inches tall.

2.4 FASTENERS

A. Fasteners to wood posts shall be steel, at least 1 1/2 inches long.

PART 3 -- EXECUTION

3.1 PREPARATION

A. Provide erosion control barriers at the indicated locations and as required to prevent erosion and silt loss from the Site.

B. CONTRACTOR shall not commence clearing, grubbing, earthwork, or other activities which may cause erosion until barriers are in place.

C. Also see Section _____ Storm Water Pollution Prevention Plan.

3.2 INSTALLATION

A. Barrier systems shall be installed in such a manner that surface runoff will percolate through the system in sheet flow fashion and allow sediment to be retained and accumulated.

B. Attach the woven wire fencing to the posts that are spaced a maximum of 6 feet apart and embedded a minimum of 12 inches. Install posts at a slight angle toward the source of the anticipated runoff.

C. Trench in the toe of the filter fabric barrier with a spade or mechanical trencher so that the downward face of the trench is flat and perpendicular to the direction of flow. Lay fabric along the edges of the trench. Backfill and compact.

D. Securely fasten the fabric materials to the woven wire fencing with tie wires.

E. Reinforced fabric barrier shall have a height of 18 inches.

F. Provide the filter fabric in continuous rolls and cut to the length of the fence to minimize the use of joints. When joints are necessary, splice the fabric together only at a support post with a minimum 6-inch overlap and seal securely.

3.3 MAINTENANCE

A. Regularly inspect and repair or replace damaged components of the barrier. Unless otherwise directed, maintain the erosion control system until final acceptance; then remove erosion and sediment control systems promptly.

B. Remove sediment deposits when silt reaches a depth of 6 inches or 1/2 the height of the barrier, whichever is less. Dispose of sediments on the Site, if a location is indicated on the Drawings, or at a site arranged by the CONTRACTOR which is not in or adjacent to a stream or floodplain.

- END OF SECTION -

SECTION 02270 - EROSION CONTROL (VEGETATIVE)

PART 1 -- GENERAL

1.1 THE REQUIREMENT

A. The CONTRACTOR shall provide erosion protection including fertilizing, seeding, and mulching for all disturbed areas that are not to be paved or otherwise treated in accordance with the Contract Documents.

PART 2 -- PRODUCTS

2.1 MATERIALS

A. **Fertilizer:** Fertilizer shall be a commercial, chemical type, uniform in composition, free-flowing, conforming to state and federal laws and suitable for application with equipment designed for that purpose. Fertilizer shall have a guaranteed analysis showing not less than 11percent nitrogen, 8 percent available phosphoric acid, and 4 percent water soluble potash.

B. **Seed:** Seed shall be delivered in original unopened packages bearing an analysis of the contents. Seed shall be guaranteed 95 percent pure with a minimum germination rate of 80 percent.

   1. Seed mix shall be equal parts by weight of fescue and perennial ryegrass or perennial ryegrass and barley.

C. **Mulch:** Mulch shall be a fibrous, wood cellulose product produced for this purpose. It shall be dyed green and shall contain no growth or germination inhibiting substances, and shall be manufactured so that when thoroughly mixed with seed, fertilizer, and water, in the proportions indicated it will form a homogenous slurry which is capable of being sprayed. The mulch shall be **Silva Fiber** as manufactured by **Weyerhaeuser Company; Conwood Fiber** as manufactured by **Consolidated Wood Conversion Corp.;** or equal.

D. Erosion Control Blanket:

   1. Biodegradable erosion control blanket.

   2. Anchorage Devices: Nine-inch, 2-legged staple from the manufacturer or staples of the proper length as recommended by the manufacturer for specific soil condition.

E. Manufacturers, or Equal

   1. **North American Green;**

   2. **Synthetic Industries.**

PART 3 -- EXECUTION

3.1 GENERAL

A. **Weather Conditions:** Fertilizing, seeding, or mulching operations will not be permitted when wind velocities exceed 15 miles per hour or when the ground is frozen, unduly wet, or otherwise not in a tillable condition.

B. **Soil Preparation:** The ground to be seeded shall be graded in conformance with the Drawings and shall be loose and reasonably free of large rocks, roots, and other material which will interfere with the work.

C. **Method of Application:** Fertilizer, seed, and mulch may be applied separately (Dry Method), or they may be mixed together with water and the homogeneous slurry applied by spraying (Hydraulic Method), except that all slopes steeper than 3 units horizontal to 1 unit vertical shall be stabilized by the Hydraulic Method.

3.2 DRY METHOD

A. **Fertilizing:** The fertilizer shall be spread uniformly at the rate of 800 lbs per acre (approximately 1 lb per 55 square feet). The fertilizer shall be raked in and thoroughly mixed with the soil to a depth of approximately 2 inches prior to the application of seed or mulch.

B. **Seeding:** The seed shall be broadcast uniformly at the rate of 60 lbs/acre (approximately 1 lb per 730 sq ft). After the seed has been distributed it shall be incorporated into the soil by raking or by other approved methods.

C. **Mulch Application:** Mulch shall be applied at the rate of 1,500 lb (air dried weight) per acre (approximately 1 lb per 30 sq ft).

3.3 HYDRAULIC METHOD

A. The hydraulic method consists of the uniform application by spraying of a homogeneous mixture of water, seed, fertilizer, and mulch. The slurry shall be prepared by mixing the ingredients in the same proportions as indicated above. The slurry shall have the proper consistency to adhere to the earth slopes without lumping or running. Mixing time of materials shall not exceed 45 minutes from the time the seeds come into contact with the water in the mixer to the complete discharge of the slurry onto the slopes, otherwise the batch shall be recharged with seed. The mixture shall be applied using equipment containing a tank having a built-in, continuous agitation and recirculation system, and a discharge system which will allow application of the slurry to the slopes at a continuous and uniform rate. The application rates of the ingredients shall be the same as those specified for the Dry Method. The nozzle shall produce a spray that does not concentrate the slurry nor erode the soil.

3.4 EROSION CONTROL BLANKET

A. Placement

1. Biodegradable erosion control blanket shall be used on all slopes 4H:1V and steeper. The erosion control blanket shall also be used on flatter areas where surface soil protection is critical to the establishment of vegetation and stabilization of erosive forces i.e. water, wind, raveling, etc.

2. The erosion control shall be spread only on prepared, fertilized and seeded surfaces.

3. On all slopes, the erosion control blanket shall be laid up-and-down the slope in the direction of water flow.

4. Waste of erosion control material shall be minimized by limiting overlaps as specified and by utilizing the full length of the netting at roll ends.

B. Anchorage

1. Ends and sides of adjoining pieces of material shall be overlapped 6 inches and 4 inches respectively, and stapled. Six anchors shall be installed across ends. A common row of staples shall be used at side joints. Staple through both blankets, placing staples approximately 6 inches apart.

2. The top edge of the erosion control blanket shall be anchored in a 6-inch deep by 6-inch wide trench. Backfill and compact trench after stapling.

3. Anchorage shall be by means of 9-inch long, 2-legged staples driven vertically and full-length into the ground. The legs shall be spread 3 inches to 4 inches apart at the ground to improve resistance to pull-out. In loose soils the use of 18-inch metal/washer pins may be required to properly anchor the blankets.

4. All slopes which are 3:1 or greater shall be stapled with 2 staples per square yard in a triangular pattern. Staples shall be installed per the manufacturer's recommended staple pattern guide.

5. The erosion control blanket shall not be stretched, but should be laid loosely over the ground to avoid pulling the blanket downslope.

6. The erosion control blanket shall not be rolled out onto ground containing frost within the 9-inch penetration zone of the anchorage staples. Further, no stapling shall be undertaken while any frost exists within the staple penetration zone.

3.5 WATERING

A. Upon completion of the erosion control seeding, the entire area shall be soaked to saturation by a fine spray. The new planting shall be kept watered by a sprinkling system on the Site during dry weather or whenever necessary for proper establishment of the planting until final project acceptance. At no time shall the planting be allowed to dry out. Care shall be taken to avoid excessive washing or puddling on the surface and any such damage caused thereby shall be repaired by the CONTRACTOR.

3.6 MAINTENANCE PRIOR TO FINAL ACCEPTANCE

A. The CONTRACTOR shall maintain the planted areas in a satisfactory condition until final acceptance of the project. Such maintenance shall include the filling, leveling, and repairing of any washed or eroded areas, as may be necessary, and sufficient watering to maintain the plant materials in a healthy condition. The ENGINEER may require replanting of any areas in which the establishment of the vegetative ground cover does not appear to be developing satisfactorily.

3.7 MAINTENANCE AFTER FINAL ACCEPTANCE

A. The CONTRACTOR shall water the permanently planted areas sufficiently to maintain the plant materials in a healthy condition during the 1 year correction period.

- END OF SECTION -

SECTION 02273 - RIPRAP

PART 1 -- GENERAL

1.1 THE REQUIREMENT

A. The CONTRACTOR shall provide riprap, including associated earthwork, complete and in place, in accordance with the Contract Documents.

1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. Commercial Standards:

ASTM C 88	Standard Test Method for Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulfate
ASTM C 535	Standard Test Method for Resistance to Degradation of Large Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine.
AASHTO T 85	Standard Method of Test for Specific Gravity and Absorption of Coarse Aggregate
AASHTO T 210	Method of Test for Aggregate Durability Index.

1.3 CONTRACTOR SUBMITTAL

A. Furnish submittals in accordance with Section 01300 – Contractor Submittals.

B. Testing certificates from a qualified testing agency shall be submitted prior to acceptance of the rock source to verify the conformity to the requirements of the Contract Documents

PART 2 -- PRODUCT

2.1 STONES FOR RIPRAP

A. Stones shall be graded in size to produce a reasonably dense mass. Riprap shall consist of dense, natural rock fragments. Stones shall be resistant to weathering and to water action; free from overburden, spoil, shale and organic material; and shall meet the gradation requirements below. Shale and stones with shale seams are not acceptable.

B. Riprap shall conform to the size types as follows:

1. Type I (6-inch Average Size):

Diameter	Percentage Passing
12-inch	95 - 100
6-inch	25 - 75
3-inch	0 - 10

2. Type II (12-inch Average Size):

Diameter	Percentage Passing
18-inch	95 - 100
12-inch	25 - 75
6-inch	0 - 5

3. Type III (18-inch Average Size):

Diameter	Percentage Passing
24-inch	95 - 100
18-inch	25 - 75
13-inch	0 - 5

4. Type IV (24-inch Average Size):

Diameter	Percentage Passing
30-inch	95 - 100
24-inch	25 - 75
18-inch	15 - 25
12-inch	0 - 5

C. The greatest dimension of 50 percent of the stones shall be at least two-thirds but not more than 1-1/2 times the diameter of the average size. Neither the breadth nor thickness of any piece of riprap shall be less than one-third its length. Material shall be of shapes which will form a stable protection structure of required depth. Rounded boulders or cobbles shall not be used.

D. Stones shall consist of durable, sound, hard, angular rock meeting the following requirements for durability absorption ratio, soundness test, and abrasion test:

Durability Absorption Ratio	Acceptability
Greater than 23	Passes
10 to 23	Passes only if Durability Index is 52 or greater
Less than 10	Fails
Durability Absorption Ratio	$\frac{\text{Durability Index (Coarse)}}{\text{\% absorption} + 1}$

E. The durability index and percent absorption shall be determined by AASHTO T 210 and AASHTO T 85, respectively. The minimum apparent specific gravity of the stones shall be 2.5 as determined by AASHTO T 85.

F. Stones shall have less than 10 percent loss of weight after five cycles, when tested per ASTM C 88.

G. Stones shall have a wear not greater than 40 percent, when tested per ASTM C 535.

H. Control of gradation shall be by visual inspection. The CONTRACTOR shall furnish a sample of the proposed gradation of at least 5 tons or 10 percent of the total riprap weight, whichever is less. If approved, the sample may be incorporated into the finished riprap at a location where it can be used as a frequent reference for judging the gradation of the remainder of riprap. Any difference of opinion between the ENGINEER and the CONTRACTOR shall be resolved by dumping and checking the gradation of two random truckloads of stones. Arranging for and the costs of mechanical equipment, a sorting site, and labor needed in checking gradation shall be the CONTRACTOR's responsibility.

I. The acceptability of the stones will be determined by the ENGINEER prior to placement.

2.2 GEOTEXTILE FABRIC

A. Geotextile fabric shall conform to the requirements of Section 02274 - Geotextiles.

2.3 FILTER MATERIAL

A. Filter material shall be clean and free from organic matter. It shall be crushed rock or gravel, durable and free from slaking or decomposition under the action of alternate wetting or drying. The material shall be uniformity graded and shall conform to the following gradation:

1. Type 1

Size	Percentage Passing
3-inch	85 – 100
1-1/2 inch	45 – 75
3/4-inch	10 – 25

In many areas, standard aggregate base materials defined by the state or county highway department would also be acceptable as filter material. The example below shows how such materials can be incorporated into the specification.

2. Type 2: CLASS 2, 1-1/2 inch aggregate base material, as described in Specification Section 26 of the Caltrans Standard Specifications is acceptable as Type 2 filter material.

PART 3 -- EXECUTION

3.1 SURFACE PREPARATION

A. Surfaces to receive riprap shall be smooth and firm, free of brush, trees, stumps, and other objectionable material, and shall be brought to the line and grade indicated.

B. If a boulder is encountered during excavation of areas where large riprap is to be placed, the CONTRACTOR shall excavate around the boulder. If the boulder is larger than the largest allowable stone size for that area, the CONTRACTOR shall break up the boulder to an acceptable size or remove it entirely.

C. Prior to placement of the geotextile, the surface shall be prepared to a smooth condition free of debris, depressions, or obstructions which may damage the geotextile. The geotextile shall be overlapped a minimum of 2-feet at longitudinal and transverse joints. Upstream sheets shall overlap downstream sheets. For slope placement, each strip shall overlap the next downhill strip. The geotextile shall be anchored using key trenches or aprons at the crest and toe of the slope. Pins may be used in securing the geotextile during installation. In no instance shall the geotextile be left exposed to sunlight longer than 7 calendar days. Overexposed geotextile shall be removed and replaced.

3.2 PLACEMENT OF FILTER BLANKET

A. Area of riprap placement shall be excavated to the bottom of the filter blanket as indicated and in accordance with Section 02200 – Earthwork. After the excavation has been completed, the top 12 inches of exposed surface shall be scarified, brought to optimum moisture content, and compacted to 95 percent of maximum density. The

finished grade shall be even, self-draining and in conformance with the slope of the finished grade.

B. Placement of filter material shall be in accordance with Section 02200. Filter material shall be placed, spread, and compacted in lifts not to exceed 12 inches.

C. The CONTRACTOR shall remove any portion of the filter blanket that has been disturbed to the degree that the layers become mixed. Replace the removed portion with the required sizes to the satisfaction of the ENGINEER.

D. Filter material shall be placed as follows, unless otherwise indicated.

1. For Type II, III and IV riprap, use 12 inches of Type 1 filter material.

2. For Type I riprap, use 6 inches of Type 2 filter material.

E. No filter material is required if riprap is placed directly on bedrock.

3.3 PLACEMENT OF RIPRAP

A. Placement of riprap shall begin at the toe of the slope and proceed up the slope. The stones may be placed by dumping and may be spread by bulldozers or other suitable equipment as long as the underlying material is not displaced. Stones shall be placed so as to provide a minimum of voids. Smaller stones shall be uniformly distributed throughout the mass. Sufficient hand work shall be done to produce a neat and uniform surface, true to the lines, grades, and sections indicated.

B. Where riprap is placed over a geotextile fabric, the riprap shall be placed so as to avoid damage to the geotextile. Stones shall not be dropped from a height greater than 3-feet, nor shall large stones be allowed to roll downslope.

3.4 GROUTED RIPRAP

A. After the riprap has been placed, sand or fine gravel shall be swept into the interstices to fill them to within 4 inches of the average surface of the riprap. After wetting the stones, the remaining volume of the interstices shall be filled with a well-mixed grout composed of 1 part Portland cement and 3 parts of sand, mixed to a workable consistency. The grout shall be kept wet by sprinkling or covering with wet material for at least 3 days. The grout shall be protected from stream water or any other disturbance during this curing period, and shall not be placed in freezing weather or when conditions are unfavorable.

- END OF SECTION -

SECTION 02274 - GEOTEXTILES

PART 1 -- GENERAL

1.1 THE REQUIREMENT

A. The CONTRACTOR shall provide geotextiles, complete and in place, in accordance with the Contract Documents.

B. **Definitions:** The following definitions apply to the WORK of this Section:

1. Fabric: Geotextile, a permeable geosynthetic comprised solely of textiles.

2. Minimum Average Roll Value (MinARV): Minimum of series of average roll values representative of geotextile provided.

3. Maximum Average Roll Value (MaxARV): Maximum of series of average roll values representative of geotextile provided.

4. Nondestructive Sample: Sample representative of finished geotextile, prepared for testing without destruction of geotextile.

5. Overlap: Distance measured perpendicular from overlapping edge of one sheet to underlying edge of adjacent sheet.

6. Seam Efficiency: Ratio of tensile strength across seam to strength of intact geotextile, when tested according to ASTM D 4884.

7. Woven geotextile: A geotextile fabric composed of polymeric yarn interlaced to form a planar structure with uniform weave pattern.

8. Nonwoven geotextile: A geotextile fabric composed of a pervious sheet of polymeric fibers interlaced to form a planar structure with uniform random fiber pattern.

1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. The following standards are referenced in this Section:

ASTM D 4355	Standard Test Method for Deterioration of Geotextiles by Exposure to Light, Moisture, and Heat in a Xenon-Arc Type Apparatus
ASTM D 4491	Standard Test Methods for Water Permeability of Geotextiles by Permittivity
ASTM D 4533	Standard Test Method for Trapezoid Tearing Strength of Geotextiles
ASTM D 4595	Standard Test Method for Tensile Properties of Geotextiles by the Wide-Width Strip Method
ASTM D 4751	Standard Test Method for Determining Apparent Opening Size of a Geotextile

ASTM D 4833	Standard Test Method for Index Puncture Resistance of Geotextiles, Geomembranes, and Related Products
ASTM D 4884	Standard Test Method for Strength of Sewn or Thermally Bonded Seams of Sewn Geotextiles
ASTM D 4886	Standard Test Method for Abrasion Resistance of Geotextiles (Sand Paper/Sliding Block Method)

1.3 CONTRACTOR SUBMITTALS

A. Furnish submittals in accordance with Section 01300 - Contractor Submittals.

B. Shop Drawings

1. Manufacturer material specifications and product literature.

2. Installation drawings showing geotextile sheet layout, location of seams, direction of overlap, and sewn seams.

3. Description of proposed method of geotextile deployment, sewing equipment, sewing methods, and provisions for holding geotextile temporarily in place until permanently secured.

C. Samples

1. Geotextile: One-piece, minimum 18 inches long, taken across full width of roll of each type and weight of geotextile. Label each with brand name and furnish documentation of lot and roll number from which each sample was obtained.

2. Field Sewn Seam: 5-foot length of seam, 12 inches wide with seam along center, for each type and weight of geotextile.

3. Securing Pin and Washer: 1 each.

D. Certifications

1. Certification from geotextile manufacturer that products satisfy the indicated requirements.

2. Field seam efficiency test results.

PART 2 -- PRODUCTS

2.1 WOVEN GEOTEXTILE

A. Woven geotextile shall be composed of polymeric yarn interlaced to form a planar structure with uniform weave pattern. Products shall be calendared or finished so that yarns will retain their relative position with respect to each other.

B. Polymeric yarn shall be long-chain synthetic polymers (polyester or polypropylene) with stabilizers or inhibitors added to make filaments resistant to deterioration due to heat and ultraviolet light exposure.

C. **Sheet Edges:** Selvaged or finished to prevent outer material from separating from sheet.

D. Unseamed Sheet Width: Minimum 6 feet.

E. Nominal Weight per Square Yard: 6.

F. Physical Properties: Conform to requirements below.

PHYSICAL PROPERTY REQUIREMENTS FOR WOVEN GEOTEXTILE		
Property	**Requirement**	**Test Method**
Apparent Opening Size (AOS)	No. 10 to No. 100 U.S. Standard Sieve Size	ASTM D 4751
Water Permittivity	0.02 to 3.34 sec.$^{-1}$, MinARV	ASTM D 4491 (Falling Head)
Vertical Waterflow Rate	10 to 150 gpm/sq ft, MinARV	
Wide Width Strip Tensile Strength	60 to 1,500 lb/in.-width, MinARV	ASTM D 4595
Wide Width Strip Elongation	14 to 60 percent, MaxARV	
Trapezoidal Tear Strength	30 to 200 lb, MinARV	ASTM D 4533
Puncture Strength	50 to 250 lb, MinARV	ASTM D 4833
Abrasion Resistance	5 to 25 percent loss, 250 cycles, MaxARV	ASTM D 4886
Ultraviolet Radiation Resistance	70 to 90 percent strength retention, MinARV after 500 hours	ASTM D 4355

2.2 NONWOVEN GEOTEXTILE

A. Geotextile for pipeline trench and other excavations applications shall be non-woven geotextile as specified below.

B. Nonwoven geotextile shall be composed of a pervious sheet of polymeric fibers interlaced to form a planar structure with uniform random fiber pattern. Products shall be calendared or finished so that yarns will retain their relative position with respect to each other.

C. Polymeric yarn shall be long-chain synthetic polymers (polyester, polypropylene, or polyethylene) with stabilizers or inhibitors added to make filaments resistant to deterioration due to heat and ultraviolet light exposure.

D. **Geotextile Edges:** Selvaged or finished to prevent outer material from separating from sheet.

E. **Unseamed Sheet Width:** Minimum 6-feet.

F. **Nominal Weight per Square Yard:** 12 ounces.

G. **Physical Properties:** Conform to requirements below.

PHYSICAL PROPERTY REQUIREMENTS FOR NONWOVEN GEOTEXTILE		
Property	**Requirement**	**Test Method**
Apparent Opening Size (AOS)	No. 100 to No. 140 U.S. Standard Sieve Size	ASTM D 4751
Water Permittivity	1.2 $sec.^{-1}$, MinARV	ASTM D 4491 (Falling Head)
Vertical Waterflow Rate	90 gpm/sq ft, MinARV	
Wide Width Strip Tensile Strength	300 MinARV	ASTM D 4595
Wide Width Strip Elongation	70 percent, MaxARV	ASTM D 4595
Trapezoidal Tear Strength	120 lb, MinARV	ASTM D 4533
Puncture Strength	130 lb, MinARV	ASTM D 4833
Ultraviolet Radiation Resistance	90 percent strength retention, MinARV after 500 hours	ASTM D 4355

2.3 SEWING THREAD

A. Sewing thread shall be polypropylene, polyester, or Kevlar thread with durability equal to or greater than durability of geotextile sewn.

2.4 SECURING PINS

A. Securing pins shall be steel rods or bars conforming to the following:

1. 3/16-inch diameter.

2. Pointed at one end; head on other end, sufficiently large to retain washer.

3. Minimum Length: 12 inches.

B. Steel washers for securing pins shall be:

1. Outside Diameter: Not less than 1-1/2 inches.

2. Inside Diameter: 1/4-inch.

3. Thickness: 1/8-inch.

C. Steel Wire Staples

1. U-shaped.

2. 10-gauge.

3. Minimum 6 inches long.

PART 3 -- EXECUTION

3.1 PRODUCT DELIVERY, STORAGE, AND HANDLING

A. Deliver each roll with sufficient information attached to identify manufacturer and product name or number.

B. Handle products in manner that maintains undamaged condition.

C. Do not store products directly on ground. Ship and store geotextile with suitable wrapping for protection against moisture and ultraviolet exposure. Store geotextile in a way that protects it from elements. If stored outdoors, elevate and protect geotextile with waterproof cover.

3.2 LAYING GEOTEXTILE

A. Notify the ENGINEER whenever geotextiles are to be placed. Do not place geotextile prior to obtaining ENGINEER's approval of underlying materials.

B. Lay and maintain geotextile smooth and free of tension, folds, wrinkles, or creases.

3.3 ORIENTATION ON SLOPES

A. Orient geotextile with long dimension of each sheet parallel to direction of slope.

B. Geotextile may be oriented with long dimension of sheet transverse to direction of slope only if sheet width, without unsewn seams, is sufficient to cover entire slope and anchor trench and extend at least 18 inches beyond toe of slope.

3.4 JOINTS

A. Unseamed Joints

1. Unseamed joints shall be overlapped to the following dimensions unless otherwise indicated:

a. Foundation/Subgrade Stabilization: Minimum 18 inches.

b. Riprap: Minimum 18 inches.

c. Drain Trenches: Minimum 18 inches, except overlap shall equal trench width if trench width is less than 18 inches.

d. Other Applications: Minimum 12 inches.

B. Sewn seams shall be used wherever stress transfer from one geotextile sheet to another is necessary. Sewn seams, as approved by ENGINEER, also may be used instead of overlap at joints for applications that do not require stress transfer.

1. Seam efficiency shall be minimum 70 percent, verified by preparing and testing minimum of one set of nondestructive samples per acre of each type and weight of geotextile provided. Test according to ASTM D 4884.

2. Type: "J" type seams are preferred, but flat or butterfly seams are acceptable.

3. Stitch Count: Minimum 3 to maximum 7 stitches per inch.

4. Stitch Type: Double-thread chainstitch, Type 401, Federal Standard No. 751a.

5. Stitch Location: 2 inches from geotextile sheet edges, or more if necessary to develop required seam strength.

6. Sewing Machines: Capable of penetrating 4 layers of geotextile.

3.5 SECURING GEOTEXTILE

A. Secure geotextile during installation as necessary with sand bags or other means approved by ENGINEER.

B. Securing Pins

1. Insert securing pins with washers through geotextile, midway between edges of overlaps and 6 inches from free edges.

2. Spacing

Slope	**Maximum Pin Spacing, feet**
Steeper than 3:1	2
3:1 to 4:1	3
Flatter than 4:1	5

3. Install additional pins across each geotextile sheet as necessary to prevent slippage of geotextile or to prevent wind from blowing geotextile out of position.

4. Push each securing pin through geotextile until washer bears against geotextile and secures it firmly to subgrade.

3.6 PLACING PRODUCTS OVER GEOTEXTILE

A. Notify ENGINEER before placing material over geotextile,. Do not cover installed geotextile prior to receiving authorization from the ENGINEER to proceed.

B. If tears, punctures, or other geotextile damage occurs during placement of overlying products, remove overlying products as necessary to expose damaged geotextile. Repair damage as indicated below.

3.7 INSTALLING GEOTEXTILE IN TRENCHES

A. Geotextile for pipeline trench and other excavation applications shall be non-woven geotextile as per Paragraph 2.2 of this Specification Section.

B. Place geotextile in a way that will completely envelope granular material to be placed in trench and with indicated overlap at joints. Overlap geotextile in direction of flow. Place geotextile in a way and with sufficient slack for geotextile to contact trench bottom and sides fully when trench is backfilled.

C. After granular material is placed to grade, fold geotextile over top of granular material, unless otherwise indicated. Maintain overlap until overlying fill or backfill is placed.

3.8 RIPRAP APPLICATIONS

A. Overlap geotextile at each joint with upstream sheet of geotextile overlapping downstream sheet.

B. Sew joints where wave runup may occur.

3.9 GEOTEXTILE-REINFORCED EARTH WALL APPLICATIONS

A. Sew exposed joints; extend sewn seams minimum 3-feet behind face of wall.

B. Protect exposed geotextile from damage and deterioration until permanent facing is applied.

3.10 SILT FENCE APPLICATIONS

A. Install geotextile in one piece or continuously sewn to make one piece, for full length and height of fence, including portion of geotextile buried in toe trench.

B. Install bottom edge of sheet in toe trench and backfill in a way that securely anchors geotextile in trench.

C. Securely fasten geotextile to a wire mesh backing and each support post in a way that will not result in tearing of geotextile when fence is subjected to service loads.

D. Promptly repair or replace silt fence that becomes damaged.

3.11 REPAIRING GEOTEXTILE

A. Repair or replace torn, punctured, flawed, deteriorated, or otherwise damaged geotextile. Repair damaged geotextile by placing patch of undamaged geotextile over damaged area plus at least 18 inches in all directions beyond damaged area. Remove interfering material as necessary to expose damaged geotextile for repair. Sew patches

or secure them with pins and washers, as indicated above for securing geotextile, or by other means approved by ENGINEER.

3.12 REPLACING CONTAMINATED GEOTEXTILE

A. Protect geotextile from contamination that would interfere, in ENGINEER's opinion, with its intended function. Remove and replace contaminated geotextile with clean geotextile.

- END OF SECTION -

SECTION 02275 - GEOTEXTILE PAVING FABRIC

PART 1 -- GENERAL

1.1 THE REQUIREMENT

A. Where shown, the CONTRACTOR shall provide a geotextile paving fabric beneath pavement overlays or between pavement layers, as shown or specified, to provide a waterproof membrane and crack-retarding layer.

1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. Commercial Standards:

ASTM D 276	Method for Identification of Fibers of Textiles
ASTM D 4354	Practice for Sampling of Geotextiles for Testing
ASTM D 4632	Test Method for Breaking Load and Elongation of Geotextiles (Grab Method)
ASTM D 4873	Practice for Identification and Storage and Handling of Geotextiles

1.3 CONTRACTOR SUBMITTALS

A. **Samples:** The CONTRACTOR shall submit samples of all geotextile paving materials proposed to be used on the WORK. The samples shall be clearly marked to show the manufacturer's name and product identification and shall be submitted along with the manufacturer's technical data and installation instructions. Sample submittals shall be in accordance with Section 01300 - Contractor Submittals.

B. **Certificates:** The CONTRACTOR shall provide a certificate from the geotextile manufacturer stating conformance with the Contract Documents.

PART 2 -- PRODUCTS

2.1 GEOTEXTILE PAVING FABRIC

A. The geotextile paving fabric shall be a nonwoven material consisting of at least 85 percent by weight of polyolefins, polyesters, or polyamides. The paving fabric shall be resistant to chemical attack, rot and mildew and shall have no tears or defects which will adversely alter its physical properties. The fabric shall be specifically designed for pavement application and be heat bonded on one side only to assist in preventing bleed through of tack coat and sticking of fibers to wheels of laydown equipment. The fabric shall meet the following physical requirements:

Property	Requirement	Test Method
Tensile Strength, lbs.	80	ASTM D 4632
Elongation, percent	50	ASTM D 4632
Asphalt Retention, gal/sq yd	0.2	Texas DOT 3099
Melting Point, degrees F	300	ASTM D 276
Surface Texture	Heat bonded on	Visual inspection one side only

Note: All numerical values shown above represent minimum average roll values. Test results from any sampled roll in a lot shall meet or exceed the minimum values shown. Lot sampled in accordance with ASTM D 4354.

B. The geotextile paving fabric shall be **Amoco 4599**, or approved equal.

2.2 TACK COAT

A. The tack coat used to bond the fabric to the base pavement shall be in accordance with the requirements of Section 02460 - A.C. Pavement and Base, except that the use of cutbacks or emulsions which contain solvents shall not be allowed.

PART 3 -- EXECUTION

3.1 GENERAL

A. Geotextile paving fabric shall be provided in rolls wrapped with protective covering to protect the fabric from mud, dirt, dust, debris, ultraviolet radiation, and abrasion due to shipping and handling. The fabric shall be free of defects or flaws which significantly affect its physical properties. Each roll of fabric in the shipment shall be labeled in accordance with ASTM D 4873.

B. Geotextile paving fabric shall be handled and placed in accordance with the manufacturer's recommendations.

3.2 SURFACE PREPARATION

A. The pavement surface shall be cleaned to remove all dirt, water, and oil from base pavement. Cracks 1/4-inch wide and wider shall be cleaned and filled with suitable bituminous material or by a method approved by the ENGINEER. Crack filling material shall be allowed to cure prior to geotextile placement. Where pavement is severely cracked, rutted, deformed, or otherwise distressed, a leveling course shall be placed as directed by the ENGINEER.

3.3 TACK COAT

A. Minimum air and pavement temperature shall be 50 degrees F or higher for placement of asphalt and shall be 60 degrees F or higher for placement of asphalt emulsion.

B. The sealant material shall be spread by means of a calibrated pressure distributor truck. The asphalt sealant shall be uniformly spray-applied to the prepared dry pavement surface at the rate of 0.20 to 0.30 gallons per square yard or as recommended by the geotextile manufacturer and approved by the ENGINEER. When using emulsions, the application rate must be increased as directed by the ENGINEER to offset water content of the emulsion. Some underlying surfaces may require a higher application rate. Within street intersections, on steep grades, or in other zones where vehicle speed changes are commonplace, the normal application rate shall be reduced about 20 percent as directed by the ENGINEER but to no less than 0.20 gallons per square yard.

C. For paving grade asphalt cements, the maximum distributor tank temperature shall not exceed 325 degrees F to avoid damage to the geotextile. For asphalt emulsions, the distributor tank temperatures shall be maintained between 130 degrees and 160 degrees F.

D. The target width of sealant application shall be geotextile width plus 6 inches. The sealant shall be applied only as far as in advance of geotextile installation as is appropriate to insure a tacky surface at the time of geotextile placement. Fabric shall be placed the same day as the sealant. Traffic shall not be allowed on the sealant. Excess asphalt shall be cleaned from the road surface.

3.4 PLACEMENT OF GEOTEXTILE FABRIC

A. The geotextile shall be placed into the sealant using mechanical or manual laydown equipment capable of providing a smooth installation with a minimum amount of wrinkling or folding prior to the sealant cooling and losing tackiness. When asphalt emulsions are used, the emulsion shall be allowed to cure properly, essentially with no moisture remaining prior to placing the geotextile and overlay. Wrinkles or folds in excess of one inch shall be slit and laid flat. All transverse joints and slit folds or wrinkles shall be shingle-lapped in the direction of the paving operation. Brooming and/or pneumatic rolling will be required to maximize geotextile contact with pavement surface. Additional hand-placed sealant material may be required at laps and repairs as determined by the ENGINEER.

B. All areas with fabric placed will be paved the same day. No traffic except necessary construction equipment and emergency vehicles will be allowed to drive on the fabric. Turning of the paver and other vehicles shall be done gradually and kept to a minimum to avoid movement and damage to the geotextile. Abrupt starts and stops shall also be avoided. Damaged geotextile shall be removed and replaced with the same type of geotextile, and the overlaps shall be shingle-lapped in the direction of paving. Overlaps shall not exceed six inches.

3.5 PLACEMENT OF OVERLAY

A. All areas in which fabric has been placed shall be paved during the same day. The temperature of the hot mix shall not exceed 325 degrees F. Sealant bleeding through the geotextile shall be removed. Excess sealant can be removed by broadcasting hot mix or sand on the fabric. Excess sand or hot mix should be removed before beginning the paving operation. In the event of rainfall on the fabric prior to the placement of the asphalt overlay, the fabric must be allowed to dry completely before asphalt is placed. This will prevent the trapping of water (steam) under the hot asphalt which could induce cracking.

B. A minimum thickness of 1-1/2 inches of asphalt pavement shall be placed over the geotextile fabric.

- END OF SECTION -

SECTION 02282 - TERMITE CONTROL

PART 1 -- GENERAL

1.1 THE REQUIREMENT

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes soil treatment for termite control.

1.3 SUBMITTALS

A. General: Submit the following according to Conditions of Contract and Division 1 Specification Sections.

B. Product data and application instructions.

C. Certification that products used comply with U.S. Environmental Protection Agency (EPA) regulations for termiticides.

1.4 QUALITY ASSURANCE

A. In addition to requirements of these specifications, comply with manufacturer's instructions and recommendations for preparing substrate and application.

B. Engage a professional pest control operator who is licensed according to regulations of governing authorities to apply soil treatment solution.

C. Use only termiticides that bear a federal registration number of the EPA and are approved by local authorities having jurisdiction.

1.5 JOB CONDITIONS

A. Restrictions: Do not apply soil treatment solution until excavating, filling, and grading operations are completed, except as otherwise required in construction operations.

B. To ensure penetration, do not apply soil treatment to frozen or excessively wet soils or during inclement weather. Comply with handling and application instructions of the soil toxicant manufacturer.

1.6 WARRANTY

A. Warranty Period: 3 years from date of Substantial Completion.

B. The warranty shall not deprive the OWNER of other rights the OWNER may have under other provisions of the Contract Documents and will be in addition to and run concurrent with other warranties made by the Contractor under requirements of the Contract Documents.

PART 2 -- PRODUCTS

2.1 SOIL TREATMENT SOLUTION

A. **General**: Use an emulsible, concentrated termiticide that dilutes with water, specially formulated to prevent termites infestation. Fuel oil will not be permitted as a diluent. Provide a solution consisting of one of following chemical elements.

B. Products: Subject to compliance with requirements, provide one of the following:

1. Chloropyrifos:
   a. Dursban TC, Dow Chemical Co.
2. Permathrin:
   a. Dragnet FT, FMC Corp.
   b. Torpedo, ICI Americas, Inc.
3. Cypermethrine:
   a. Prevail FT, FMC Corp.
   b. Demon, ICI Americas, Inc.
4. Fenvalerate:
   a. Gold Coast Tribute, Du Pont.
5. sofenphose:
   a. Pryfon, Mobay Corp.

C. Dilute with water to concentration level recommended by manufacturer.

D. Other solutions may be used as recommended by Applicator if approved for intended application by local authorities having jurisdiction. Use only soil treatment solutions that are not harmful to plants.

PART 3 -- EXECUTION

3.1 APPLICATION

A. Surface Preparation: Remove foreign matter that could decrease treatment effectiveness on areas to be treated. Loosen, rake, and level soil to be treated, except previously compacted areas under slabs and foundations. Toxicants may be applied before placing compacted fill under slabs if recommended by toxicant manufacturer.

B. Application Rates: Apply soil treatment solution as follows:

1. Under slab-on-grade structures, treat soil before concrete slabs are placed, using the following application rates:

a. Apply 4 gallons or more of chemical solution per 10 linear feet (5.1 L of chemical solution per meter) to soil in critical areas under slab, including entire inside perimeter of foundation walls, along both sides of interior partition walls, around plumbing pipes and electric conduit penetrating slab, and around interior column footers.

b. Apply 1 gallon or more of chemical solution per 10 sq. ft. (4.1 L of chemical solution per sq. m) as an overall treatment under slab and attached slab areas where fill is soil or unwashed gravel. Apply 1-1/2 gallon of chemical solution per 10 sq. ft. (6.1 L of chemical solution per sq. m) to areas where fill is washed gravel or other coarse absorbent material.

c. Apply 4 gallons or more of chemical solution per 10 linear feet (5.1 L of chemical solution per meter) of trench for each 12 inches (300 mm) of depth from grade to footing, along outside edge of building. Dig a trench 6 to 8 inches (150 to 200 mm) wide along outside of foundation to a depth of not less than 12 inches (300 mm). Punch holes to top of footing at not more than 12 inches (300 mm) o.c. and apply chemical solution. Mix chemical solution with the soil as it is being replaced in the trench.

C. Post signs in areas of application to warn workers that soil termiticide treatment has been applied. Remove signs after areas are covered by other construction.

D. Reapply soil treatment solution to areas disturbed by subsequent excavation, landscape grading, or other construction activities following application.

- END OF SECTION -

SECTION 02310 - TUNNEL GROUNDWATER CONTROL

PART 1 -- GENERAL

1.1 DESCRIPTION

A. **Scope of Work:** This Section includes specifications for designing, furnishing, installing, maintaining, operating and removing systems required to control groundwater levels and hydrostatic pressures during tunnel and portal construction; disposing of pumped water; constructing, maintaining, observing, and removing of observation wells; and instrumentation for control of the system.

B. **Dewatering:** Dewatering includes lowering the groundwater table and intersecting seepage which would otherwise emerge from the tunnel excavation; preventing loss of material from the tunnel excavation; improving the excavating and hauling characteristics of tunnel materials; and preventing rupture or heaving of the bottom of the tunnel excavation.

C. **Instrumentation:** Instrumentation for control of the dewatering system includes furnishing, installing, and operating observation wells as well as reading and logging of water levels in the wells.

1.2 DESIGN CRITERIA

A. **Dewatering System:** The CONTRACTOR shall design a dewatering system which will:

1. Lower the groundwater level in the ground above and up to 10 feet below the tunnel opening, and 2 feet below the bottom of the excavated tunnel invert.

2. Develop a substantially dry and stable subgrade for the performance of subsequent operations;

3. Result in no damage to adjacent properties, buildings, structures, utilities, and other work; and

4. Not remove soil particles during pumping operations.

B. **Methods:** Methods may include sump pumping, single or multiple stage well point systems, eductor and ejector type systems, deep wells, and combinations thereof. It is the CONTRACTOR's responsibility to review and investigate the soils and groundwater conditions at the site and to determine the type or combination of methods necessary to provide the dewatering required to perform the work.

C. **Location:** The dewatering facilities shall be located only where they will not interfere with utilities and other construction work.

D. **Modifications:** Dewatering procedures which cause, or in the opinion of the ENGINEER threaten to cause, damage to new or existing facilities shall be modified so as to prevent further damage. The CONTRACTOR is responsible for determining and implementing any modifications, which shall be made at no additional expense to the OWNER.

1.3 SUBMITTALS

A. **Shop Drawings:** Prior to installation of the dewatering system, working drawings and design data shall be submitted for review by the ENGINEER, showing the following:

1. The proposed type of dewatering system, including relief of hydrostatic head and procedure for maintaining the tunnel and portal excavations in a dewatered and hydrostatically relieved condition.

2. Arrangement, location, and depths of the components of the system.

3. A complete description of equipment to be used, with installation, operation, and maintenance procedures.

4. Standby equipment and power supply.

5. Location, size, and construction details of berms, dikes, observation wells, sumps, and discharge lines, including discharge points and plans for removing system and restoration of the area disturbed by dewatering operations.

6. Types and sizes of filters.

7. Cement-bentonite grout mix and placing procedures.

8. Design calculations demonstrating adequacy of the selected system and equipment.

B. **Records:** The CONTRACTOR shall furnish the ENGINEER with the following records:

1. The average flow rate and time of operation of each pump used in the dewatering system shall be observed and recorded. Where necessary, appropriate devices, such as flow meters for observing the flow rates, shall be provided. The data, on a form approved by the ENGINEER, shall be submitted during the period that the dewatering system is in operation.

2. The elevation of the groundwater in observation wells shall be observed and recorded during the period that the dewatering system is in operation. The depth to the bottom of each observation well shall be sounded on a weekly basis to assure that fine soil particles are not penetrating the screen to build up in the standpipe. Observation well records shall be submitted to ENGINEER within 24 hours of reading.

3. During the initial period of the dewatering, required observations shall be made on a daily basis. After the initial period, when dewatering operations have stabilized, observations can be made at longer intervals as approved by the ENGINEER.

1.4 JOB CONDITIONS

A. **Surface Drainage:** All precipitation, surface water, and groundwater shall be intercepted and diverted away from the excavations, observation wells and piezometer installations, through the use of dikes, curb walls, ditches, pipes, sumps, or other means.

B. **Drainage of Excavated Area:** Ditches of adequate size shall be provided and maintained to collect surface and seepage water which may enter the excavations. The water shall be diverted into sumps and drains, or pumped into drainage channels or storm drains, subject to the approval of the appropriate authority. The CONTRACTOR

shall be responsible for obtaining any permits required for discharge of water from dewatering operations. When water is to be diverted into a storm drain, settling basins or other approved facilities shall be provided as required to reduce the amount of fine particles which may be carried into the drain. If a storm drain becomes blocked or its capacity restricted due to dewatering operations, arrangements shall be made with the appropriate agency to clean the drain at no additional expense to the OWNER.

PART 2 -- PRODUCTS (NOT USED)

PART 3 -- EXECUTION

3.1 DEWATERING

A. Dewatering shall be accomplished in accordance with reviewed shop drawings. The ENGINEER shall be kept advised of any changes made to accommodate field conditions and, on completion of the dewatering system installation, shop drawings shall be revised and submitted.

B. Dewatering operations shall be organized to lower the groundwater level in excavations as required for prosecution of the work, and to provide a stable, dry subgrade for the prosecution of subsequent operations.

C. The water level shall be maintained at such lower elevations until no danger to the tunnel and related facilities can occur because of buildup of excessive hydrostatic pressure, and in any event, the water level shall be maintained a minimum of 2 feet below the excavated tunnel invert and portal excavation until all tunnel or portal work has been satisfactorily completed, unless otherwise permitted by the ENGINEER.

D. Dewatering operations shall be prosecuted 24 hours a day, 7 days a week. Qualified personnel shall be on-site at all times to monitor system operations and to perform maintenance as necessary and to keep the dewatering system in operation. The responsible person in charge of the dewatering program shall be available for communication with the site at all times, and shall be able to be on the site within one hour of being alerted, should the need arise.

3.2 OBSERVATION WELLS

A. Observation wells shall be used as the primary basis for determining compliance with the dewatering requirements of this Section.

B. Up to 6 observation wells shall be installed at the locations, and to the depths indicated on the working drawings and as required by the ENGINEER. Existing wells may be used if available and appropriate.

C. Using approved drilling methods, 6-inch minimum diameter holes shall be drilled for observation wells, of the size and depth indicated, and cased with temporary casing. Bentonite drilling mud shall not be used in drilling holes for the observation wells. A log shall be made of the soils encountered during drilling and delivered to the ENGINEER.

D. All cased holes shall be flushed with clean water through an approved bit, until the discharge water is free of soil particles.

E. **Observation Well Construction:** Two-inch minimum inside diameter observation wells shall be constructed using slotted PVC well screen, filter sand, solid PVC casing,

couplings, a pipe cap, and a locking hole cover. Two feet of filter sand shall be placed in the bottom of the drilled hole, followed by the well screen and surrounded with filter sand, as the temporary casing is carefully withdrawn, to within 10 feet of the top. The solid PVC casing and cap shall be inserted and the annular space filled with cement-bentonite grout in the top 10 feet. If the well is located in a paved area, a locking well cover and a suitable precast concrete vault shall be installed.

F. Maintenance of the observation wells is the responsibility of the CONTRACTOR.

G. Damaged or destroyed observation wells shall be replaced within 48 hours, unless otherwise approved by the ENGINEER, at no additional expense to the OWNER.

H. Removal of Observation Wells:

1. Observation wells shall be removed only with the permission of the ENGINEER.

2. Observation wells outside paved areas shall be removed by removing PVC pipe construction to a depth of 5 feet below finished surface grade. Using approved tremie methods, the observation wells shall be completely filled with non-shrink cement-bentonite grout. The excavation shall be backfilled and the surface restored to a condition approved by the ENGINEER.

3. Observation wells in paved areas shall be removed by removing the vaults and hole covers to the pavement subgrade. The observation well shall be filled with cement-bentonite grout and the pavement patched in accordance with the requirements of the appropriate agency.

3.3 REMOVAL OF SYSTEM AND RESTORATION

A. When groundwater control is necessary, the dewatering wells shall be abandoned in an approved manner, drain lines and connections removed and the ground surface restored to its original condition, as required by the ENGINEER.

- END OF SECTION -

SECTION 02340 - BORING AND JACKING

PART 1 -- GENERAL

1.1 THE REQUIREMENT

A. The CONTRACTOR shall provide bored or jacked steel casing, complete and in place, all in accordance with the Contract Documents. Carrier pipe installation within the steel casing shall be in accordance with the requirements contained within this Section.

B. Boring and jacking shall not be performed in groundwater. Tunnels in groundwater shall be constructed only by microtunneling as per Section 02345. Boring and jacking in areas without groundwater shall be equipped with provisions to address flowing or loose sands and other unstable materials, and shall be performed with jacking heads with closeable doors or other means ("Closed heading" boring machines) to prevent the uncontrolled entry of material into the head, loss of ground and surface settlement.

C. In the performance of the WORK, the CONTRACTOR shall comply with the lawful requirements of the affected railway companies, public agencies, and owners of public utilities or other facilities for the safeguarding of traffic and improvements which might be endangered by the boring and jacking operations. Approach trenches in public streets will not be permitted to remain open for extended periods of time.

D. If the CONTRACTOR is not ready to place the carrier pipe in the casing at the time of completion of boring and jacking operations, the ends shall be bulkheaded, and the approach trenches in public streets shall be backfilled, temporary surfacing placed thereon, and the affected portion of the street reopened to traffic.

E. The CONTRACTOR shall be responsible for maintaining the required line and grade, and for preventing settlement of overlying structures, or other damage due to the boring and jacking operations.

1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. Commercial Standards:

ASTM A 283	Low Tensile Strength Carbon-Steel Plates
ANSI/AWS D1.1	Structural Welding Code.
ANSI/AWWA C200	Steel Water Pipe 6 Inches and Larger.

RELATED WORK SPECIFIED ELSEWHERE

A . SECTION 01535 - SETTLEMENT MONITORING

B. SECTION 02100 - SITE PREPARATION

C. SECTION 02120 - SHORING

D. SECTION 02140, DEWATERING

E. SECTION 02200 - EARTHWORK

1.3 CONTRACTOR SUBMITTALS

A. **Shop Drawings:** The CONTRACTOR shall submit shop drawings of pipe casing in accordance with the requirements in Section 01300 - Contractor Submittals and the following supplemental requirements as applicable:

1. Jacking head and other jacking equipment details and information.

2. Casing installation schedules which include schedules of excavation, pipeline installation, and backfill operations.

3. Material list including diameter, thickness, and class of steel casing.

4. Detailed locations. sizes and layout of all boring or jacking and receiving pits.

5. Permits associated with the boring or jacking operations.

6. The CONTRACTOR, prior to beginning any trench or structure excavation 5 feet deep or over, shall submit to the OWNER and shall be in receipt of the OWNER'S written acceptance of the CONTRACTOR's detailed plan showing design of all shoring, bracing, sloping of the sides of excavation, or other provisions for worker protection against the hazard of caving ground during the excavation of such trenches or structure excavation. The CONTRACTOR'S attention is directed to the provisions for "Shoring and Bracing Drawings" in Section 6705 of the California Labor Code. If such plan varies from the shoring system standards established in the Construction Safety Orders of the State of California, such alternative systems plans shall be prepared by a civil or structural engineer licensed in the State of California. The CONTRACTOR shall design shoring systems to accommodate the generally sandy site and groundwater conditions described in the geotechnical report. Shoring plans shall be stamped and signed by a California Registered Civil or Structural Engineer.

B. **Certifications:** The CONTRACTOR shall furnish a certified affidavit of compliance for all pipe and other products or materials furnished under this Section of the Specifications and the following supplemental requirements:

1. Physical and chemical properties of all steel.

C. All costs incurred in making samples for certification of tests shall be the CONTRACTOR's responsibility.

1.4 QUALITY ASSURANCE

A. Boring or jacking operations shall be done by a qualified CONTRACTOR with at least 5 years experience involving work of a similar nature.

B. The CONTRACTOR shall give the ENGINEER a minimum of 3 days advance notice of the start of excavation or boring operations.

C. WORK shall be performed in the presence of the ENGINEER, unless the ENGINEER has granted prior approval to perform such WORK in its absence.

D. **Welding Requirements:** Welding procedures used to fabricate steel casings shall be prequalified under the provisions of ANSI/AWS D1.1. Welding procedures shall be required for, at a minimum, longitudinal and girth or special welds for pipe cylinders, casing joint welds, reinforcing plates, and grout coupling connections.

E. Welding shall be done by skilled welders, welding operators, and tackers who have had adequate experience in the type of materials to be used. Welders shall be qualified under the provisions of ANSI/AWS D1.1 by an independent local, approved testing agency not more than 6 months prior to commencing work on the casing or pipeline. Machines and electrodes similar to those used in the WORK shall be used in qualification tests. The CONTRACTOR shall be responsible for all material and bear the expense of qualifying welders.

F. No exterior or interior joints of the carrier pipe shall have mortar grout applied over a seam until the seam has cooled. Exterior and interior joints of the carrier pipe shall be mortar coated and lined in the field, in accordance with the requirements of the carrier pipe specifications.

1.5 SAFETY

A. The OWNER has obtained from the Division of Occupational Safety and Health Administration a preliminary gas classification for each bore. Preliminary Gas Classifications are included with these specifications. It shall be the CONTRACTOR's responsibility to hold the on-site kick off/safety meeting with Cal OSHA and to ensure that the WORK is done in conformance with all applicable federal, state, and local safety requirements.

PART 2 -- PRODUCTS

2.1 GENERAL

A. Steel casings shall be welded steel pipe with minimum diameters and plate thicknesses indicated and shall be furnished complete with welded joint ends and pressure grout couplings. The steel pipe casings shall conform to ANSI/AWWA C200, subject to the following supplemental requirement. The CONTRACTOR may select a greater diameter or thickness for the method of work and loadings involved, site conditions, and possible interferences.

B. Annular space between the carrier pipe and the casing shall be filled with sand.

2.2 MATERIALS

A. **Steel Casing:** The casing pipe steel shall be in accordance with ASTM A283, Grade C, unless indicated otherwise. Casing section joints shall be butt welded, lap welded, or welded using butt straps in the field. Each end of the casing for butt welding shall be prepared by providing a 1/4-inch by 45-degree chamfer on the outside edges.

B. **Grout:** Grout shall consist of one part Portland cement, three parts sand, and the minimum amount of water necessary to obtain the desired consistency; all grout mixtures shall contain 2 percent of bentonite by weight of the cement. Portland cement, water, and sand shall conform to the applicable requirements of Section 03300 - Cast-in-Place Concrete, except that sand to be used shall be of such fineness that 100 percent will pass a Standard No. 8 sieve and at least 45 percent, by weight, will pass a Standard

No. 40 sieve. Bentonite shall be a commercial-processed powdered bentonite, Wyoming type, such as **Imacco-gel, Black Hills,** or equal.

C. **Grout Connections:** The CONTRACTOR shall provide 2-inch threaded grout connections on the interior of the steel casing pipe, regularly spaced at 5 feet on center, alternating at 30 degrees from plumb on each side of the vertical centerline at the top of the casing . Longitudinal spacing between the connections may be decreased to provide more extensive grouting, but in no case shall the spacings be exceeded. Upon completion of grouting, the grout connections shall be sealed with threaded cast iron plugs.

D. **Sand:** Sand for the annular space between the carrier pipe and the steel casing shall be clean, sized such that 100 percent passes a Standard No. 30 sieve.

PART 3 -- EXECUTION

3.1 INSTALLATION OF STEEL CASING

A. **Jacking Head:** A steel jacking head shall be fitted to the lead section of the casing in such a manner that it extends around the entire outer surface of the steel casing and projects at least 18 inches beyond the driving end of the casing. The jacking head shall not protrude more than 1/2-inch outside of the outer casing surface. The head shall be securely anchored to prevent any wobble or alignment variation during the boring or jacking operations. To minimize voids outside the casing, excavation shall be carried out entirely within the jacking head and not in advance of the head. Excavated materials shall be removed from the casing as the boring or jacking operation progresses and no accumulation of excavated materials within the casing shall be permitted. Also see Paragraph 1.1.B.

B. **Jacking and Receiving Pits:** The excavations for the boring and jacking operations shall be shored with solid sheeting to safeguard existing substructures and surface improvements and to ensure against ground movement in the vicinity of the jack supports or in the receiving pit. Heavy guide timber, structural steel, or concrete cradles of sufficient length shall be provided to assure accurate control of boring or jacking alignment. The CONTRACTOR shall provide adequate space within the excavations to permit the insertion of the lengths of casing to be bored or jacked and the extraction of the boring head. Timbers and structural steel sections shall be anchored to ensure action of the jacks in line with the axis of the casing. A bearing block, consisting of a timber or structural steel framework, shall be constructed between the jacks and the end of the casing to provide uniform end bearing over the perimeter of the casing and distribute the jacking pressure evenly. All jacking and receiving pits shall be provided with concrete Type K railing and 8 foot high chain link fencing around the perimeter. Chain link fence shall have a lockable gate. Flashing lights shall be provided in traffic areas. Provide "Danger, Keep Out" signs at each side of the pit.

C. **Control of Alignment and Grade:** The CONTRACTOR shall control the application of the jacking pressure and excavation of materials ahead of the casing as it advances to prevent the casing from becoming earthbound or deviating from the required line and grade. The CONTRACTOR shall restrict the excavation of the materials to the least clearance necessary to prevent binding in order to avoid loss of ground and consequent settlement or possible damage to overlying structures. Allowable grade deviations in horizontal and vertical alignments shall be no greater than 0.2 feet per 100 feet in any direction over the length of the jacking or boring to a maximum deviation of 0.5 feet at any point.

D. **Grouting:** Immediately after completion of the boring or jacking operations, the CONTRACTOR shall inject grout through the grout connections in such a manner as to completely fill all voids outside the casing pipe resulting from the boring or jacking operations. Grout pressure shall be controlled so as to avoid deformation of the steel casing and avoid movement of the surrounding ground. After completion of the grouting operations, the CONTRACTOR shall close the grout connections with cast-iron threaded plugs.

E. **Installation:** The installation of the casing shall be in accordance with the Contract Documents and be subject to the approval of the agency having jurisdiction over the area containing the boring or jacking operations.

F. **Surface Settlement Monitoring:** The CONTRACTOR shall establish a settlement monitoring grid located over the pipeline centerline and 5 feet on each side to monitor for surface settlement. Also see Section 01535 – Settlement Monitoring.

Monitoring of ground surface movements shall be performed by the CONTRACTOR's California Licensed Surveyor to assess whether or not settlement or heaving is impacting the road surface, ground surface, or adjacent structures as a result of the casing installation. The CONTRACTOR shall submit a detailed plan of the monitoring program and casing installation procedures. The program shall monitor surface movement at a minimum of 3 locations along the proposed trenchless installation, and at no more than 100-foot spacings during boring.

At each monitoring location, surface monuments shall be established to measure surface deflection at the centerline of the pipe, and 5 feet left and right of centerline. The frequency of monitoring and tolerances for the monitoring program are summarized as follows.

Point	Frequency	Tolerance	Maximum Allowable
Surface	Hourly when heading is within 15 feet of the monitoring point; otherwise daily.	± 0.25 inches	0.5 inches

When the tolerance is exceeded, modifications to the casing installation shall be made to prevent excessive settlement or heave. If heave or settlement exceeds the maximum allowable then mitigation such as grouting and repair to the roadway or structures shall be provided, all at the CONTRACTOR's cost.

3.2 INSTALLATION OF CARRIER PIPE

A. **Carrier Pipe Requirements:** Carrier pipe shall be installed in accordance with the respective Specifications for the pipe material shown. Care shall be taken to maintain the pipeline vertical and horizontal alignment, to prevent flotation and to prevent joint separation. Steel pipe joints shall be welded.

B. **Testing of the Carrier Pipe:** Hydrostatic testing of the carrier pipe shall be completed prior to the filling of the annular space with sand. Hydrostatic testing shall be performed in accordance with Section 01656 - Pressure Pipe Testing.

C. **Sand Backfill for Annular Space in Jacked Casing:** Sand shall be conveyed by air through a hose to its final position. The sand shall be free of lumps to flow unimpeded and to completely fill all voids. In general, sand backfill will be considered completed

when no more sand can be forced into the annular space. The CONTRACTOR shall protect and preserve the interior surfaces of the steel casing from damage. The ends of the casing shall be sealed in accordance with the casing detail shown in the Drawings.

D. **Closing of Pits:** After jacking equipment and excavated materials from the boring or jacking operations have been removed from the jacking pit, the CONTRACTOR shall prepare the bottom of the jacking pit as a pipe foundation. The CONTRACTOR shall remove loose and disturbed materials below pipe grade down to undisturbed earth as determined by Engineer. The contractor shall then place approved compacted Pipe Zone or Trench Zone Backfill material in accordance with Section 02200 - Earthwork.

- END OF SECTION -

SECTION 02345 - MICROTUNNELING

PART 1 -- GENERAL

1.1 THE REQUIREMENT

A. **Microtunneling shall be performed only by contractors or subcontractors that have been prequalified by the OWNER. See Section 00030CA.**

B. The CONTRACTOR shall construct sanitary sewer pipeline shown and specified in the contract documents using the microtunneling construction method as defined herein.

C. The CONTRACTOR shall furnish all items including, but not limited to, the microtunnel boring machine (MTBM), automated spoil transport and separation system, jacking frame and jacks, laser control system, control trailer with CCTV monitoring and data logger, hoists, signal systems, safety equipment, and survey controls necessary to excavate and construct the sanitary sewer.

D. The CONTRACTOR shall thoroughly review the project Geotechnical Report to become familiar with the site soil and groundwater conditions and plan, bid and execute its microtunneling work accordingly. The CONTRACTOR's microtunneling approach shall be proposed to address and handle mixed face soil conditions, if encountered.

1.2 DEFINITIONS

A. **Jacking Record:** A computer-generated or manually recorded report that contains information on all pertinent microtunneling operations, including rate of advance, slurry flow rates and pressures, jacking forces, face pressure, cutter-head torque, steering corrections, machine inclination, roll, machine position, installed tunnel length, intermediate jacking station forces, date, time, name of Operator, problems encountered with the tunneling machine or other components or equipment, and reasons for delays.

B. **Launch Seal:** A mechanical seal, usually comprised of a rubber flange attached to a steel housing, that is mounted to the wall of the jacking shaft. The microtunneling machine distends the flange seal as it passes through, creating a seal to prevent water, slurry, or lubrication inflows into the shaft during tunneling operations.

C. **Lubrication Port:** A port located in a jacking pipe segment, fitted with a one-way valve, for injection of lubrication material or grout into the annular space between the pipe and the ground. The port is typically threaded to accept a pipe plug, inserted after installation and grouting are completed.

D. **Microtunneling:** A remotely controlled, guided, pipe-jacking process that provides continuous support to the excavation face. The guidance system usually consists of a laser, mounted in the jacking pit as a reference, with a target mounted inside the microtunneling machine's articulated steering head. The microtunneling process does not require routine personnel entry into the tunnel. A key element of microtunneling is the ability to control the stability of the face by applying mechanical or fluid pressure to the face to balance the earth and groundwater pressures.

E. **Obstruction:** Objects or portions of objects located wholly or partially within the cross-sectional area excavated by the microtunneling machine that are larger than one-third

the outer diameter of the shield or cutter-head, and that prevent the forward motion of the microtunneling machine.

F. **Settlement Point:** A point with elevation and spatial location established by survey prior to construction. The point is re-surveyed periodically to monitor ground movements. The point may be a nail, pin, subsurface settlement rod, or other device that can be readily located and surveyed.

RELATED WORK SPECIFIED ELSEWHERE

A . SECTION 01535 – SETTLEMENT MONITORING

B . SECTION 02100 - SITE PREPARATION

C. SECTION 02120 - SHORING

D. SECTION 02140 - DEWATERING

E. SECTION 02200 - EARTHWORK

1.3 CONTRACTOR SUBMITTALS

A. Submit a detailed description of the microtunneling equipment and procedures to be employed. Provide manufacturer's literature and operator's manual, including specifications, describing the microtunneling equipment in detail, including any modifications made since manufacturing. Submit details of any major component overhauled or replaced in the last 2 years.

B. Submit a detailed description, calculations and drawings showing the proposed shoring and dewatering systems at the microtunneling bore and receiving pits. Shoring and dewatering systems shall be designed compatibly. The Contractor shall design its shoring systems to accommodate the generally sandy site and groundwater conditions described in the geotechnical report. Shoring plans shall be stamped and signed by a California Registered Civil or Structural Engineer. These factors shall be considered when designing and sizing pits.

C. Describe method and capabilities for providing stabilizing pressure at the tunnel heading. Indicate the range of face pressures anticipated to be required to stabilize the heading and the methods and equipment to be used to monitor and control the face pressure. Indicate the torque and torque pressure gage or amp meter reading required to rotate the cutterhead under no face pressure. Indicate the torque pressure gage reading or amp meter reading corresponding to maximum available torque.

D. Submit a description of the alignment control and steering system. Confirm that these systems can achieve the required tolerances for pipeline line and grade. Include a description of the equipment and procedure for checking the position of the laser. Provide documentation that the laser has been tested and that required function, accuracy, and precision have been verified by the CONTRACTOR.

E. Submit details on the lubrication injection system used for lubrication of the pipeline during microtunneling operations. Provide details on the planned lubrication injection scheme that will be used. Provide details of the calculated volume of the annular space (the minimum volume that will be continuously pumped throughout installation procedures). Provide a description of the lubrication materials that will be used. Also see Paragraph G, below.

F. Submit details on the muck/slurry handling, transport, recovery, and disposal equipment and procedures. Include dimensions, manufacturer's specifications, and details on the slurry separation and recirculation systems. Details shall be provided on the planned slurry composition and any slurry additives that are planned for use during the microtunneling operations. Include diagrams showing the location of all slurry delivery and return pumps. Provide written documentation signed by the site owner or manager of the disposal site(s) indicating that they will accept the muck or slurry and are in compliance with all applicable local, state, and federal regulations. Provide detailed description of the slurry separation plant and process, including dimensions, type of equipment, specifications, noise ratings, and sound-proofing. Submit details of planned additives to assist in the separation process such as polymers. Submit muck transport plans, including route to be used and measures to avoid spillage onto streets and highways.

G. Provide details on the jacking frame, including a diagram of the main jacks, thrust ring, jacking controls, and pressure gages. Provide details on the maximum jacking capacity of the jacking frame and the hydraulic pressure required to develop the maximum pressure. Provide the conversion factor from gage pressure for the hydraulic jacks to thrust, in tons.

H. Provide details and dimensioned drawings on the entry and exit shaft seals and the mounting procedures.

I. Provide details on the generator, including dimensions, noise ratings at 50 feet, and soundproofing. Confirm that the generator and other on-site equipment meet the maximum allowable noise levels as dictated by local ordinances or codes. Confirm that vibrations produced by the equipment shall be below objectionable levels as dictated by local ordinances or codes.

J. Provide a schedule for all microtunneling work, identifying all major construction activities as independent items. The schedule shall include, as a minimum, the following activities: mobilization, groundwater control at jacking and receiving shafts, shaft excavation and support, working slab, thrust wall construction, jacking equipment set up, ground stabilization and entry ring installation for launch of machine, microtunneling for each drive, retrieving MTBM, moving or turning equipment between drives, shaft abandonment, site restoration, cleanup, and demobilization. The schedule shall also include the work hours and workdays for each activity, and a written description of the construction activities. The CONTRACTOR is advised that planned work hours and work days shall be in compliance with the Contract requirements. The schedule shall be reviewed by the ENGINEER and will be updated and resubmitted by the CONTRACTOR every two weeks or more frequently if requested by the ENGINEER.

K. Ground Stabilization. Submit details on the method of controlling groundwater inflows and loss of ground into the shafts at all times, including the periods during launch and retrieval of the microtunneling machine, i.e. when exiting the launch shaft and entering

the reception shaft. Pit entry and exit faces shall be grouted to prevent loss of ground and settlement.

L. Daily Records. The following daily records shall be submitted by the CONTRACTOR to the on-site ENGINEER for review:

1. Jacking Records. The CONTRACTOR shall provide complete written jacking records to the ENGINEER at the end of each day. These records will include, at a minimum, the name of the operator, tunnel drive identification, the date, the installed length of pipe, thrust force, slurry flow rates, face pressure, cutter-head torque, slurry pressure, penetration rate, roll, inclination, steering adjustments, laser position, line and grade deviations, any movement or adjustments of the laser, use of intermediate jacking stations, jacking force at the intermediate jacking stations, any problems including malfunction of equipment or gauges that monitor performance, reason for stopping operations, and duration of any stops. The operating system should continuously provide performance data to the operator. Computer recorded data should be referenced to the length of installed tunnel and should be recorded at length intervals of one-half foot or less. Manually recorded observations should be made at intervals of not less than three times per pipe, as conditions change, or as directed by the ENGINEER.

2. Lubrication Records. The CONTRACTOR shall provide lubrication records to the ENGINEER. These records will include the amount of lubrication pumped throughout a drive, reported as pumped volume per shift, and total for each drive.

3. Slurry Additives. The CONTRACTOR shall provide records of slurry additives to the ENGINEER. These records will include all slurry additives, including any bentonite and polymers and will be submitted with the daily jacking record. The time and volume of the addition to the slurry shall be noted. Measurements of specific gravity and viscosity will be made at the beginning, middle, and end of each shift, and submitted with the daily logs.

4. Survey Measurements. Survey measurements of settlement points will be submitted to the ENGINEER by the end of the day after the measurements were taken. Measurements shall be performed by a California Licensed Land Surveyor.

M. Protection of Adjacent Structures. Provide details on measures to be taken to monitor and protect adjacent utilities, structures, roadways, and provide details on monitoring equipment and provisions, including the layout of all settlement points and other monitoring points. Also see Section 01535 – Settlement Monitoring and Paragraph 3.2.A.13, below.

N. Safety Plan. The CONTRACTOR shall submit a Safety Plan for conducting the microtunneling operations, including provisions for lighting, ventilation, gas monitoring and electrical system safeguards. The safety plan shall include a code of safe practices and an emergency plan in accordance with OSHA and Cal/OSHA requirements, including holding the initial site meeting with the Division of Industrial Safety Mines representative. The CONTRACTOR shall provide the name and resume, with references for the on-site safety representative.

O. Slurry Control and Cleanup Plan. The CONTRACTOR shall develop and submit a plan which will discuss in detail the operation and control of the MTBM to prevent hydrofracture of the microtunnel slurry to ground surface, roadways, or buried utilities. The Slurry Control and Cleanup will include detailed procedures that will be used to

control and cleanup of microtunnel slurry hydrofracture and spills to the ground surface, roadways, and underground utilities. The Slurry Control and Cleanup Plan will include a list of necessary equipment and materials and identify the storage location of such equipment and materials. Any special traffic controls for the Slurry Control and Cleanup should be addressed and included in the Traffic Control Plan requirements of The Special Provisions.

PART 2 -- PRODUCTS

2.1 PIPE

A. Provide pipes of nominal inside diameter shown on the Drawings and as specified in the contract documents.

B. Pipe used for this specification section shall be specifically designed for microtunneling by the pipe manufacturer. The pipe shall be round, smooth, and with flush-jointed outer surfaces. Pipe ends shall be square and smooth so that jacking loads are evenly distributed against the pipe end faces without point loads when the pipe is jacked. Pipe used for microtunneling shall be capable of withstanding forces imposed by the process of installation, as well as the final in-place loading conditions. The driving ends of the pipe and intermediate joints shall be protected against damage. The detailed method proposed to cushion and distribute the jacking forces shall be submitted to the Engineer for approval.

C. Damaged pipe shall be jacked through to the reception shaft and removed. Other methods of repairing the damaged conduit may be used, as recommended by the manufacturer and approved by the ENGINEER.

D. The pipe manufacturer's design jacking loads shall not be exceeded during the installation process. The pipe shall be designed to take full account of all temporary installation loads.

E. The maximum jacking capacity used shall not exceed the allowable jacking capacity of the pipe using a minimum factor of safety of 3.

F. The pipe materials acceptable for microtunneling shall be Polymer Concrete Pipe, as defined in Section 02587, and Fiberglass Reinforced Polyester Mortar Pipe, as defined in Section 02586.

PART 3 -- EXECUTION

3.1 EQUIPMENT

A. MTBM

1. ONLY slurry microtunneling equipment shall be used for the pipe installation work described in this section. The microtunneling equipment shall be manufactured by **Akkerman, Herrenknecht, Iseki, Soltau**, or approved alternate.

2. The machine shall be equipped with a computerized data acquisition system for collecting information for the jacking record. An on-site printer and disk drive will also be required for production of the printed daily jacking record and diskette files. As an alternative or supplement to the computerized data acquisition system the

CONTRACTOR may use manual data acquisition for collecting information for the jacking record. All data required and specified in this section shall be collected and submitted to the ENGINEER by the CONTRACTOR, regardless of the methods for data collection.

3. The machine shall have an articulated shield with a watertight joint. The shield shall be steerable in both the vertical and horizontal directions that allow the operator to maintain line and grade within the specified tolerances. The cutter head shall have a reversible drive system so that it can rotate in either direction to minimize rotation or roll of the machine during operation.

4. The machine shall be capable of advancing through the geologic and groundwater conditions to be encountered at the site, as described in the Geotechnical Report and as determined by the CONTRACTOR's own investigation. The machine shall be able to excavate/handle mixed face soil conditions, if encountered.

5. The machine shall be equipped for continuous gas monitoring. The CONTRACTOR shall have a shut-down plan that includes activation of the slurry by-pass in the event that a gassy environment is detected in the heading.

6. The maximum radial overcut will be 1-inch. The minimum radial overcut will be 1/4-inch. The radial overcut will be determined as the difference between the maximum diameter created by the cutting teeth or overcut band on the machine and the outer diameter of the pipeline, divided by two.

7. The connection between the tail of the machine and the first pipe section should be fully gasketed and sealed to prevent material or water from flowing into the machine during tunneling operations.

B. Jacking Equipment

1. The jacking system shall be capable of continuously monitoring the jacking pressure, rate of advance, and jacking distance. The jacking system shall develop a uniform distribution of jacking forces on the ends of the pipe.

2. A lubrication injection system shall be provided to inject pipe lubricant to decrease required jacking forces. Lubrication materials may include a mixture of bentonite and/or polymers and water.

C. Automated Spoils Transport System

1. The machine shall be capable of fully supporting the face during both excavation and shutdown periods and shall have the capability of exerting a controllable, measurable, continuous, stabilizing pressure at the face required to prevent loss of ground and groundwater inflows. The machine shall be capable of controlling the volume of excavated material removed at the tunnel face, independent of machine advance.

2. The machine shall have a slurry chamber capable of being pressurized. A pressure gage shall be provided to monitor the pressure exerted by the slurry at the heading.

3. The microtunneling system shall include a slurry separation plant that can achieve the rates of spoil separation and slurry cleaning required by the CONTRACTOR to achieve planned production rates. Shaker screens, hydrocyclones and centrifuges

may be required for efficient separation of spoils. The CONTRACTOR is advised that the separation plant must fit within available work areas and that excavated slurry pits or ponds will not be allowed.

D. Active Steering Controls

1. The machine shall be remotely operated, guided, and monitored continuously by the operator. Steering information shall be displayed at the operation console to allow the operator and site inspector to monitor the machine in relation to the design line and grade, face pressure, torque, roll, inclination, laser position, steering attitude, rate of advance, installed length, and jacking force, slurry flow rates and pressures, and positions of slurry bypass valves and high pressure jets.

E. Guidance/Monitoring Equipment

1. The MTBM display equipment shall continuously show and automatically record the position of the shield with respect to the project design line and grade. The automated recording system shall include real time information such as earth and ground pressure, roll, pitch, attitude, rate of advance, installed length, cutter head torque, jacking loads, slurry pressure, slurry flow, and slurry valve positions.

2. Line and grade shall be controlled by a guidance system that relates the actual of the position MTBM to a design reference (e.g., by a laser beam transmitted from the jacking shaft along the line of the pipe to a target mounted in the shield). The line and grade tolerances of pipe installed shall be ± 1 inch on grade and 1-1/2 inches on line between shafts, unless otherwise approved by the ENGINEER.

3. The rate of return to line and grade shall not exceed 1-inch in 25 feet.

3.2 EXECUTION AND JACKING OF PIPE

A. Tunnel excavation shall be between the limits indicated on the Contract Drawings to the specified line and grade and shall be accomplished using methods which include due regard for safety of workers, adjacent structures and improvements, utilities, and the public. Jacking and receiving pits shall be located as identified on the Contract Drawings, unless otherwise approved in writing by the ENGINEER.

1. The CONTRACTOR shall furnish all necessary equipment, power, water, and utilities for microtunneling, shoring and shafts, excavation, bentonite mixing and pumping, removal and disposal of spoils, and other associated work consistent with the CONTRACTOR's methods of construction.

2. The CONTRACTOR shall not begin microtunneling until the following conditions have been met:

a. All required submittals have been made and the ENGINEER has reviewed and accepted all submittals.

b. Required pre-construction surveys have been completed and submitted to the ENGINEER for review.

c. Shaft excavation and support has been completed. Pits shall be shored with continuous interlocked steel sheet piles or continuous soldier piles and lagging systems.

d. The soil shall be stabilized behind the shaft wall through which the MTBM shall be launched or retrieved. Soil grouting shall be employed to prevent soil and water inflows during the launch or retrieval. The CONTRACTOR shall demonstrate to the ENGINEER that the soil behind the shaft wall is stable by removing a small portion of the shoring. If the soil is not stable, the CONTRACTOR shall employ additional soil stabilization measure prior to launching or retrieving the machine.

e. A pre-construction on-site safety conference has been conducted in accordance with Cal/OSHA requirements. This conference must be arranged and the ENGINEER notified of the date at least 7 days in advance of the conference. See Preliminary Gas Classification attached to this specification section.

3. The CONTRACTOR shall survey the location and orientation of the pipe guide rails prior to starting jacking operations to ensure they are on the proper line and grade.

4. The CONTRACTOR shall ensure that the axial forces from the main jacks shall be distributed to the pipe uniformly through cushion materials to prevent damage to the ends of the pipe.

5. The CONTRACTOR shall ensure that each pipe section shall be jacked as the excavation progresses in such a way that no length of tunnel is left exposed at any time.

6. The CONTRACTOR shall ensure that steering corrections are gradual, with corrections made at a rate of no more than 1-inch over 25 feet of drive length.

7. The CONTRACTOR shall jack the pipes into place without damaging the pipe. In the event a section of pipe is damaged during the jacking operation, the CONTRACTOR, with written approval from the ENGINEER, may jack the pipe through to the next shaft for removal. Other methods of repairing or replacing the damaged pipe may be used, subject to the written approval of the ENGINEER.

8. The CONTRACTOR shall control the advance rate of the machine and shall balance the rate of removal of excavated material with the rate of excavation and pipe installation to avoid over-excavation that can lead to subsidence and under-excavation that can lead to heave.

9. The CONTRACTOR shall mount the laser or other guidance tracking system independently from the thrust block and jacking frame to maintain the alignment of the laser. The CONTRACTOR shall stop tunneling operations and reset the laser if the laser alignment shifts or is moved off design alignment and grade for any reason. The CONTRACTOR shall immediately notify the ENGINEER if the laser has been disturbed and must be reset. Any laser disturbances or adjustments shall be noted on the daily log. The CONTRACTOR may propose alternative guidance/tracking systems, subject to the ENGINEER's approval.

10. If the pipe installation does not meet the specified tolerance, the CONTRACTOR shall correct the installation including, if necessary, redesign of the pipeline or structures and acquisition of necessary easements. All corrective work shall be performed by the CONTRACTOR at no additional cost to the OWNER and is subject to the approval of the ENGINEER.

11. The CONTRACTOR shall maintain and control face pressure exerted at the heading of the tunneling machine to balance soil and groundwater pressures and prevent loss of ground, groundwater inflows, and settlement or heave of the ground surface. Face pressures (slurry and earth) shall be measured at the face of the machine and slurry flow rates shall be measured at the shaft.

12. The CONTRACTOR's operations shall prevent settlement or heave of the ground. The CONTRACTOR shall repair any damage resulting from surface settlement or heave caused by shaft excavation, shaft dewatering, or microtunneling at no additional cost to the OWNER, and shall immediately modify any practices that caused or contributed to the ground disturbance to avoid continued or recurring problems.

13. **Surface Settlement Monitoring:** The CONTRACTOR shall establish a settlement monitoring grid located over the pipeline centerline and 5 feet on each side to monitor for surface settlement.

    Monitoring of ground surface movements shall be performed by the CONTRACTOR's California Licensed Surveyor to assess whether or not settlement or heaving is impacting the road surface, ground surface, or adjacent structures as a result of the pipe installation. The contractor shall submit a detailed plan of the monitoring program and pipe installation procedures. The program shall monitor surface movement at a minimum of 3 locations along the proposed trenchless installation, and at no more than 100-foot spacings during boring.

    At each monitoring location, surface monuments shall be established to measure surface deflection at the centerline of the pipe, and 5 feet left and right of centerline. The frequency of monitoring and tolerances for the monitoring program are summarized as follows.

Point	Frequency	Tolerance	Maximum Allowable
Surface	Hourly when heading is within 15 feet of the monitoring point; otherwise daily.	± 0.25 inches	0.5 inches

    When the tolerance is exceeded, modifications to the pipe installation shall be made to prevent excessive settlement or heave. If heave or settlement exceeds the maximum allowable then mitigation such as grouting and repair to the roadway or adjacent structures shall be provided, all at the CONTRACTOR's cost.

14. The CONTRACTOR shall take active measures to prevent loss of ground during launch and retrieval of the machine. Groundwater or slurry inflows into the shaft during launch and retrieval shall not be permitted. A launch seal shall be required for each microtunneling drive. A retrieval seal shall be used if unstable ground conditions are encountered, or if ground losses or soil or groundwater inflows occur into the shaft before or during execution of the work.

15. The CONTRACTOR shall use an alignment control and steering system capable of maintaining the position of the machine to within the specified tolerances for line and grade. The system shall be field-calibrated to the longest drive length, to ensure that the position of the laser on the target can be distinguished and that the signal is sufficiently strong to provide accurate steering data to the operator.

16. The CONTRACTOR shall use a lubrication/bentonite injection system to provide continuous lubrication of the pipeline. Lubrication material shall be pumped in sufficient volume to completely fill the annular space of the pipeline, or that area between the outer diameter of the pipe and the overcut diameter. The Contractor shall continuously monitor the slurry pressure to prevent hydro-fracture.

17. The composition of the slurry shall be monitored by the CONTRACTOR during the tunneling operations. Specific gravity and viscosity measurements shall be taken at the beginning, middle, and end of each shift and will be included in the daily record. The CONTRACTOR shall keep accurate records of all slurry additives, including type of additive and volumes added to the slurry tanks.

18. The CONTRACTOR or pipe manufacturer shall install pipe cushion materials between each pipe joint. The cushion materials or compression rings will be made of plywood or other materials recommended by the pipe manufacturer and reviewed by the ENGINEER. The compression rings shall not protrude beyond the inner or outer diameter of the pipe. The compression rings shall be of sufficient thickness to distribute the jacking load between successive pipe sections, and minimize eccentric loading.

19. The CONTRACTOR shall conduct all operations such that slurry separation operations, trucks and other vehicles do not create a dust or mud nuisance or traffic hazard in the streets and adjacent properties. Any muck spillage or slurry breakthroughs shall be promptly cleaned up, removed and properly disposed. The CONTRACTOR's slurry separation plant shall discharge into a truck, tank or container that prevents slurry spillage onto any street or ROW. Discharge from the slurry separation plant onto the street or ROW shall not be permitted. Slurry discharges into the storm or sanitary sewers and/or creeks shall not be permitted.

20. The CONTRACTOR shall perform all work so as not to disturb roadways, adjacent structures, landscaped areas, or utilities. Any damage shall be immediately repaired by the CONTRACTOR to the satisfaction of the ENGINEER, at no additional cost to the OWNER.

21. If the microtunneling operations should encounter an obstruction that prevents the forward progress of the machine, the CONTRACTOR shall notify the ENGINEER immediately. The CONTRACTOR shall remove, clear, or otherwise make it possible for the microtunneling machine and jacked pipe to advance past any and all objects or obstructions that halt forward progress of the machine. Upon written notification of the ENGINEER, the CONTRACTOR shall immediately proceed with removal of the obstruction by means of an obstruction removal shaft or by other approved means, as submitted by the CONTRACTOR in reviewed submittals. An obstruction removal shaft shall consist of a small excavation for the purpose of removing the obstruction The CONTRACTOR shall backfill the receiving pit with approved compacted Pipe Zone or Trench Zone Backfill Material in accordance with Section 02200- Earthwork.. The CONTRACTOR will receive compensation for removal of obstructions, as defined as hard objects with a maximum dimension larger than one-third the outer diameter of the shield or cutting head, whichever is larger. Payment will be negotiated with the OWNER on a case-by-case basis. However, any removal process that does not allow direct inspection of the nature and position of the obstruction will not be considered for payment. The CONTRACTOR will receive no additional compensation for removing, clearing, or otherwise making it possible for the microtunneling machine to advance past

objects consisting of cobbles, boulders, wood, non-reinforced concrete, and other nonmetallic objects or debris with maximum lateral dimensions less than one-third the outer diameter of the shield or cutterhead, whichever is larger.

22. Prior to the launch of the machine, the CONTRACTOR shall conduct a start-up inspection of all mechanical and hydraulic systems associated with the microtunneling operations. The system shall be tested on the surface to ensure that the microtunneling machine and supporting equipment is functioning properly. The ENGINEER shall be notified at least 48 hours prior to the start-up inspection and a site inspector representing the OWNER shall be present during the start-up inspection. Key machine performance data will be measured and recorded by the CONTRACTOR during this inspection, including cutterhead rotational torque, correct functioning of main and steering jacks, laser and target, and other components. The records of the start-up inspection shall be submitted to the ENGINEER within 24 hours of the completed inspection.

23. After microtunneling equipment, jacking equipment, and excavated materials from the microtunneling operations have been removed from the jacking /receiving pits, the CONTRACTOR shall prepare the bottom of the jacking /receiving pits as a pipe foundation. The CONTRACTOR shall remove loose and disturbed materials below pipe grade down to undisturbed earth as determined by Engineer. The CONTRACTOR shall then place approved compacted Pipe Zone or Trench Zone Backfill material in accordance with Section 02200 – Earthwork.

24. In the event that voids are created or encountered around the pipeline, the CONTRACTOR shall immediately notify the ENGINEER. The CONTRACTOR shall, at it's cost grout the voids and take any additional measures necessary to repair the damage to the ENGINEER's satisfaction. The CONTRACTOR shall immediately modify construction practices or equipment as appropriate to avoid or protect against further voids and damage.

25. The CONTRACTOR shall perform all work within the noise requirements as set forth in the Contract Documents and all federal, state and/or local laws and ordinances.

- END OF SECTION -

SECTION 02347 - HORIZONTAL DIRECTIONAL DRILLING

PART 1 -- GENERAL

1.1 THE REQUIREMENT

A. This Specification covers the installation of pipe or conduit by horizontal directional drilling. Horizontal directional drilling is a trenchless excavation method which is accomplished in two phases. The first phase consists of drilling a small diameter pilot hole along a designed directional path. The second phase consists of enlarging the pilot hole to a diameter suitable for installation of the pipe or conduit, and pulling the pipe or conduit into the enlarged hole. Horizontal directional drilling is accomplished using a specialized horizontal drilling rig with ancillary tools and equipment.

1.2 EXISTING FACILITIES AND UTILITIES

A. CONTRACTOR shall undertake the following steps prior to commencing drilling operations in this project location which contains existing underground facilities.

1. Contact the utility location/notification service, for the construction area.

2. Positively locate and stake all existing lines, cables, or other underground facilities including exposing any facilities which are located within 10 feet of the designed drilled path.

3. Modify drilling practices and downhole assemblies to prevent damage to existing facilities.

B. CONTRACTOR shall be responsible for locating any and all underground facilities regardless of any previous efforts in this regard. CONTRACTOR shall be responsible for all losses and repairs occasioned by damage to underground facilities resulting from drilling operations.

1.3 INSTRUMENTATION

A. The CONTRACTOR shall at all times provide and maintain instrumentation which will accurately locate the pilot hole, measure drill string axial and torsional loads, and measure drilling fluid discharge rate and pressure. The OWNER will have access to these instruments and their readings at all times. However, one CONTRACTOR shall be solely responsible for the line and grade accuracy of the installed pipeline.

1.4 CONTRACTOR SUBMITTALS

A. All procedure or material descriptions requiring the OWNER'S approval shall be submitted per Section 01300 not less than 30 days prior to commencing any horizontal directional drilling activities at the crossing location.

1.5 PHYSICAL CONDITIONS REFERENCE DOCUMENTS

A. The CONTRACTOR shall thoroughly familiarize itself with the soil and groundwater conditions described in the project Geotechnical Report. The CONTRACTOR is encouraged to make any additional investigations for the purposes of performing the work.

PART 2 -- PRODUCTS

2.1 POLYETHYLENE PIPE

A. Pipe for horizontal directional drilling shall be solid wall butt-fused polyethylene pipe as specified in Section 02594 - Polyethylene Pressure Pipe.

PART 3 -- PART 3 – EXECUTION

3.1 PILOT HOLE DIRECTIONAL TOLERANCE

A. Description: The pilot hole shall be drilled along the path shown on the plan and profile drawings to the tolerances listed. However, in all cases, right-of-way restrictions shall take precedence over the listed tolerances. Regardless of the tolerance achieved, no pilot hole will be accepted if it will result in any or all of the pipeline being installed in violation of right-of-way restrictions. In all cases, concern for adjacent utilities and/or structures shall take precedence over the listed tolerances. Listing of tolerances does not relieve CONTRACTOR from responsibility for safe operations or damage to adjacent utilities and structures.

B. Curve Radius: Curves shall be drilled at radii which fall within the tolerances listed. The drilled radius will be calculated over any 3 joint (range 2 drill pipe) segment using the following formula:

$$R_{drilled}=(L_{drilled}/A_{avg})*57.32$$

Where: $R_{drilled}$=drilled radius over $L_{drilled}$
$L_{drilled}$=length drilled, no less than 75 feet and no greater than 100 feet

A_{avg} =total change in angle over $L_{drilled}$

C. As-Built Survey: At the completion of pilot hole drilling, CONTRACTOR shall provide a tabulation and sealed drawings of coordinates, referenced to the drilled entry point, which accurately describe the location of the pilot hole.

3.2 REAM AND PULL BACK

A. **Hydrostatic Pretest:** The entire pull section shall be subjected to a 4-hour hydrostatic test prior to being installed in the hole. The test pressure shall be equal to or exceed that required for final certification. The hydrostatic pretest shall be conducted and documented in accordance with the applicable Specification.

B. **Pre-Reaming:** Pre-reaming operations shall be conducted at the discretion of CONTRACTOR. All provisions of this Specification relating to simultaneous reaming and pulling back operations shall also pertain to pre-reaming operations.

C. **Pulling Loads:** The maximum allowable tensile load imposed on the pull section shall be equal to 80 percent of the product of the specified minimum yield strength of the pipe and the area of the pipe section. If more than one value is involved for a given pull section, the lesser shall govern.

D. **Torsional Stress:** A swivel shall be used to connect the pull section to the reaming assembly to minimize torsional stress imposed on the section.

E. **Pull Section Support:** The pull section shall be supported as it proceeds during pull back so that it moves freely and the pipe and corrosion coating are not damaged.

F. **External Collapse Pressure:** The pull section shall be installed in the reamed hole in such a manner that external pressures are minimized. Any damage to the pipe resulting from external pressure during installation shall be the responsibility of CONTRACTOR.

G. **Buoyancy Modification:** Buoyancy modification shall be used at the discretion of CONTRACTOR. Any buoyancy modification procedure proposed for use shall be submitted to OWNER for approval. No procedure shall be used which has not been approved. CONTRACTOR is responsible for any damage to the pull section resulting from buoyancy modification.

H. CONTRACTOR shall provide a sufficient number of rollers, cradles and motorized equipment to support the pipe and prevent over-stressing due to sags or bends during the pull back Procedure.

I. **Relaxation Period:** The installed polyethylene pipe shall be allowed to relax and cool following installation in accordance with the manufacturer's recommended time, but not less than a minimum of four (4) hours prior to final connections at the pipe ends.

3.3 DRILLING FLUIDS

A. **Composition:** The composition of all drilling fluids proposed for use shall be submitted to the OWNER for approval. No fluid will be approved or utilized that does not comply with permit requirements and environmental regulations.

B. **Water:** CONTRACTOR is responsible for obtaining, transporting, and storing any water required for drilling fluids. The water sources will be provided by the OWNER.

C. **Recirculation:** CONTRACTOR shall maximize recirculation of drilling fluid surface returns. CONTRACTOR shall provide solids control and fluid cleaning equipment of a configuration and capacity that can process surface returns and produce drilling fluid suitable for reuse. The CONTRACTOR will be solely responsible for solids control and cleansing equipment performance or for treatment of excess drilling fluid and drilled spoil.

D. **Disposal:** Disposal of excess drilling fluids and cuttings is the responsibility of CONTRACTOR and shall be conducted in compliance with all environmental regulations, right-of-way and workspace agreements, and permit requirements.

E. **Inadvertent Returns:** CONTRACTOR shall employ his best efforts to maintain full annular circulation of drilling fluids. Drilling fluid returns at locations other than the entry and exit points shall be minimized. In the event that annular circulation is lost, CONTRACTOR shall take steps to restore circulation. If inadvertent surface returns of drilling fluids occur, they shall be immediately contained with hand placed barriers (i.e. hay bales, sand bags, silt fences, etc.) and collected using pumps as practical. If the amount of the surface return is not great enough to allow practical collection, the affected area shall be diluted with fresh water and the fluid will be allowed to dry and dissipate naturally. If the amount of the surface return exceeds that which can be contained with hand placed barriers, small collection sumps (less than 5 cubic yards) may be used. If the amount of the surface return exceeds that which can be contained and collected using small sumps, drilling operations shall be suspended until surface return volumes can be brought under control.

3.4 TRENCH SAFETY

A. The CONTRACTOR shall comply with Cal-OSHA requirements in the performance of all work. The CONTRACTOR shall be responsible for the design, installation, maintenance and removal of any sheeting and shoring necessary for the drilling operation, including fluid containment and permitted disposal practices.

3.2 NOISE

A. The CONTRACTOR is required to meet the requirements of "SP-29 Noise" in the Special Provisions.

3.3 ALIGNMENT CONTROL

A. All pipelines, in particular gravity sewers, shall be installed strictly to the lines and grades shown in the Contract Drawings.

- END OF SECTION -

SECTION 02355 – PUMP STATION – CAISSON CONSTRUCTION

PART 1 -- GENERAL

1.1 THE REQUIREMENT

A. This Section specifies minimum construction requirements using the sunken caisson method, for construction of the wet well structure for the submersible and pocket pump stations. The caissons are permanent structures, and shall be constructed using the sunken caisson method.

1.2 CONTRACTOR SUBMITTALS

A. In accordance with the procedures of Section 01300 – Contractor Submittals, the CONTRACTOR shall submit the following information on the construction of each shaft for review by the ENGINEER prior to commencing construction of the shafts:

1. Overall sequence of construction for each of the caissons.

2. Description and schedule of equipment and procedures proposed to be utilized to construct the caissons; to execute the associated excavation, dewatering and vertical and horizontal deformation monitoring; and to protect existing structures and utilities.

3. Information and details of the cutting shoe including size, dimensions, materials, caisson connection details, and anchorage details for the plug reinforcing beams.

4. Method and details of excavation including method of hoisting excavated material and methods for hauling and off-site disposal of the excavated materials. Off-site disposal of excavated materials is required for the Wet Well Caisson.

   a. The CONTRACTOR shall remove and dispose of all the excavated material at the site, selected by the CONTRACTOR and reviewed by the ENGINEER.

   b. The CONTRACTOR shall obtain all required permits, landowner, and agency approval for disposal of excavated material and shall pay all costs associated with the removal and disposal.

5. Design calculations for caisson buoyancy, for the bottom tremie concrete plug thickness, for the design of the bottom tremie concrete plug reinforcing beams, and for the reinforced concrete pipe caisson. The calculations shall be signed and sealed by a Registered Civil or Structural Engineer, registered in the state of California.

6. Concrete mix information and placement procedures for the underwater concrete (also called the tremie concrete plug) See Section 03320 – Concrete Placed Underwater, for the requirements of the bottom tremie concrete plug.

7. Procedures for checking and maintaining plumbness of the reinforced concrete pipes.

8. Procedures for checking and ensuring proper elevation of the caisson placement.

9. Details for dewatering the inside of the shafts following placement of the bottom tremie concrete plug.

10. Details for placement of the bottom structural concrete slab.

11. Details for forming and placement of the top concrete slab.

1.3 QUALIFICATIONS

A. The CONTRACTOR or Subcontractor who shall perform the WORK specified herein shall have successfully completed at least 2 caisson constructions of similar size, depth, and complexity, and in similar soil conditions, within the past 5 years. In addition, the Superintendent for the caisson construction work shall have demonstrated successful experience with caisson construction using the sunken caisson method.

PART 2 -- PRODUCTS

2.1 GENERAL

A. Concrete formwork shall be in accordance with Section 03100 – Concrete Formwork.

B. Reinforced concrete pipe shall be in accordance with Section 02557 – Reinforced Pipe, PVC-Lined.

C. Steel reinforcement shall be in accordance with Section 03200 – Reinforcement Steel.

D. Concrete joints shall be in accordance with Section 03290 – Concrete Placed Under Water.

PART 3 -- EXECUTION

3.1 CONSTRUCTION

A. **Caissons:** The caissons shall be constructed and installed by the open (sunken) caisson method, which includes placing a section of the reinforced concrete pipe above grade and sinking the pipe/caisson by excavating soil from the interior of the caisson thus allowing it to sink under its own weight,. Care shall be taken to keep the caisson plumb during sinking. The deviation from plumb shall not exceed 1-foot (12 inches) in 100 feet. Any correction of caisson deviation, and any construction and associated costs resulting from relocation of appurtenances inside the caisson, including the pipe connections and the launch and retrieval seals, caused by the caisson's deviation from plumbness shall be at the CONTRACTOR's expense. In addition, any construction and associated costs resulting from relocation of appurtenances resting on the top slab of the caisson, including submersible pumps, motors, piping, valves, power supply, controls, etc. caused by the caisson's deviation from plumbness shall be at the CONTRACTOR's expense.

B. Between the caisson sections, the CONTRACTOR shall install construction joints and waterstop as shown on the Structural Drawings.

C. When the cutting edge of the caisson has been sunk to the depth determined by the CONTRACTOR to allow placement of the bottom tremie plug, and the top of the caisson is at the proper top of wall elevation, the CONTRACTOR shall clean the cutting shoe

bevel area and the bottom area and shall install plug reinforcing beams, as submitted upon by the CONTRACTOR. The plug reinforcing beams shall be designed to assist the bottom tremie plug and the caisson walls in resisting buoyancy. Calculations determining the size of the beams and the thickness of the plug shall be submitted to the ENGINEER. In the calculations, buoyancy shall be resisted only by the dead weight of the caisson (wall and bottom plug but not he concrete top slab) neglecting the friction interaction of the caisson wall and soil. The critical buoyancy case shall be considered to be when the interior of the caisson is empty (no interior fluid) and groundwater outside the caisson is at top elevation. The minimum acceptable factor of safety for buoyancy shall be 1.1. All loose material shall be removed to sound surface a the plug prior to its placement. The plug concrete shall be placed underwater in accordance with the requirements of Section 03320 – Concrete Placed Under Water. The minimum thickness of the plug for the Wet Well Caisson shall be as shown on the Structural Drawings. When complete, the plug and plug reinforcing beams, in conjunction with the caisson, will resist hydrostatic pressure when the caisson is completely dewatered and groundwater outside the caisson is at top elevation. The plug will insure the caisson remains dry when dewatered.

D. The CONTRACTOR shall install piping in the caisson shell to provide for water or water/air jetting a the cutting shoe to facilitate sinking. The CONTRACTOR shall not use bentonite or other friction reducers on the outside of the Well to help sink the caisson.

E. The CONTRACTOR shall sink the caisson by interior excavation.

F. Settling of adjacent property will not be permitted. Settlement monitoring of adjacent facilities shall be conducted in accordance with Section 01540 – Settlement Monitoring.

G. The CONTRACTOR shall maintain the water level inside the caisson equal to the surrounding ground water level throughout the excavation process and until the entire vertical caisson structure and bottom tremie concrete plug are in place and have attained their minimum specified 28-day strength.

H. **Dead Weight:** If sinking cannot be achieved under the dead weight of the caisson shell along, the CONTRACTOR shall provide temporary extra dead weight for this purpose. The CONTRACTOR shall be responsible for the design of the scheme for adding temporary dead weight and shall submit this design to the ENGINEER for approval.

I. The CONTRACTOR shall sink the caisson uniformly and shall maintain the caisson sections plumb at all times.

3.2 MONITORING CAISSON CONSTRUCTION

A. **Caisson:** The CONTRACTOR shall retain the services of a licensed surveyor to monitor the progress of sinking. The CONTRACTOR shall take readings at least twice daily during normal sinking operations and at least hourly when water or water/air jets are being employed.

B. Adjacent Ground The CONTRACTOR shall monitor the level of the ground surface in the immediate vicinity of the caisson. The CONTRACTOR shall establish 8 survey points in 2 circles around the caisson shell (4 in each ring). One circle shall be at a 20 foot radius from the center of the caisson and one circle shall be at a 30 foot radius from the center of the caisson. The survey points shall be distributed to 4 points on the circle

among the 4 quadrants of the circles. The CONTRACTOR shall notify the ENGINEER immediately if evidence of settlement is found.

C. **Excavated Material:** The CONTRACTOR shall record the volume of material excavated from inside the caisson. The CONTRACTOR shall immediately cease excavation and shall notify the ENGINEER immediately if the ratio of actual to theoretical excavation material exceeds 1.3

- END OF SECTION -

SECTION 02460 - A.C. PAVEMENT AND BASE

PART 1 -- GENERAL

1.1 THE REQUIREMENT

A. The CONTRACTOR shall provide A.C. pavement and base, complete and in place, in accordance with the Contract Documents.

B. Pavement restoration sections are shown in the details provided in the Contract Drawings. The thickness of the base and paving to be replaced shall be determined in one field and shall be at least equal in Section to that adjacent to the trench area. Pavement shall be a minimum of 2-1/2 inches thick. Pavement shall be replaced with hot mix asphalt which shall conform to State requirements for ¾ inch maximum medium grading (Type B as specified in Caltrans Standard Specifications Section 39.) Base material shall conform to State requirements for Class 2 base.

C. The CONTRACTOR shall restore A.C. pavement and base removed for trenching and other excavations in accordance with the details provided in the Contract Drawings. The CONTRACTOR shall minimize damage and removal of existing pavement to that necessary to accomplish the work. If the CONTRACTOR removes or damages 50 percent or greater of the pavement within any block area, the CONTRACTOR shall patch the trench or excavation and then also at it's cost provide a 1-1/2 inch thick A.C. pavement overlay from edge of pavement to edge of pavement.

1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. **Commercial Standards**

AASHTO M 82	Cut-Back Asphalt (Medium Curing Type)
AASHTO M 140	Emulsified Asphalt
AASHTO M 208	Cationic Emulsified Asphalt
AASHTO M 226	Viscosity Graded Asphalt Cement
ASTM D 242	Mineral Filler for Bituminous Paving Mixtures
ASTM D 692	Coarse Aggregate for Bituminous Paving Mixtures
ASTM D 977	Emulsified Asphalt
ASTM D 1073	Fine Aggregate for Bituminous Paving Mixtures
ASTM D 1188	Bulk Specific Gravity and Density of Compacted Bituminous Mixtures Using Paraffin-Coated Specimens
ASTM D 1557	Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf per cu ft)
ASTM D 2027	Cutback Asphalt (Medium Curing Type)
ASTM D 2397	Cationic Emulsified Asphalt

ASTM D 2726	Bulk Specific Gravity and Density of Non-Absorptive Compacted Bituminous Mixtures.
ASTM D 3381	Viscosity-Graded Asphalt Cement for Use in Pavement Construction
ASTM D 3515	Hot-Mixed, Hot-Laid Bituminous Paving Mixtures.

1.3 CONTRACTOR SUBMITTALS

A. Submittals shall be in accordance with Section 01300 - Contractor Submittals. Include materials testing reports, job-mix formulas, and other pertinent information satisfactory to the ENGINEER.

B. **Suitability Tests of Proposed Materials:** Tests for conformance with the Specifications shall be performed prior to start of the WORK. The samples shall be identified to show the name of the material, aggregate source, name of the supplier, contract number, and the segment of the WORK where the material represented by the sample is to be used. Results of all tests shall be submitted to the ENGINEER for approval. Materials to be tested shall include aggregate base, coarse and fine aggregate for paving mixtures, mineral filler, and asphalt cement.

C. **Trial Batch:** Before placing any paving material, a testing laboratory acceptable to the ENGINEER shall prepare a trial batch of asphalt concrete for each job-mix formula to be used by the CONTRACTOR for the work. The trial batch shall be prepared using the aggregates and asphalt cement proposed by the CONTRACTOR, and approved by the ENGINEER. The compacted trial batch shall provide a basis for computing the voids ratio, provide an indication of the optimum asphalt content, and establish a basis for controlling compaction during construction. The cost of not more than 2 laboratory trial batch tests will be paid by the OWNER but the CONTRACTOR shall be responsible for the materials. Performing and paying for any additional trial batch testing shall be the CONTRACTOR's responsibility.

PART 2 -- PRODUCTS

2.1 AGGREGATE BASE

A. Materials for aggregate base shall be Type G (aggregate base) material in accordance with Section 02200 - Earthwork.

2.2 PRIME COAT

A. Prime coat shall be Grade SC-250 liquid asphalt complying with the requirements of AASHTO M 82 (ASTM D 2027). Grade SC-70 liquid asphalt may be used when acceptable to the ENGINEER.

2.3 TACK COAT

A. Tack coat shall be emulsified asphalt Grade SS-1 or SS-1h, CSS-1 or CSS-1h diluted with one part water to one part emulsified asphalt, undiluted asphalt Grade RS-1 or CRS-1, or paving asphalt Grade AR-1000. Emulsified asphalt shall comply with the requirements of AASHTO M 140 (ASTM D 977) or M 208 (ASTM D 2397); paving asphalt shall comply with the requirements of AASHTO M 226 (ASTM D 3381).

2.4 ASPHALT CEMENT

A. Asphalt Cement shall be Grade AR-8000 or AR-4000 complying with the requirements of AASHTO M226 (ASTM D 3381).

2.5 MINERAL AGGREGATE

A. Mineral aggregate shall be crushed stone, crushed slag, crushed gravel, stone or slag screening, sand, mineral filler, or a combination of 2 or more of these materials. Coarse and fine aggregates shall comply with all the quality requirements, except soundness, of ASTM D 692 and D 1073, respectively. Coarse aggregate failing to comply with abrasion requirements may be used if experience has demonstrated it to be satisfactory.

B. Mineral filler shall comply with ASTM D 242.

C. Combinations of aggregates having a history of polishing shall not be used in surface courses.

2.6 ASPHALT-AGGREGATE MIXTURE

A. **Base Course Mixture:** The CONTRACTOR shall submit for approval a job-mix formula for each mixture. The job-mix formula for the asphalt-aggregate base course mixture shall be within the following limits:

Sieve Size	Total Percent Passing by Weight
2-inch	-
1-1/2 inch	-
1-inch	100
3/4-inch	90-100
1/2-inch	-
3/8-inch	60-85
No. 4	49-54
No. 8	36-40
No. 50	18-21
No. 200	0-11

Asphalt Content: 6.1 to 6.2 percent by weight of the dry aggregate

B. **Base Course Mixture Test Criteria:** The asphalt-aggregate surface course mixture shall meet the following test criteria:

Stability (Hveem)	37 min.
Flow (Marshall Method)	-
Swell (Hveem Method)	0.030"
Air Voids	3-5 percent
Voids in Mineral Aggregate	15 percent

C. **Surface Course Mixture:** The job-mix formula for the asphalt-aggregate surface course mixture shall be within the following limits:

Sieve Size	Total Percent Passing by Weight
2-inch	-
1-1/2 inch	-
1-inch	100
3/4-inch	90-100
1/2-inch	-
3/8-inch	60-85
No. 4	49-54
No. 8	36-40
No. 30	18-21
No. 200	0-11

Asphalt Content 6.1 to 6.2 percent by weight of the dry aggregate

D. **Surface Course Mixture Test Criteria:** The asphalt-aggregate surface course mixture shall meet the following test criteria:

Stability (Hveem)	37 min.
Flow (Marshall Method)	-
Swell (Hveem Method)	0.030"
Air Voids	3-5 percent
Voids in Mineral Aggregate	15 percent

E. **Asphalt-Aggregate Mixture Tolerances:** The following tolerances for the job-mix formula will be allowed per single test:

Passing Sieve	Percent
1/2-inch and larger	plus and minus 8
3/8-inch and No. 4	plus and minus 7
No. 8	plus and minus 6
No. 50	plus and minus 5
No. 200	plus and minus 3

Asphalt Content, percent by weight of total mixture plus and minus 0.5

Results of single extraction and sieve tests shall not be used as the sole basis for acceptance or rejection of the mixture. Any variation from the job-mix formula greater than

the tolerances shown above shall be investigated and the conditions causing the variations corrected.

2.7 PAVEMENT MARKING PAINT

A. Pavement marking paint shall be a product specifically formulated for use on asphalt concrete pavement and shall have a proven record of performance and durability.

2.8 SLURRY SEAL

A. Asphalt emulsion shall be Grade SS-1 or SS-1h, or Grade CSS-1 or CSS-1h complying with the requirements of AASHTO M 140 (ASTM D 977). Aggregate shall consist of rock dust and plaster sand or other sands of similar nature, except that an aggregate or combination of aggregates shall contain not less than 50 percent of the product obtained by crushing rock. The material shall be free from vegetable matter and other deleterious substances. Asphalt emulsion shall be added at a rate of 11 to 25 percent weight of the dry aggregate. The exact rate shall be as acceptable to the ENGINEER.

2.9 SOIL STERILANT

A. Soil sterilant or chemical weed control agent shall be a commercial product manufactured specifically to sterilize the subgrade soil to prevent the growth of weeds, plants or any type of vegetation.

PART 3 -- EXECUTION

3.1 SUBGRADE PREPARATION

A. The subgrade shall be prepared in accordance with Section 02200 - Earthwork as applicable to roadways and embankments. The surface of the subgrade after compaction shall be hard, uniform, smooth and true to grade and cross-section. Subgrade for pavement shall not vary more than 0.02-foot from the indicated grade and cross section. Subgrade for base material shall not vary more than 0.04-foot from the indicated grade and cross section.

B. Apply soil sterilant or chemical weed control agent in strict compliance with manufacturer's dosages and application instructions, and any applicable laws, ordinances or regulations governing the use of such chemicals.

3.2 AGGREGATE BASE

A. Aggregate base shall be provided where indicated to the thickness indicated. Imported aggregate bases shall be delivered to the Site as uniform mixtures and each layer shall be spread in one operation. Segregation shall be avoided and the base shall be free of pockets of coarse or fine material. Where the required thickness is 6 inches or less, the base materials may be spread and compacted in one layer. Where the required thickness is more than 6 inches; the base material shall be spread and compacted in two or more layers of approximately equal thickness, and the maximum compacted thickness of any one layer shall not exceed 6 inches. The relative compaction of each layer of aggregate base shall be not less than 95 percent of maximum density when measured in accordance with ASTM D 1557. The compacted surface of the finished aggregate shall be hard, uniform, smooth and at any point shall not vary more than 0.02 foot from the indicated grade or cross-section.

3.3 PRIME COAT

A. Prior to placing of pavement a prime coat of cutback asphalt shall be applied to the compacted base or subgrade at a rate between 0.10 and 0.25 gal/sq yd.

3.4 TACK COAT

A. A tack coat shall be applied to existing paved surfaces where new asphalt concrete is to be placed on existing pavement. It shall also be applied to the contact surfaces of all cold pavement joints, curbs, gutters, manholes and the like immediately before the adjoining asphalt pavement is placed. Care shall be taken to prevent the application of tack coat material to surfaces that will not be in contact with the new asphalt concrete pavement. Diluted emulsified asphalt shall be applied at the rate of 0.05 to 0.15 gal/sq yd. Undiluted emulsified asphalt shall be applied at the rate of 0.025 to 0.075 gal/sq yd. Paving asphalt shall be applied at the rate of approximately 0.05 gal/sq yd.

3.5 ASPHALT CONCRETE

A. At the time of delivery to the Site, the temperature of mixture shall not be lower than 260 degrees F or higher than 320 degrees F, the lower limit to be approached in warm weather and the higher in cold weather.

B. Asphalt concrete shall not be placed when the atmospheric temperature is below 40 degrees F or during unsuitable weather.

C. The asphalt concrete shall be evenly spread upon the subgrade or base to such a depth that, after rolling, it will be of the required cross section and grade of the course being constructed.

D. The depositing, distributing, and spreading of the asphalt concrete shall be accomplished in a single, continuous operation by means of a self-propelled mechanical spreading and finishing machine designed specially for that purpose. The machine shall be equipped with a screed or strike-off assembly capable of being accurately regulated and adjusted to distribute a layer of the material to a definite pre-determined thickness. When paving is of a size or in a location that use of a self-propelled machine is impractical, the ENGINEER may waive the self-propelled requirement.

E. Spreading, once commenced, shall be continued without interruption.

F. The mix shall be compacted immediately after placing. Initial rolling with a steel-wheeled tandem roller, steel three-wheeled roller, vibratory roller, or a pneumatic-tired roller shall follow the paver as closely as possible. If needed, intermediate rolling with a pneumatic-tired roller shall be done immediately behind the initial rolling. Final rolling shall eliminate marks from previous rolling. In areas too small for the roller, a vibrating plate compactor or a hand tamper shall be used to achieve thorough compaction.

G. Upon completion the pavement shall be true to grade and cross-section. When a 10-ft straightedge is laid on the finished surface parallel to the center of the roadway, the surface shall not vary from the edge of the straightedge more than 1/8-inch except at intersections or changes of grade. In the transverse direction, the surface shall not vary from the edge of the straightedge more than 1/4-inch.

H. The relative density after compaction shall be 95 percent of the density obtained by using ASTM D 1188 or D 2726. A properly calibrated nuclear asphalt testing device

shall be used for determining the field density of compacted asphalt concrete, or slabs or cores may be laboratory tested in accordance with ASTM D 1188.

3.6 PAVEMENT MARKING

A. Pavement marking paint shall be applied where indicated only when the pavement surface is dry and clean, and when the air temperature is above 40 degrees F. All equipment used in the application of pavement marking shall produce stripes and markings of uniform quality with clean and well-defined edges that conform to the details and dimensions indicated. Drips, overspray, improper markings, and paint material tracked by traffic shall be immediately removed from the pavement surface by methods previously reviewed by the ENGINEER.

3.7 PAVEMENT REFLECTORS AND DELINEATORS

A. Pavement reflectors and delineators, if present, disturbed during construction shall be replaced in like and kind.

3.8 SLURRY SEAL

A. A slurry seal shall be applied to the surfaces of existing pavement as indicated. Before placing slurry seal, the pavement shall be cleaned by sweeping, flushing, or other means necessary to remove all loose particles of paving, dirt, and other extraneous material. Slurry seal shall not be placed when the atmospheric temperature is below 65 degrees F, or during unsuitable weather. The slurry mixture shall be uniformly spread by means of a controlled spreader box. Slurry mixture to be spread in areas inaccessible to the controlled spreader box may be spread by other approved methods. Slurry seal shall be spread at a rate of 15 pounds of dry aggregate per square yard. Ridges or bumps in the finished surface will not be permitted. The mixture shall be uniform and homogeneous after spreading and shall not show separation of the emulsion and the aggregate after setting.

- END OF SECTION -

SECTION 02464 – PORTLAND CEMENT CONCRETE PAVEMENT AND BASE

PART 1 -- GENERAL

1.1 THE REQUIREMENT

A. Concrete pavement, curbs and sidewalk shall be constructed to the lines and grades and dimensions required for a complete installation as shown on the Drawings and specified herein.

1.2 SUBMITTALS

A. Shop drawings for reinforcing, joint material and mix designs shall be submitted for review in accordance with Section 01300 – Contractor Submittals.

PART 2 -- PRODUCTS

2.1 CONCRETE

A. Concrete shall be Class B, conforming to Section 03300 - Cast-in-Place Concrete.

2.2 REINFORCING AND WELDED WIRE FABRIC

A. Joint reinforcing and welded wire fabric shall conform to Section 03290 - Reinforcement Steel.

2.3 JOINT SEALER FOR PAVEMENT

A. Joint sealer shall be a 1 or 2 part polysulfide base self leveling sealant for horizontal surfaces that has been developed for foot and vehicular traffic. The sealant shall conform to the requirements of Section 07920 - Sealants and Caulking.

2.4 PREFORMED JOINT FILLER

A. Preformed joint filler shall be sponge rubber or cork and conform to the requirements of AASHTO Designated M148, Type 1.

PART 3 -- EXECUTION

3.1 SUBGRADE CONDITION

A. The finished subgrade shall be maintained in a smooth, compact condition and any areas which are disturbed prior to placing of the concrete shall be restored at the CONTRACTOR's expense. The subgrade shall be moist at the time the concrete is placed. Water shall be uniformly applied ahead of the paving operations as directed by the ENGINEER. If the CONTRATOR does not maintain the subgrade in the required moist condition, a vapor barrier sheet will be required between the subgrade and the concrete.

B. The subgrade shall be accurately trimmed to the required elevation with a 1/4-inch tolerance. High areas shall be trimmed to proper elevation. Low areas may be filled

with suitable material and compacted to the specified density or filled with concrete integrally with the placing of the pavement.

3.2 SETTING FORMS

A. The forms shall be accurately set to line and grade and such that they rest firmly, throughout their entire length upon the compacted subgrade surface. Forms shall be joined neatly and tightly and braces to test the pressure of the concrete and the finishing operations. The alignment and grade of all forms shall be acceptable to the ENGINEER before and immediately prior to the placing of concrete.

3.3 MIXING CONCRETE

A. Concrete shall be mixed in accordance with Section 03300 - Cast-in-Place Concrete.

3.4 PLACING CONCRETE

A. The concrete shall be distributed on the subgrade to such depth, that, when it is consolidated and finished, the slab thickness required by the Drawings will be obtained at all points and the surface will at no point be below the grade specified for the finished surface, after application of the allowable tolerance. The concrete shall be deposited on the subgrade in a manner which will require as little rehandling as possible.

B. Fabric reinforcement shall be placed at mid slab depth, and the fabric shall be maintained at this location during the placing and finishing operations.

C. Concrete shall be thoroughly consolidated against and along the faces of all forms, by means of hand-operated, spud-type vibrators. Vibrators shall not be permitted to come in contact with the subgrade or a side form. Vibration at any one location shall not continue so long as to produce puddling or the accumulation of excessive grout on the surface. In no case shall the vibrator be operated longer than 15 seconds in any one location.

3.5 STRIKING-OFF, CONSOLIDATING AND FINISHING CONCRETE

A. Immediately after the placing, the concrete shall be struck off, consolidated and finished, to produce a finished pavement conforming to the cross section, width and surface sequence of operations shall be as follows: Strike-off; vibratory consolidation; screening; floating; removal of laitance; straight edging; and final surface finish.

3.6 STRAIGHTEDGING AND SURFACE CORRECTIONS

A. After floating has been completed and the excess water removed, but while the concrete is still in a plastic state, the surface of the concrete shall be tested for trueness with an accurate 10 foot straightedge. The straightedge shall be furnished by the CONTRACTOR. The straightedge shall be held in successive positions parallel to the road tested from one side of the slab to the other as necessary, and depressions shall be immediately filled with freshly mixed concrete and struck-off; consolidated and refinished. High areas shall be cut down and refinished. Straightedge testing and surface correction shall continue until the entire surface appears to conform to the required grade and cross section.

3.7 FINAL FINISH

A. As soon as the water sheen has disappeared from the surface of the pavement and just before the concrete becomes nonplastic, a light broom finish shall be given to the surface.

3.8 EDGING

A. After the final finish has been applied, but before the concrete has become nonplastic, the edges of the pavement along each side of the strip being placed, on each side of the construction joints and along any structure extending into the pavement, shall be carefully rounded to a 1/4-inch radius except as otherwise indicated. A well-defined and continuous radius shall be produced and a smoother, dense mortar finish obtained. All concrete shall be completely removed from the top of the joint filler.

B. All joints shall be checked with a straightedge before the concrete has become nonplastic and, if one side of the joint is higher than the other or the entire joint is higher or lower than the adjacent slab, corrections shall be made as necessary.

3.9 JOINTS

A. Construction joints shall be located as shown on the Drawings.

B. Expansion joints shall be formed by placing premolded expansion joint material about all structures and features projecting through, into or against the pavement. Unless otherwise indicated, such joints shall be 1/2-inch in width.

C. Open type transverse expansion joints shall be as provided at all sidewalk returns and at 50 feet intervals and wherever indicated on the Drawings. Open type joints shall be formed by staking a 1/4-inch thick metal bulkhead in place and placing concrete on both sides. After the concrete has set sufficiently to preserve the width and shape of the joint, the bulkhead shall be removed. After the sidewalk has been finished over the joint, the slot shall be opened and edged with a tool having a 1/2-inch radius. Transverse expansion joints shall be cleaned and filled with joint filler strips 1/4-inch thick conforming to the requirements of AASHTO M-153.

D. Scored joints shall be either formed or sawed at 5 feet intervals and shall extend to a depth of at least 1/4 of the sidewalk slab thickness.

3.10 CURING

A. After the finishing operations have been completed and as soon as the concrete has hardened sufficiently that marring of the surface will not occur, the entire surface and the edges of the newly placed concrete shall be covered and cured with membrane curing compound.

B. Curing compound shall be uniformly applied to the surfaces to be cured, in a single coat, continuous film, at the rate of one gallon to not more than 200 square feet, by a mechanical sprayer.

C. Curing compound shall not be applied during periods of rainfall. Curing compounds shall not be applied to the inside faces of joints to be sealed. Should the film become damaged from any cause within the required curing period, the damaged portions shall

be repaired immediately with additional compound. Upon removal of side forms the sides of the slabs exposed shall immediately be coated to provide a curing treatment equal to that provided for the surface.

3.11 CURB AND SIDEWALK CONSTRUCTION

A. The concrete curbs and sidewalks shall be constructed on a prepared smooth subgrade of uniform density. Large boulders and other obstructions shall be removed to a minimum depth of 6 inches below the finished subgrade elevation and the space suitable material which shall be thoroughly compacted by rolling or tamping. The CONTRACTOR shall furnish a template and shall thoroughly check the subgrade prior to depositing concrete.

B. Concrete for curbs, and sidewalks shall be formed, mixed, placed and finished in conformance with the requirements of Division 3, except as modified herein. Concrete shall be cured with a clear membrane curing compound which shall be applied at a uniform rate of one gallon per 200 square feet in accordance with the requirements specified herein before under pavement construction. Sidewalks shall be given a light broom finish.

3.12 CURBS

A. Curbs shall be constructed in uniform sections ten feet in length except where shorter sections are necessary for closures or arcs. The sections shall be separated by sheet metal templates set perpendicular to the face and tip of the curve and not less than 2 inches longer than the depth of the curb. The templates shall be held firmly during the placing of the concrete and shall be allowed to remain in place until the concrete has set sufficiently to hold its shape, but shall be removed while the forms are still in place.

B. After the concrete has sufficiently set for a minimum of 12 hours, the CONTRACTOR shall remove the forms and backfill the spaces on each side. The earth shall be compacted in satisfactory manner without damage to the concrete work. Minor defects shall be filled with a mortar composed of 1 part portland cement and 2 parts fine aggregate.

END OF SECTION

SECTION 02475 – AUTOMATIC IRRIGATION SYSTEM

PART 1 -- GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and the Provisions of Bid and Contract Documents, including General and Supplementary Conditions and Division 1 Specification Sections, shall apply to the work specified in this Section.

1.2 DESCRIPTION

A. CONTRACTOR shall provide all material, labor, equipment transportation, and services necessary for the furnishing and installation of the complete automatic sprinkler irrigation systems as shown on the Drawings and as specified herein. The work includes, but is not limited to:

1. Trenching, stockpiling excavation materials and refilling trenches.
2. Providing a complete system including piping, valves, fittings, sprinkler heads, emitters, automatic controls and final adjustment of heads to ensure complete coverage.
3. Line voltage connections to all irrigation controllers; low voltage control wiring from controller to remote control valves.
4. Cleanup, inspection and approval.
5. Furnish and install items to be attached to, or embedded in, concrete work.
6. Automatic controller assembly and installation including electrical enclosure and panel, and concrete pad.
7. Submittals, tests, as-built and record drawings.
8. Erosion control and repair of damage due to overwatering and erosion.
9. Warranty replacement.
10. Water meter and water supply line installation.

1.3 QUALITY ASSURANCE AND REQUIREMENTS

A. Requirements of Regulatory Agencies: All work and materials shall be in full conformance with the latest rules and regulations of the Uniform Building Code.

B. Manufacturer's Directions: Manufacturer's directions and detailed drawings shall be followed in all cases where the manufacturers of articles used in this contract furnish directions covering points not shown in the Drawings and specifications.

C. Underwriters Laboratories: Electrical wiring, controls, motors, and devices shall be UL listed, and so labeled.

1.4 CONTRACTOR SUBMITTALS

A. Product List: Complete product list shall be submitted prior to performing any work. Product list shall conform to the requirements of 1.06 Submittals of Section 01900.

B. Record Drawings:

1. Provide and keep up to date and complete "Record Drawings" of the work of this Section. "Record Drawings" shall conform to the requirements of Division 1 Specification Sections.

2. Dimension from two permanent points of reference, building corners, sidewalk, or road intersections, etc., the location of the following items:

a. Connection to existing water lines.

b. Connection to existing electrical power.

c. Gate valves.

d. Routing and/or directional turns of sprinkler pressure lines (dimension max. 100' along routing).

e. Sprinkler control valves.

f. Routing of control wiring.

g. Quick coupling valves.

h. Other related equipment as directed by the Architect.

C. Detail Drawings: Submit detailed drawings for OWNER approval, for all assemblies not detailed on the Drawings.

D. Controller Charts:

1. Record drawings will be accepted by the ENGINEER before controller charts are prepared. Provide one controller chart for each controller supplied. The chart shall show the area controlled by the automatic controller and shall be the maximum size which the controller door will allow.

2. The chart is to be a reduced drawing of the actual "as-built" system. However, in the event the controller sequence is not legible when the drawing is reduced, it shall be enlarged to a size that will be readable when reduced. The chart shall be a black line or blue line ozalid print and a different color shall be used to indicate the area of coverage for each station. When completed and approved, the chart shall be hermetically sealed between two pieces of plastic, each piece being a minimum of 10 mils. These charts shall be completed and approved by the ENGINEER prior to final observation of the irrigation system.

E. Operation and Maintenance Manuals:

1. Prepare and deliver to the ENGINEER, within 10 calendar days prior to completion of construction, two hardcover binders with three rings containing the following information:

    a. Index sheet stating CONTRACTOR's address and telephone number, list of equipment with name and addresses of local manufacturer's representative.

    b. Catalog and part sheets on every material and equipment installed under this contract.

    c. Guarantee statement.

    d. Complete operating and maintenance instruction on all major equipment.

2. In addition to the above-mentioned maintenance manuals, provide the OWNER's maintenance personnel with instructions for major equipment and show evidence in writing to the ENGINEER at the conclusion of the project that this service has been rendered.

F. Equipment to be furnished:

1. Supply as part of this contract the following tools:

    a. Two keys for opening valve boxes.

    b. One 36-inch soil probe, Oakfield Model B.

    c. Two keys for each automatic controller.

    d. One quick-coupler key and matching hose swivel and globe valve for every five, or fraction thereof, valves installed.

2. Before final observation the above-mentioned equipment shall be turned over to the ENGINEER.

1.5 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Handling of PVC Pipe and Fittings: The CONTRACTOR is cautioned to exercise care in handling, loading, unloading, storing and installation of PVC pipe and fittings. All PVC pipe shall be transported in a vehicle which allows the length of pipe to lie flat so as not to subject it to undue bending or concentrated external load at any point. Any section of pipe that has been dented or damaged will be discarded and, if installed, shall be replaced with new piping.

1.6 JOB CONDITIONS

A. The CONTRACTOR shall not willfully install the irrigation system as shown on the Drawings when it is obvious in the field that obstructions, grade differences or discrepancies in area dimensions exist that might not have been considered in engineering. Such obstructions or differences should be brought to the attention of the ENGINEER. In the event this notification is not performed, the irrigation CONTRACTOR shall assume full responsibility for any revision necessary.

1.7 SUBSTITUTIONS

A. Procedure: Submit information in conformance with the requirements of Division 1 Specification Sections.

B. Provide descriptive catalog literature, performance charts and flow charts for each item to be substituted.

1.8 WARRANTY

A. The warranty for the sprinkler irrigation system shall be made in accordance with the following form.

B. A copy of the warranty form shall be included in the operations and maintenance manual.

C. The warranty form shall be retyped onto the CONTRACTOR's letterhead and contain the following information:

WARRANTY FOR SPRINKLER IRRIGATION SYSTEM

We hereby warrant that the sprinkler irrigation system we have furnished and installed is free from defects in materials and workmanship, and the work has been completed in accordance with the Drawings and specification. We agree to repair or replace any defects in material or workmanship which may develop during the period of one year from the date of acceptance, except those that may be caused by ordinary wear and tear, unusual abuse or neglect. We also agree to repair or replace any damage resulting from the repairing or replacing of such defects at no additional cost to the OWNER. We shall make such repairs or replacements within a reasonable time, as determined by the OWNER, after receipt of written notice. In the event of our failure to make such repairs or replacements within a reasonable time after receipt of written notice from OWNER, we authorize the OWNER to proceed to have said repairs or replacements made at our expense, and we will pay the costs and charges therefore upon demand.

PROJECT:_____

CONTRACTOR:_____ PHONE NO.:_____

ADDRESS:_____ BY:_____

_____

DATE OF ACCEPTANCE:_____ BY:_____

PART 2 -- PRODUCTS

2.1 GENERAL

A. CONTRACTOR shall use only new materials of brands and types noted in Contract Documents, or approved equals.

2.2 PIPE AND FITTINGS

A. Pressure Main Line Piping and Fittings: From meter to backflow prevention unit shall be PVC schedule 80 solvent weld type.

B. Pressure and Non-Pressure Main Line Piping and Fittings: Sizes 2 inches and smaller shall be Schedule 40 PVC.

C. Non-pressure lines (buried): Shall be PVC Schedule 40.

D. Non-pressure lines (surface): Shall be PVC Schedule 40.

E. All pipe and fittings shall conform to specific requirements as follows:

1. PVC (Solvent Weld):

   a. Pipe: Manufactured from virgin polyvinyl chloride compound in accordance with ASTM D1784 or ASTM D2241, cell classification 12454B, hydrostatic design stress rating not less than 2,000 psi.

   b. Fittings (solvent weld or thread): Standard weight, schedule 40, side gated, injection molded PVC complying with ASTM D1784, cell classification 13454B, including threads when required.

   c. Fittings (2-inch through 8-inch) slip type may be used, but must be similar in all respects to those manufactured by Cal Am Manufacturing Company and installed in accordance with their recommendations.

2. PVC nipples shall be Schedule 80 with molded threads.

3. All PVC pipe must bear the following markings:

   a. Manufacturer's name.

   b. Nominal pipe size.

   c. Schedule or class.

   d. Pressure rating in AST (not required on drip tubing).

   e. NSF (National Sanitation Foundation) approval (not required on drip tubing).

   f. Date of extrusion.

4. Solvent cement and primer for PVC solvent-weld pipe and fittings shall be of type and installation method prescribed by the manufacturer.

5. Brass Pipe and Fittings:

   a. Brass pipe shall be 85% red brass, American National Standard Institute (ANSI), Schedule 40 screwed pipe.

   b. Fittings shall be medium brass, screwed 125 pound class.

2.3 ELECTRICAL (HIGH VOLTAGE)

A. All high voltage electrical service required for automatic controller and other equipment noted on drawing for irrigation system will be provided by others.

2.4 ELECTRICAL (LOW VOLTAGE)

A. Connections between controller and remote control valves shall be made with direct burial AWG-UH, 600-volt wire, insulation thickness 3/64-inch, utilizing low density high molecular weight polyethylene insulation.

B. Splices, where permitted, shall be waterproofed using **Rain Bird, Pen-Tite Connectors** or fusible heat shrinking tubing, and housed in a box. Boxes for other irrigation use may be utilized for this purpose.

C. Wire sizing shall be minimum of #14 "UF" 600 volt underground wiring, unless a shielded cable is used in which case #18 wire may be used. Common wire to be white in color, and all others a different color.

2.5 QUICK COUPLING VALVES

A. Two-piece type brass body, 150-pound class, with 1-inch female threads opening at base permitting operation with a special connecting device (coupler) designed for this purpose.

   1. Coupler threads: Lug type.

   2. Hinge cover: Provide with rubber-like vinyl cover.

B. Check Valves

   1. Swing check valve, 2 inches and smaller on non-pressure lines: Bronze or plastic construction, 100 pound swp, female ips.

   2. Anti-drain Valve: Plastic construction, with soft composition disc, stainless steel internal parts. Spring tension adjustable from 4 psi to 15 psi. Valve may be an integral part of sprinkler head.

2.6 BACKFLOW PREVENTION UNITS

A. Backflow Preventer: Designed to operate on a "reduced pressure" principle; equipped with gate valves and field test cocks.

B. All equipment shall be housed in an enclosure as noted on drawing.

C. Wye strainers at backflow prevention units shall be 125# class cast brass with 40 mesh monel screen, unless otherwise noted on drawing.

2.7 AUTOMATIC CONTROLLER

A. Type: Fully automatic operation, capable of operating the number of stations and type indicated on Drawings.

1. Wall-mount type in a housing with locking hinged cover.

2. Automatic controller enclosure shall be made of vandal-resistant 3/16-inch steel plate and 10-gauge metal, with hinged door. The enclosure shall be similar to the LeMeur Type "A" or acceptable equal, and shall be painted inside and outside with two coats of rust-resistant paint prior to the installation of the automatic controller. Color and type of paint shall be approved by the ENGINEER.

2.8 REMOTE CONTROL VALVES

A. Valve Type: Spring loaded, packless diaphragm activated, normally closed type with brass body, equipped with flow control and pressure regulation capabilities where noted.

B. Valve solenoid: 24 volt ac, 4.5 watt maximum, 500 milli-amp maximum surge, corrosion-proof, stainless steel construction, epoxy encapsulated to form a single integral unit, and equipped with a 24-volt Irritrol DC latching solenoid.

C. Provide bleeder valve to permit operation in the field without power at the controller.

2.9 ROTARY SPRINKLER HEADS

A. Type: Gear driven, with pop-up sprinkler heads.

1. Rubber covered.

B. Part circle heads shall have arc setting as noted.

2.10 SMALL SHRUBBERY SPRINKLER HEADS

A. Sprinklers shall be similar in all respects to type noted on drawing.

B. Where noted, pop-up type body shall be used, with height as noted in legend on drawing.

C. When noted, body shall be equipped with a built-in check valve.

2.11 VALVE BOXES

A. Valve boxes for remote control valves shall be 12" x 18" of a concrete material with cast iron locking tops. Brooks No. HFL or approved equal.

B. Valve box for gate valves shall be 12 inches round of a concrete material with cast iron locking tops. Brooks #1-RT.

C. Valve box extensions shall be by the same manufacturer as the valve box.

PART 3 -- EXECUTION

3.1 GENERAL

A. The CONTRACTOR is responsible for providing an optimum water supply to all plants and trees by the irrigation system, including uniform coverage of all planting areas by the spray system. Report to the ENGINEER all conditions preventing compliance with these requirements, and obtain the ENGINEER's instructions prior to proceeding with the work affected. Failure to report to the ENGINEER constitutes acceptance of this requirement by the CONTRACTOR.

3.2 FIELD QUALITY CONTROL

A. CONTRACTOR shall be responsible for notifying the ENGINEER in advance for the following observation meetings, according to the time indicated:

1. Pre-job conference: 7 days.
2. Backflow assembly location: 48 hours.
3. Pressure supply line installation and testing: 48 hours.
4. Automatic controller location: 48 hours.
5. Control wire installation: 48 hours.
6. Lateral line and sprinkler installation: 48 hours.
7. Coverage test: 48 hours.
8. Final site review: 7 days.

B. When observations have been conducted by other than the ENGINEER, show evidence in writing of when and by whom these observations were made.

C. No site observations will commence without "As-Built" record prints.

D. Final Observation:

1. The CONTRACTOR shall operate each system in its entirety for the ENGINEER at time of final observation as noted in 3.01 Field Quality Control of Section 02480. Any items deemed not acceptable by the ENGINEER, or not in compliance with these specifications and Drawings, shall be reworked to the complete satisfaction of the ENGINEER.

2. The CONTRACTOR shall show evidence to the ENGINEER that the OWNER has received all accessories, charts, record drawings, and equipment as required before final observation can occur.

3.3 WATER SUPPLY

A. Sprinkler irrigation system shall be connected to water supply points of connection as indicated on the Drawings.

B. Connections shall be made at approximate locations as shown on Drawings. CONTRACTOR is responsible for minor changes caused by actual site conditions.

3.4 LAYOUT

A. Drawings:

1. Drawings are generally diagrammatic and indicative of the work to be installed. Due to the scale of drawings, it is not possible to indicate all offsets, fittings, sleeves, etc., which may be required. The CONTRACTOR shall carefully investigate the structural and finished conditions affecting all of his work and plan accordingly, furnishing such fittings, etc., as may be required.

2. All scaled dimensions are approximate. The CONTRACTOR shall check and verify all size dimensions and receive ENGINEER's approval prior to proceeding with work under this section.

B. Coordination: Coordinate installation of irrigation system, including pipe, so there will be NO interference with utilities or other construction or difficulty in planting trees, shrubs, and ground covers. The CONTRACTOR shall carefully check all grades to satisfy themselves that they may safely proceed before starting work on the irrigation system.

C. All piping or equipment shown diagrammatically on Drawings outside planting areas shall be installed inside planting areas whenever possible.

D. Prior to installation, the CONTRACTOR shall stake out all pressure supply lines, routing and location of sprinkler heads.

E. All layouts shall be approved by the ENGINEER prior to installation.

3.5 INSTALLATION

A. **General**

1. All plastic pipe and fittings shall be installed in complete accord with manufacturer instructions for same.

2. Line Clearance: All lines shall have a minimum clearance of 6 inches from each other and from lines of other trades. Parallel lines shall not be installed directly over one another.

B. Trenching:

1. Excavate trenches to required depths. Follow approved layout for each system.

2. Trench bottom shall be flat to ensure piping is supported continuously on an even grade.

3. Where lines occur under paved areas, consider dimension to be below the subgrade.

4. Provide minimum coverage as follows:

a. Pressure supply lines (2-1/2 inches and smaller): 18 inches.

b. Non-pressure lines: 12 inches.

c. Control wire: 18 inches.

C. Backfilling:

1. Buried pipe in trenches shall be center loaded only until all required tests are performed. Trenches shall be carefully backfilled with the excavated materials approved for backfilling, consisting of earth, loam, sandy clay, sand or other approved materials, free from large clods of earth or stones. Backfill shall be mechanically compacted in landscaped areas to a dry density equal to adjacent undisturbed soil in planting areas. Backfill will conform to adjacent grades without dips, sunken areas, humps or other surface irregularities.

2. A fine granular material backfill will be initially placed on all lines. No foreign matter larger than 1/2-inch in size will be permitted in the initial backfill.

3. Flooding of trenches will be permitted only with approval of the ENGINEER.

4. If settlement occurs and subsequent adjustments in pipe, valves, sprinkler heads, lawn or planting, or other construction are necessary, the CONTRACTOR shall make all required adjustments without cost to the OWNER.

D. Assemblies:

1. Routing of sprinkler irrigation lines as indicated on the Drawings is diagrammatic. Install lines (and various assemblies) in such a manner as to conform with the details per plans.

2. Install NO multiple assemblies in plastic lines. Provide each assembly with its own outlet.

3. Install all assemblies specified herein in accordance with respective detail. In absence of detail Drawings or specification pertaining to specific items required to complete work, perform such work in accordance with best standard practice, with prior approval from ENGINEER.

4. PVC pipe and fittings shall be thoroughly cleaned of dirt, dust and moisture before installation. Installation and solvent welding methods shall be as recommended by the pipe and fitting manufacturer.

5. On PVC to metal connections, the CONTRACTOR shall work the metal connections first. Teflon tape or approved equal shall be used on all threaded PVC to PVC, and on all threaded PVC to metal joints. Light wrench pressure is all that is required. Where threaded PVC connections are required, use threaded PVC adapters into which the pipe may be welded.

6. Quick Coupling Valves: Unless otherwise indicated, locate valves within 12 inches of hardscape.

7. Backflow Prevention Unit and Controllers: Verify exact location with the ENGINEER. Install at minimum height permitted by local code.

E. Electrical Supply:

1. Low voltage wiring shall be placed in the same ditch and taped on bottom side of main lines unless otherwise approved.

2. Wire is to be taped a maximum 12 feet on center.

3. Provide a 12-inch expansion loop at each connection and directional change.

4. Use a continuous wire between controller and remote control valves. Except as otherwise approved, do not splice wire at any point. All approved splices shall be enclosed in an acceptable box.

5. Each controller shall be provided with separate ground wire.

F. Automatic Controller:

1. Install as per manufacturer's instructions. Remote control valves shall be connected to controller in numerical sequence as shown on the Drawings.

2. Controller shall be mounted inside lockable electrical panel box mounted on a wall.

G. Flushing of System:

1. necessary diversion work has been completed, and prior to installation of sprinkler heads, the control valves shall be opened and full head of water used to flush out the system.

2. Sprinkler heads shall be installed only after flushing of the system has been accomplished to the complete satisfaction of the ENGINEER.

H. Sprinkler Heads:

1. Install the sprinkler heads as designated on the Drawings and in accordance with their respective detail.

2. Spacing of heads shall not exceed the maximum indicated on the Drawings. In no case shall the spacing exceed the maximum recommended by the manufacturer.

I. Valve Boxes:

1. All buried valves and equipment shall be installed with a proper box as specified in PART 2 PRODUCTS.

2. Fill area under box with a minimum of 3 cubic feet of pea gravel before box is installed.

3. Identification tags shall be attached to each remote control valve, showing number that corresponds with controller sequence. Tags shall be manufactured of

polyurethane Behr Desopaid, yellow in color with black letters 2-3/4 inches by 2-1/4 inches.

4. All boxes shall be permanently marked on top, designating type of equipment installed as noted in drawing.

3.6 TEMPORARY REPAIRS

A. The OWNER reserves the right to make temporary repairs as necessary to keep the sprinkler system equipment in operating condition. The exercise of this right by the OWNER shall not relieve the CONTRACTOR of his responsibilities under the terms of the warranty as herein specified.

3.7 SYSTEM ADJUSTMENT

A. The CONTRACTOR shall adjust all sprinkler heads and valves for optimum performance and to prevent as much as possible any overspray onto walks and roadways. No spray is permitted on buildings.

B. If it is determined that adjustments in the irrigation equipment will provide proper and more adequate coverage, the CONTRACTOR shall make such adjustments prior to planting. Adjustments may include changes in nozzle sizes or degrees of arc, as required.

C. All sprinkler heads shall be set perpendicular to finished grades unless otherwise designated on the plans and at height and distance from walks, buildings, etc., as noted.

3.8 SYSTEM TESTING

A. Test all pressure lines under hydrostatic pressure of 150 pounds per square inch, and prove watertight.

B. Testing of pressure main lines shall occur prior to installation of electrical control valves, quick couplers or any other equipment that might prevent a proper test from being performed.

C. All piping under paved areas shall be tested under hydrostatic pressure of 150 pounds per square inch, and proved watertight, prior to paving.

D. Sustain pressure in lines for not less than 2 hours. If leaks develop, replace joints and repeat test until entire system is proven watertight.

E. All hydrostatic tests shall be made only in the presence of the ENGINEER, or other duly authorized representative of the OWNER. No pipe shall be completely backfilled until it has been inspected, tested and approved in writing.

F. Furnish necessary force pump and all other test equipment.

G. When the sprinkler irrigation system is completed, perform a coverage test in the presence of the ENGINEER to determine if the water coverage for planting areas is complete and adequate. Furnish all materials and perform all work required to correct any inadequacies of coverage due to deviations from plans, or where the system has been willfully installed as indicated on the Drawings when it is obviously inadequate,

without bringing this to the attention of the ENGINEER. This test shall be accomplished before any ground cover is planted.

H. Upon completion of each phase of work, entire system shall be tested and adjusted to meet site requirements.

I. Low voltage wire under paving shall be tested for continuity, prior to paving.

3.9 MAINTENANCE

A. The entire sprinkler irrigation system shall be under full automatic operation for a period of seven days prior to any planting.

B. The ENGINEER reserves the right to waive or shorten the operation period.

3.10 CLEANUP

A. Cleanup shall be performed as each portion of the work progresses. Refuse and excess dirt shall be removed from the site, all walks and paving shall be broomed or washed down, and any damage sustained to the work of others shall be repaired and work returned to its original condition.

3.11 OPERATING INSTRUCTIONS

A. The CONTRACTOR shall be required to train OWNER's maintenance personnel in proper operation of all major equipment. Provide written evidence of the person or persons so trained to the ENGINEER.

- END OF SECTION -

SECTION 02480 – LANDSCAPE PLANTING

PART 1 -- GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and the Provisions of Bid and Contract Documents, including General and Supplementary Conditions and Division 1 Specification Sections, shall apply to the work specified in this Section.

1.2 DESCRIPTIOIN

A. CONTRACTOR shall provide all material, labor, equipment and services necessary for the furnishing and installation of a complete planting installation, as shown on the drawings and as specified herein. The work includes, but is not limited to:

1. Finish grading of landscaped areas.
2. Soil amendment.
3. Soil separator.
4. Sub-drains.
5. Drain rock.
6. Planting.
7. Sand and soil mix.
8. Shredded Cedar Bark Mulch.
9. Root control barrier.
10. Maintenance through Final Acceptance.
11. Warranty replacement.

1.3 DEFINITIONS

A. Site Soil: All existing soil on the site.

B. Soil Mix: Homogenous mixture of specific components for use as a planting medium in planters.

C. Planter Backfill: Distinct layers of soil mix placed in planters to depths required to achieve finish grade.

1.4 QUALITY ASSURANCE

A. Testing Laboratory: Recognized laboratory for soil and plant disease analysis for ornamental horticulture, approved by the ENGINEER. Testing laboratory is to perform

all work in accordance with the current methods of the Association of Official Agricultural Chemists.

1.5 REFERENCE STANDARDS

A. CONTRACTOR shall comply with the applicable provisions of the following:

B. Testing Laboratory: Recognized laboratory for soil and plant disease analysis for ornamental horticulture, approved by the ENGINEER. Testing laboratory is to perform all work in accordance with the current methods of the Association of Official Agricultural Chemists.

C. Nomenclature: "An Annotated Checklist of Woody Ornamental Plants of California, Washington, and Oregon", Mathias and McClintock, California Agricultural Experimental Station Extension Service, University of California, 1979, Publication No. 4091.

D. Staking and Guying Procedures: "Staking Landscape Trees", University of California Extension Publication #2576.

E. Pruning Procedures: "Pruning Landscape Trees", University of California Extension Publication #2574.

1.6 CONTRACTOR SUBMITTALS

A. **General**: Submittals to be in accordance with the requirements of Section 01900 – Supplemental General Requirements. Review or acceptance, as specified, by the ENGINEER is required prior to commencement of work.

B. Samples: Submit the following to the OWNER for acceptance:

1. Soil Separator: One square foot minimum, accompanied by product data.

a. Drain Rock: One-half cubic foot.

b. Wood Bark Mulch: One-half cubic foot.

c. Root Control Barrier: One square foot sample panel, accompanied by product data.

C. Product Data: Submit the following product information to the OWNER for acceptance.

1. Tree Ties: Manufacturer's literature.

2. Guy anchors, turn buckles, cable and cable clamps: Manufacturer's literature.

3. Grass Seed and Sod: Dealer's guaranteed analysis of content including statement of seed composition, moisture and percentage of purity and germination of each variety. Submit separate analyses for seed and sod.

D. Test Reports: Provide the following tests and submit the results to the ENGINEER: Test reports are to be the test number specified, as provided by Soil and Plant Laboratory, Santa Ana, CA, or approved equal.

1. Existing Site Soil: Provide tests upon request by the ENGINEER. Test A05, for agricultural suitability, fertility, particle size analysis; including recommendations for soil amendment, and fertilization during the maintenance period.

2. Import Soil: Submit test reports of representative sample(s) for approval prior to delivery and for every 100 yards delivered to the site. Test A05, for agricultural suitability, fertility, particle size analysis; including recommendations for soil amendment, and fertilization during the maintenance period.

3. Organic Amendments, Fir Bark: Test A08: Partial organic amendment evaluation.

4. All Other Fertilizers and Amendments: For standard products, submit manufacturer's analysis. For all other products, submit analysis by testing laboratory.

5. Sand: Test A-02, agricultural suitability; Test A-20-1: Particle size, US sieve system, percent by weight.

E. Herbicides: Submit manufacturer's analysis. Schedule for application of herbicides must be approved by the ENGINEER.

F. Soil Mix: Submit separate one-gallon samples of each accepted planter soil mix component and one-ounce samples of the fertilizers to the ENGINEER. Samples will be combined in the specified proportion by the testing laboratory, and tested to establish standards to which all batches of soil mix used on the job shall conform. Thereafter, submit test of a representative sample from every batch mixed, minimum one report for every 100 yards mixed. Test A01: Agricultural fertility.

G. Record Drawings: Prepare "As-built" plans noted below. Submit to the ENGINEER prior to the 30-day maintenance observation.

1. "As-built" Planting Plan: Indicate plant type, count, size and locations.

1.7 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Fertilizers and Amendments: Store fertilizers and amendments, bark mulch, soil mixes, and other materials which could stain concrete and similar surfaces in such a manner that staining does not occur.

B. Plants: Maintain all plant material in a healthy growing condition prior to and during planting operations. Protect plants at all times from sun and drying winds. Plants that cannot be planted immediately upon delivery shall be kept in the shade, well protected and watered. Plant material delivered to the site must be planted within 3 days of site delivery. Plants that cannot be installed on this work schedule shall be returned to the grower until installation requirements can be met.

1.8 SUBSTITUTIONS, ADDITIONS, AND DELETIONS

A. **General**: Submit proposals for substitutions in accordance with the requirements of Division 1 Specification Sections. Acceptance by the ENGINEER is required prior to proceeding with the work under this Section.

B. The ENGINEER reserves the right to substitute plant material of sizes similar to material specified, as the work progresses, at no additional cost to the OWNER.

1.9 WARRANTY

A. General: Become familiar with the anticipated growing conditions prior to commencement of work. Notify the ENGINEER immediately in writing of any conditions which will prevent the proper execution of the warranty responsibilities specified. Failure to so notify the ENGINEER constitutes acceptance of the growing conditions. Any removal, repair or replacement of plant material required by unsuitable conditions found after work has begun shall be done at no additional cost to the OWNER.

B. Requirements:

1. Plant Material: Warrant that all trees under this Contract will be vigorous, healthy, free of dead or dying branches and branch tips, bearing foliage of normal density and color, and will otherwise comply with the specifications in PART 2 PRODUCTS of this Section, for a period of one year from date of Final Acceptance. Any delay in completion of planting operations, which extends the planting into more than one growing season shall extend the warranty period correspondingly.

2. Replacements: Without cost to the OWNER, in a timely manner and as directed by the ENGINEER, replace all plants not meeting the requirements above during and at the end of the warranty period. Replacements shall closely match adjacent specimens of the same species in size and shall comply with all requirements of this specification.

PART 2 -- PRODUCTS

2.1 PLANTS

A. General: Plants shall be nursery grown in accordance with good horticultural practices under climatic conditions similar to those of project for at least one year unless otherwise approved by OWNER.

B. Acclimatization: The CONTRACTOR is responsible for supplying plant material that has been properly acclimated and conditioned, in accordance with good horticultural practices, for the exposure, wind and humidity levels, soil conditions, etc., encountered at the project site and in the proposed plant location.

C. Coordination: The CONTRACTOR shall coordinate his acclimatization schedule with the ENGINEER as to allow an adequate conditioning period for the plant material prior to the approved date of planting commencement. Notify the ENGINEER in writing prior to proceeding with any acclimatization work if approved work schedule allows insufficient time to acclimate the material.

D. Quality: Plants shall be superior in form, compactness and symmetry; sound, healthy and vigorous, well branched and densely foliated when in leaf; free of disease, insect pests, eggs or larvae, and free from physical damage or adverse conditions that would prevent thriving growth.

E. Size:

1. Plants shall conform to measurements specified. Measure plants when branches are in their normal position. Height and spread dimensions specified refer to the main body of plant and not branch tip to tip. Take caliper measurements at a point on the trunk 6 inches above natural ground line for trees up to 4 inches in caliper, and at a point 12 inches above the natural ground line for trees over 4 inches in caliper.

2. If a range of size is given, no plant shall be less than the minimum size and not less than 40% of the plants shall be as large as the maximum size specified.

3. The measurements specified are the measurements after pruning, where pruning is required. Plants that meet the measurements specified, but do not possess a normal balance between height, spread, and caliper, shall be rejected.

4. Plants larger than specified may be used if approved by the ENGINEER, and if provided at no additional cost to the OWNER. If larger plants are approved, the root ball shall be increased in proportion to the size of the plant; irrigation system shall also be adjusted as required to accommodate larger plants, in accordance with Section 02476 – Automatic Irrigation System.

F. Species: Tag each plant prior to delivery to the site; label with genus, species and variety. Any plants not so identified will be subject to rejection by the ENGINEER. Replace all plant material determined by the OWNER within two years following the final acceptance of the project, to be untrue to the species, clone and/or variety specified, to the equal condition of adjacent plants at the time of replacement, at no additional cost to the OWNER.

G. Root Ball:

1. Do not supply any bare root or ball and burlapped stock unless approved by the ENGINEER.

2. Sizes: As specified on the plans. Where no root ball dimensions have been specified, supply material in container sizes specified.

3. Material: Root ball shall consist of a soil or soil mix that is compatible with the soil or soil mix into which the plant will be planted, and that provides for thorough drainage, aeration, and adequate moisture and nutrient retention. Having sufficient density and firmness that when planted, the plant will stand upright and stable without need for additional support.

4. Containers: All plant material shall have been grown in the containers in which delivered for at least six months, but not over two years. Containers for trees shall be constructed to the specified dimensions in such a manner that the resultant root ball will approximate the slopes into which the individual tree(s) is to be planted.

5. Root Pruning: Where root pruning is required to provide material of the specified size, or for planting in the sloped containers, the pruning is to be done under the direction of a Certified Arborist. No root pruning is to be done within one year of installation unless approved by the ENGINEER.

H. Trunks and Branches: Do not prune plants before delivery. All trunks are to be straight and of uniform taper, larger at the bottom unless otherwise specified. Plants with

damaged or crooked leaders, or multiple leaders, unless specified, will be rejected. Plants with abrasions of the bark, sun scalds, disfiguring knots, or fresh cuts of limbs over 3/4-inch, which have not completely callused, will be rejected. Any plant unable to stand upright without support will be rejected.

I. Do all work necessary to bring and maintain material in conformance with the requirements of this Section.

2.2 GRASS

A. Sod: One year old, dense with grass having been mowed at one-inch height before lifting from field. Grown on fumigated soil. Sod is to be in vigorous condition, dark green in color, free of disease, weeds and harmful insects. "Marathon"" as available from Southland Sod Farms, 805-488-3585, or accepted equal.

2.3 SOILS AND PLANTER BACKFILL

A. General: All soils to be used in areas to be planted on the project shall be free of rocks over one-inch in diameter, and free of foreign debris. Soil shall be free from sub-soil, refuse, plants or roots, clods, weeds, viable weed seeds, sticks, solvents, petroleum products, concrete, base rock, or other deleterious or extraneous material. Soil shall be free of soil-borne diseases, and capable of sustaining healthy plant life.

B. Imported Topsoil:

1. Topsoil shall be fertile, friable soil of loamy character, containing an amount of organic matter normal to the region. All imported topsoil used on the job shall be from the same source.

2. Make all arrangements for obtaining and testing imported topsoil. Submit test results of a representative sample of the proposed supply for approval by the ENGINEER well in advance of its scheduled delivery to the site. The approved sample will establish the standards to which all imported topsoil used on the job must conform.

3. Do all work necessary to bring imported topsoil to standards specified above.

4. Transport imported topsoil directly from source to final position. If stockpiling is required, locations and amounts of stockpiles will be designated by the ENGINEER.

5. The ENGINEER reserves the right to take additional samples of imported topsoil at the site. If subsequent testing proves material to be at variance with the approved sample, remove rejected soil from the site and replace immediately at no additional cost to the OWNER.

C. Soil Mix: For use in planters and planter pots. The following ingredients, thoroughly blended into a homogeneous mix:

Amount	Ingredient
0.5 cubic yards	1/8-inch Fine Fir Bark as Specified
0.5 cubic yards	Fine Sand as Specified
3 pounds	Single Superphosphate 0-20-0

1 pound	Calcium Nitrate 15.5-0-0
1 pound	Iron Sulfate
8 pounds	Kaiser 65 Dolomite Lime

2.4 SOIL ADDITIVES

A. Nitrogen Stabilized Fir Bark On-Grade: Meeting the following specifications:

1. Particle Size (dry weight basis):

Sieve Size	Percent Passing
6.35 mm (1/4-inch)	95 – 100
2.38 mm (No. 8, 8 mesh)	50 – 80
500 micron (No. 35, 32 mesh)	0 – 25

2. Organic Content: Determined by ash analysis. Minimum 92% based on dry weight.

3. Nitrogen: Minimum 0.8% nitrogen based on dry weight.

4. Salinity: Maximum saturation extract conductivity 3.5 millimhos per cm at 25 degrees centigrade.

5. Iron: Minimum 0.08% dilute acid soluble Fe based dry weight, if iron treated.

6. Bulk Density: 400 pounds per cubic yard.

B. Fine Fir Bark in Planters:

1. Particle Size (Dry Weight Basis):

Sieve Size	Percent Passing
6.35 mm (1/8-inch)	95 – 100
2.38 mm (No. 8, 8 mesh)	75 – 100
500 micron (No. 35, 32 mesh)	0 – 30

2. Organic Content, Bulk Density and Chemistry: As specified for nitrogen-stabilized fir bark above.

C. Fine Sand:

1. Particle Size (dry weight basis):

Sieve Size	Percent Passing
No. 4	100
No. 10	95 – 100
No. 18	90 – 100
No. 35	65 – 100
No. 60	0 – 50
No. 140	0 – 20
No. 270	0 – 7

2. Salinity: Maximum saturation extract conductivity range in millimhos per cm at 25 degrees centigrade: 0-3.0.

3. Boron: Maximum saturation extract concentration 1.0 ppm.

4. Sodium: Maximum sodium absorption ratio (SAR) 6.0.

2.5 FERTILIZERS AND AMENDMENTS

A. Fertilizer Tablets: 21-gram tablets in the nutrient formulation 20-10-5 as manufactured by Sierra Chemical Co., Milpitas, CA, and available through Robins Fertilizer, Anaheim, CA, Target Specialty, Cerritos, CA, or Hydro-scape.

B. Commercial Grade Fertilizers: Granular type as available from Best Products or approved equal.

C. Ammonium Sulfate: 21-0-0. Caution: Ammonium sulfate fertilizer will burn leaves if applied to wet foliage. Apply to and around dry foliage only, and follow with an immediate and thorough watering-in by irrigation.

D. Iron Sulfate: Ferric sulfate, containing minimum 18% to 20% iron expressed as elemental. Caution: Iron sulfate will stain concrete, granite, stucco and tile surfaces. Avoid contact between these surfaces and any soil mix containing iron sulfate. After iron sulfate application, broom or air blow all such surfaces free of material before any water application including any impending rains.

E. Calcium Carbonate Lime: Ground oyster shell flour type.

2.6 MATERIALS

A. General: All materials supplied shall be free of deleterious and extraneous substances including contaminants detrimental to plant growth, such as excess salts, boron, solvents, etc.

B. Drain Rock: 3/4-inch diameter river rock or approved equal.

C. Soil Separator: "Mirafi 140N", as manufactured by Mirafi, Charlotte, NC, "Trevira Spunbond 1120", as manufactured by Hoechst Fibers Industries, Spartanburg, SC, or approved equal.

D. Guying and Staking Materials:

1. Tree Stakes: Steel tree stakes shall be "The Reddy Stake System" as available from Decorations for Generations, Inc., Screw Tight Post, Turlock CA (209-634-7791), or accepted equal.

2. Stakes for Sodding: 1 x 1 x 6" pine, or 6" lengths of lath.

3. Guying Cable: 1 x 19 aircord, diameter as specified under Execution.

4. Turnbuckles: Galvanized, size as specified under Execution.

5. Cable Clamps: Galvanized or copper, size as required.

6. Plastic Guy Markers: 1/2-inch diameter x 16-inch long white PVC pipe.

7. Guy Anchors: "Universal Ground Anchors", as manufactured by Laconia Malleable Iron Company, Laconia, NH, Duckbill Anchor as manufactured by Foresight Industries, Inc., Northglenn, CO, Model 88-DB-1, or approved equal.

8. Rubber Guy Covers: 1/2-inch diameter black rubber tubing. Minimum length 6 inches longer than circumference of limb the guy cover is attached to.

E. Water: Clean, potable and free of deleterious matter.

F. Pre-Emergent Herbicide: For all on-grade ground cover and shrub areas, provide "Surflan A.S." as manufactured by Elanco Products Co., Indianapolis, IN, with no acceptable substitutions. Apply per manufacturer's instructions.

G. Tree Paint: "Tree Seal" by Morrison, "Flexiblac 3230" as manufactured by Samuel Cabot, Inc., Boston, MA, Ortho "Pruning Seal", or approved equal.

H. Anti-Desiccant: For retarding excessive loss of plant moisture and inhibiting wilt, sprayable, water insoluble vinyl-vinyledine complex which will produce a moisture regarding barrier. Forming at temperatures commonly encountered out-of-doors during planting season. Film thus formed shall have a mvt (moisture vapor transmission rate) of not more than 10 grams per 24 hours at 70 percent humidity. Furnish evidence that the material can be used safely on plant materials specified.

I. Hardware:

1. All hardware required for fabrication and erection including brackets, hangers, hinges, fasteners, and nails to be hot-dip galvanized.

2. Screws, nuts, bolts and washers to be stainless steel.

J. Wood Bark Mulch: "Deco Bark" mulch, 1/4-inch to 5/8-inch diameter, as available from Sun Up Forest Products, Sacramento, CA (916) 920-0665, or approved equal.

K. Root Control Barrier: "Deep Root Control Barrier", stock number UB24-2 as manufactured by Deep Root Corp., 15040 Golden West Circle, Westminister, CA 92683 (714) 898-0563, or approved equal.

PART 3 -- EXECUTION

3.1 FIELD QUALITY CONTROL

A. Pre-Construction Conference: Schedule a pre-construction conference with the ENGINEER at least 7 days before beginning work under this Section. Submit written request for conference at least 7 days prior to proposed time of conference. Purpose of this conference is to review questions CONTRACTOR may have regarding the work, administrative procedures during construction and project work schedule.

B. Progress Observations: In addition to the installation observations specified below, periodic progress observations will be made by the ENGINEER.

C. Installation Observations: Specifically requested the following observations:

1. Observation of plants at place of growth.

2. Observation of drainage layer, soil separator and polystyrene fill installation.

3. Observation of subgrade prior to placement of fill soil.

4. Observation of planter backfill and finish grading prior to planting.

5. Observation of lath-staked plant material.

6. Observation of plant material upon delivery to the site.

7. Observation of layout and placement of plant material at time of planting.

8. Observation of staking / guying procedures.

9. Observation of sod / seed bed.

D. Maintenance Period: The CONTRACTOR will perform maintenance of all landscaping for a period of 120 days after completion of plant installation. For the purpose of establishing the 120-day maintenance period and observing completion of the work of this Section through Final Acceptance, five (5) separate field visits shall occur chronologically as follows:

1. Observation for Maintenance Period Commencement.

2. 30-Day Progress Maintenance Observation.

3. 60-Day Progress Maintenance Observation.

4. 90-Day Progress Maintenance Observation.

5. Final Observation.

3.2 ORDERING, REVIEW AND ACCEPTANCE OF PLANT MATERIAL

A. Ordering:

1. Within 30 days after award of contract, submit written certification to the ENGINEER of the quantity and species of plant material ordered, and the nursery(s) supplying the material.

2. The CONTRACTOR is responsible for providing all plant material in the quantities and sizes specified on the drawings, and for making all arrangements in advance that may be required to obtain these materials. If any material specified will be unavailable at the time of planting, submit written verification to the ENGINEER along with the bid.

B. Review of Plant Material: Before planting operations begin, all plant materials shall be reviewed for conformance to the design intent of the Contract Documents by the ENGINEER. Submit written request for review of plant material at least 10 days prior to

commencement of planting operations. Review by the ENGINEER does not waive the OWNER's right of rejection during planting or any time thereafter.

C. Rejection of Material: The ENGINEER reserves the right to review and reject plant material at any time, and at the place of growth, for nonconformance to the Specifications. Do not install plant material which has not been reviewed at the project site by the ENGINEER.

3.3 FINISH GRADING

A. General: All areas to be planted on the project shall be free of rocks over one-inch in diameter to a depth of 8" minimum below finish grade, and free of foreign debris, subsoil, refuse, plants or roots, clods, weeds, sticks, solvents, petroleum products, concrete, base rock, or other deleterious or extraneous material. Areas to be planted shall be free of soil-borne diseases and capable of sustaining healthy plant life. Do all work necessary to bring site soil, import soil and planter backfill to compliance with these requirements. Remove from the project site and dispose of in a legal manner any soils and material not meeting these requirements. Subject to acceptance of the ENGINEER, all soil and material not meeting these requirements shall be the property of the CONTRACTOR.

B. Surface Drainage: CONTRACTOR is responsible for proper surface drainage of planted areas. Report in writing to the ENGINEER any discrepancies in the Contract Documents, obstructions on the site, or any other conditions which the CONTRACTOR feels prevent establishing proper drainage, and obtain the ENGINEER's instructions prior to proceeding with the work affected.

C. Final Contouring:

1. Handle and place the soil to depths required. Remove all rocks and clods over one-inch in diameter. Provide for surface drainage and cut all necessary drain swales.

2. Work soil sufficiently so that after rolling and after full settlement has occurred, the site will be graded to within ±0.10 of a foot from the lines, grades and elevations shown, and as may be directed by the ENGINEER. Finished surface shall be smooth and uniform and shall be free of depressions that retain standing water or any surface irregularities that would impede proper drainage. Unless otherwise noted, all soil finish grades shall be 1-1/2 inches below finish grade of adjacent walks, pavements and curbs, and top of wall elevations.

D. Erosion Repair: Repair all erosion damage that occurs until Final Acceptance. Take all measures necessary to prevent erosion occurring during work under this Section. Provide and amend replacement soil in accordance with this Section.

E. On-Grade: In on-grade locations, this CONTRACTOR shall receive the site ±.15 feet from the finish grades shown on the drawings. The CONTRACTOR shall establish finish grades in these planting areas by using approved imported topsoil.

F. Cross-Rip: Cross-rip all on-grade planting areas to a minimum depth of 12 inches.

G. On-Grade Fill Areas: The ENGINEER will observe all subgrade prior to placement of fill soil. Thoroughly scarify and cross-rip all areas to receive fill to a depth of 12 inches prior to placement of fill.

3.4 SOIL AMENDMENT ON-GRADE

A. General:

1. Soil amendments and fertilizers shall be provided as recommended in the required soil tests performed by the approved testing laboratory.

2. After finish grading operations are completed, obtain required soils test and submit test report results to the ENGINEER for review. Sampling procedures and number of samples shall be as recommended by the Testing Laboratory and reflect the scope, scale and complexity of the project and soil conditions present.

3. The following soil amendments and fertilizers are to be used for bid pricing only.

4. General: After finish grading operations are completed, rototill top 6 inches as required in at least 2 perpendicular directions, and with soil at the proper moisture content so that all clods greater than 1-inch diameter will be broken up resulting in a homogenous blend of amended soil.

B. Site Soil: Amend the surface 6 inches by thoroughly blending the following amendments per 1000 square feet.

Amount	Ingredient
6 cubic yards	Nitrogen Stabilized 0" – 1/4" Fir Bark
15 pounds	12-12-12 Commercial Fertilizer as Specified
15 pounds	Soil Sulfur
100 pounds	Agricultural Gypsum

C. Backfill Mix (on-grade locations): Amend site soil as follows per cubic yard.

Amount	Ingredient
3/5 cubic yard	Surface Soil
2/5 cubic yard	Nitrogen Stabilized 0" to 1/4" Fir Bark
1 pound	12-12-12 Commercial Fertilizer as Specified
2 pounds	Iron Sulfate as Specified
10 pounds	Agricultural Gypsum

D. Additional Amendments: Soil amendment recommendations will vary for planting areas if imported topsoil is required to establish finish grade. Provide all additional amendments as may be required by subsequent soil testing of approved imported topsoil and as directed by the ENGINEER.

3.5 SOILS FIELD QUALITY CONTROL

A. General: Keep a record of where each batch of imported topsoil delivered is deposited in the landscape; mark graphically on a separate, clean set of black line prints.

B. Deficient Soils: Remove all soils determined by the ENGINEER to be deficient and provide all additional amendments as directed by the ENGINEER to modify deficient soils at no additional cost to the OWNER.

3.6 INSTALLATION OF SOIL SEPERATOR

A. General: Place soil separator fabric over entire interior surface area of planter pot bottom or over drain rock in accordance with the manufacturer's recommendations where and as shown on the drawings. The fabric shall be applied without stretching and should lie smoothly, but loosely on drain rock. Ensure that a continuous layer of soil separator covers and drain rock or planter bottom free of cracks, tears or punctures.

B. Joints and Edges: Lap all joints in the soil separator fabric 8 inches minimum.

C. Protection: Protect integrity of continuous fabric layer at all times. Avoid walking directly on the fabric either before or after the fabric is applied. Remove and replace any fabric damaged throughout the course of the work. Take care not to damage, tear or puncture soil separator at any time.

3.7 PLACEMENT OF PLANTER BACKFILL

A. General: Place planter backfill mix to the depths specified to obtain finish grades shown on the drawings. Soil mix shall be handled in a manner so as to prevent segregation of ingredients. Thoroughly water planter backfill mix after placement to compact and settle mix.

B. Planters Less Than 24 Inches In Depth: Place soil mix to the depths shown on the drawings.

C. Planters Greater Than 24 Inches In Depth: Place the following materials in the layers noted:

1. Layer One: Sand – as measured from the soil separator, and as shown on the drawings, place the specified sand as required.

2. Layer Two: Transition Zone – Place a 2-inch layer of specified planter soil mix on top of layer one. Thoroughly blend the 2 inches of soil mix into the top 4 inches of sand to create a transition zone.

3. Layer Three: Final Grade – Place 22 inches of specified planter soil mix on top of layer two, and bring planter areas to the required grades as shown on the drawings.

3.8 HANDLING OF PLANT MATERIAL

A. General: do not bind or handle any plant in such a way that would result in damage to the plant material. Lift and handle plants only from bottom of root ball.

B. Access: The CONTRACTOR shall be responsible for accessing and installing all plant material at the job site. The CONTRACTOR shall inspect the job site and become familiar with the accessing requirements and restrictions. Plant material shall be carefully bound with clear plastic wrap, burlap or other lightweight fabric as required to allow access. Care should be exercised to prevent damage or breakage to limbs, and ropes or other lines should not be allowed to damage bark. At the time of submitting bid, the CONTRACTOR shall notify the OWNER, in writing, of any conditions that would prevent the accessing and installation of the specified plant material.

C. Container Stock:

1. General: Do not lift or handle container plants by tops, stems, or trunks at any time.

2. Boxed Stock: Remove bottom of box prior to placement of plant in planting pit. Cut bands and remove box sides just prior to backfilling.

3. Canned Stock: Remove canned stock carefully after cans have been cut on two sides with acceptable cutter. Do not use spade to cut cans.

4. Ball and Burlap Stock: Dig ball and burlap (B & B) plants with firm balls of earth of diameter not less than that recommended by the American Standard for Nursery Stock, and of sufficient depth to include the fibrous and feeder roots. Plants moved with ball will not be accepted if the ball is cracked or broken before or during planting operations.

D. Anti-Desiccant: At CONTRACTOR's option, spray all evergreen and deciduous plant material in full leaf with anti-desiccant, in accordance with manufacturer's instructions. Apply an adequate film over trunks, branches, twigs and foliage. Take precautions as necessary to prevent damage, particularly from sun scald.

3.9 LAYOUT OF PLANT MATERIAL

A. **General**: The ENGINEER will review for conformance to the design intent of the Contract Documents locations of all plants in the field prior to planting. Notify the ENGINEER and schedule layout review sufficiently in advance of planting to allow for review and adjustment without disrupting construction schedule.

B. Trees: Layout tree locations shown on the drawings using a 3-foot lath (or other acceptable method), color-coded to indicate each species. The ENGINEER will review locations of trees in the field, as denoted by lath stakes, after trees are delivered to the site, but before placement and positioning. After placement of trees in approved locations, but before final planting, notify ENGINEER to review final positioning of trees.

C. Other Plant Material: Layout all other plant material where shown on the drawings.

D. Adjustments: The ENGINEER reserves the right to make minor adjustments in the layout of all plant material; adjust irrigation system as necessary.

3.10 EXCAVATION OF PLANTING PITS ON-GRADE

A. **General**: Excavate plant pits by hand or with a backhoe; use of augers will not be permitted. Prior to planting and backfill, scarify the sides and bottom of the pit as required to eliminate any glazed surfaces. Excavate container-grown tree, shrub, and vine holes to the following dimensions:

1. 1, 5, and 15 gallon containers: Two times the size of the root ball in width and depth.

2. 24-inch boxes and larger: Large enough to allow one foot of space around the ball in all directions.

3. Holes on mounds: Dig plant holes on mounds deeper than normal.

B. Excess Soil: Transport and dispose of off-site in a legal manner any excess excavated soil.

C. Obstructions: If rocks, underground construction work, tree roots or other unknown obstructions are encountered in the excavation of plant holes, alternate locations may be selected by ENGINEER. Report all such conditions in writing to the ENGINEER. If a change in the location of the planting pit is unacceptable to the ENGINEER, the original planting pit shall be over-excavated to remove the obstructions to a minimum dimension of 12" beyond the sides and bottom of the tree pit as typically specified. Obtain the ENGINEER's instructions prior to proceeding with the work affected.

3.11 DETRIMENTAL SOILS AND DRAINAGE

A. General: Prior to planting, test drain all planting areas as follows:

1. On-Grade Plant Pits: Fill with 12 inches of water. Water should drain completely in 48 hours.

2. Plant Beds: Irrigate until soil is saturated. Saturated condition should not remain after 24 hours.

B. Drainage Chimneys:

1. General: For plant pits failing the initial drainage test, provide drainage chimneys as shown on the drawings and as directed by the ENGINEER.

2. Neatly auger drainage chimneys to a depth directed by the ENGINEER. Remove loose soil from hole and plant pit. Locate chimneys at perimeter of plant pit. Repeat test for proper drainage.

3. Once required drainage test has been passed, backfill chimneys with drain rock, flush with bottom of pit. Cover chimneys with soil separator.

C. Failure of Drainage Test: report in writing to the ENGINEER all areas not passing these tests and all soil conditions that the CONTRACTOR considers detrimental to growth of plant material. State condition and proposal and cost estimate for correcting the condition. Obtain the ENGINEER's instructions prior to proceeding with the work affected. Repeat drainage testing and correction of conditions in this manner as necessary until tests are passed. Failure to perform drainage tests and/or to notify the ENGINEER in writing of the conditions specified above renders the CONTRACTOR responsible for all plant failure that occurs as a result of inadequate drainage or detrimental soil conditions, as determined by the ENGINEER.

3.12 PLANTING OPERATIONS

A. General: Do not plant any material that has not been reviewed by the ENGINEER upon delivery to the project site or that has been rejected for any reason. Do not plant under unfavorable weather conditions.

B. Container Stock: After removing plants from their containers, disentangle any small roots that encircle the container. Do not cut or otherwise disturb the root ball. Inspect all plants for rootbound condition; do not install rootbound plants or plants found to have cracked or broken root balls when taken from the container.

C. Backfilling: Backfill plant pits as shown on the drawings and specified herein. Set plant plumb and brace rigidly in position until backfill has been tamped solidly around the root ball. When plant holes have been backfilled approximately 2/3 full, water thoroughly, saturating root ball, before installing remainder of backfill to top of hole, eliminating air pockets.

D. Fertilizer Tablets On-Grade Only: Place fertilizer tablets evenly distributed in plant pit when backfilled 2/3 according to the following schedule:

1 gallon can	=	1 tablet
5 gallon can	=	3 tablets
15 gallon can	=	5 tablets
Other	=	1 tablet per 12 inches of root ball circumference
Example:		24" box = 96" cir/12" = 8 tablets

E. Top-dress Fertilizing On-Grade: When plant installation is complete, fertilize all planting areas (excluding lawn areas) with top-dress fertilizer at the rate of 4 lbs. per 100 square feet.

F. Mulching: Mulch all planting areas (excluding lawn areas) with 1-1/2-inch layer of wood bark mulch unless otherwise shown. Spread mulch uniformly to form a smooth cover free of bare spots and mounds.

G. Settlement: As shown on the drawings, the crowns of all plants shall be at least 1/2-inch above the surrounding grade after all settlement has occurred.

H. Watering Basins On-Grade: Form a watering basin, an excavated ring around the root ball of the plant for each tree and shrub. Do not form watering basins in lawn areas.

I. Watering: Thoroughly water all plants immediately after planting, taking care to avoid erosion.

3.13 STAKING AND GUYING

A. General: Complete staking and guying immediately after planting. Perform in accordance with reference standards, unless otherwise shown on the drawings or directed by the ENGINEER. Securely stake or guy all trees planted on the site using staking or guying type shown on the drawings. The ENGINEER reserves the right to make modifications to staking and guying procedures as required to accommodate field conditions at no additional cost to the OWNER.

B. Staking: Stake trees with one as shown on the drawings.

C. Guying: Plants shall typically be guyed at 3 points of branching with guys spaced evenly around and outside the perimeter of the root ball. Final number and positioning of guys are to be as directed by the ENGINEER. Cover guys with rubber guy covers at points of contact with the bark, positioned at crotches, and fasten to approved guy anchor. Provide one turnbuckle for each guy wire. Provide one white guy marker positioned above the turnbuckle for each guy.

3.14 PRUNING

A. Pruning: Prune plants only at the direction of the ENGINEER and according to reference standards to preserve the natural character of the plant. Remove all dead wood, suckers and broken or badly bruised branches. Remove sucker basal and lateral growth to prevent resprouting; retain normal side branching. Use only disinfected, sharp tools. Improperly pruned trees will be subject to rejection by the ENGINEER. Apply tree seal to cuts over one-inch diameter in accordance with manufacturer's instructions.

3.15 GROUND COVER PLANTING

A. Finish Grading: Place and amend soil or planter backfill, and do all work to provide the correct finish grades in the planting areas as specified.

B. Pre-emergent herbicide Application On-Grade Only: Apply pre-emergent herbicide, Surflan A.S. at the rate of 5-1/3 pounds per acre applied in 25 gallons of water to all on-grade locations. Apply before wood bark mulch application.

C. Mulching: Apply wood bark mulch to all planter areas at least 1-1/2 inches deep covering all exposed soil / planter backfill mix or erosion control fabric areas. Herbicide activity is enhanced when wood bark mulch is applied over the herbicide and irrigated.

D. Planting: Plant ground cover plants through wood bark mulch and erosion control fabric at the specified triangular spacings. Make planting hole with a hand mattock avoiding mixing surface applied herbicide into planting hole.

E. Activation of Herbicide On-Grade Only: After planting, irrigate with at least one-inch of water to activate the herbicide. Water areas carefully taking care to avoid erosion. Repair erosion occurring from careless watering immediately. Remove, repair and replace adjacent planting and soil damaged by careless watering and translocation of herbicide.

3.16 INSTALLATION OF DRAIN ROCK AND/OR GRAVEL MULCH

A. Install where and to depths shown on the drawings. Do all work required to ensure the drain rock is clean and free of sticks, clods, and other deleterious matter before it is placed.

3.17 LAWN INSTALLATION

A. Sodding:

1. Sodding shall take place immediately after soil conditioning and fine grading. Care shall be exercised to keep sod from drying, and it shall be installed the same day it is received.

2. Unroll the sod fitting each strip tightly to the preceding strip avoiding overlap. Do not stretch the sod. Stagger end joints in a running bond pattern.

3. Following placement of sod, roll with a 200 pound roller to make certain that no air space is left beneath the sod. Water lightly, allow to dry and provide a second rolling at right angles to the first rolling.

4. Keep sod fairly well watered the first two weeks to ensure rooting into base soil. Frequency of watering will depend upon temperature. Be sure edges do not dry out.

5. Mow to a height of not less than 2 inches. Adjust any raised areas or depressions in the sod to form even finish grade.

3.18 MAINTENANCE

A. General: Maintain all plant and planting areas from time of delivery, through installation and the 120-day maintenance period until Final Acceptance.

B. Schedule: Submit a proposed maintenance work schedule to the ENGINEER in writing for review at least 30 days prior to commencement of maintenance work. All maintenance work shall be done at times approved by the ENGINEER so as not to conflict with the operation of the project.

C. Maintenance Procedures:

1. General: Maintenance of new planting consists of, but is not limited to: Watering, cultivating, fertilizing, weeding, mulching; restaking, tightening and repairing guys; resetting plants to proper grades or upright positions; restoring watering basins; providing such sprays and invigorants as are necessary to keep the planting free of insects and disease and in thriving condition; restoring finish grades by replenishing planter areas with soil; replacing eroded soil, or soil made sterile by herbicidal application, with approved and tested imported topsoil; repairing damage to jute mesh; taking precautions as necessary to prevent sun scald damage.

2. Protection: Protect planting areas and plants against damage until Final Acceptance. Maintenance also includes temporary fences, barriers, and signs as required for protection. If any plant becomes damaged or injured, treat or replace as directed by the ENGINEER at no additional cost to the OWNER.

3. Fertilization: Including, but not necessarily limited to the following applications:

a. Ground cover and All Planting Areas: 16-6-8 fertilizer at the rate of 7 pounds per 1,000 square feet, 30 days after installation.

b. Apply 16-6-8 fertilizer at 45-day intervals after the 30-day application until landscape areas become well established.

D. Observation for Maintenance Period Commencement: Make request for observation after all plant material is installed and after first lawn cutting and after all irrigation work and other work of this Section is completed. Maintenance period shall begin upon observation and review by the ENGINEER and shall continue for a minimum of 90 days until Final Acceptance.

E. 30-day Progress Maintenance Observation:

1. General: Notify the ENGINEER and request 30 days after commencement of landscape maintenance period for a progress maintenance observation. All items determined to be deficient during the observation for maintenance period commencement shall be completed prior to the meeting. In addition, prior to this meeting, furnish the ENGINEER with the following information:

a. An as-built "Record Drawing" of all plantings installed, as specified.

b. All supplier invoices for the nursery stock, commercial fertilizers, soil amendments, mulches and herbicides as shown and specified, and as installed.

c. Maintenance schedule for fertilization, irrigation, and for cutting of all lawn areas.

d. Failure to submit the above items to the OWNER may result in the delay of the 30-day progress maintenance observation and the extension of the 90-day maintenance period.

e. Notify the ENGINEER prior to the 30-day progress maintenance observation of any conditions that impede proper plant establishment and/or growth.

F. 60-Day Progress Maintenance Observation: Notify the ENGINEER 60 days after commencement of the landscape maintenance period and request the 60-day maintenance observation. Prior to this observation, all items determined to be deficient during the 30-day progress maintenance observation shall be completed.

G. 90-Day Progress Maintenance Observation: Notify the ENGINEER 90 days after commencement of the landscape maintenance period and request the 90-day maintenance observation. Prior to this observation, all items determined to be deficient during the 60-day progress maintenance observation shall be completed.

3.19 FINAL OBSERVATION

A. General: CONTRACTOR shall notify the ENGINEER and request final observation 120 days after commencement of the landscape maintenance period, and after all work of this Section, Section 02476 and previously identified deficiencies have been corrected.

B. Termination of Observation: During the final observation, any landscape item previously identified as deficient in the 30-day, 60-day, or 90-day progress maintenance observations, and determined by the ENGINEER to be still deficient, shall automatically terminate the final observation and result in the extension of the maintenance period an additional 30 days at no additional cost to the OWNER.

- END OF SECTION -

SECTION 02490 - PRECAST CONCRETE MANHOLES AND VAULTS

PART 1 -- GENERAL

1.1 THE REQUIREMENT

A. The CONTRACTOR shall provide precast concrete manholes and vaults, complete and in place, in accordance with the Contract Documents.

1.2 SPECIFICATIONS, CODES AND STANDARDS

A. Commercial Standards

ASTM A 48	Gray Iron Castings
ASTM C 150	Portland Cement
ASTM C 443	Joints for Circular Concrete Sewer and Culvert Pipe, Using Rubber Gaskets
ASTM C 478	Precast Reinforced Concrete Manhole Sections
ASTM C 923	Resilient Connectors Between Reinforced Concrete Manhole Structures, Pipes, and Laterals

1.3 CONTRACTOR SUBMITTALS

A. **General:** Furnish submittals in accordance with Section 01300 - Contractor Submittals.

B. **Shop Drawings**

1. Show dimensions, locations, lifting inserts, reinforcement, and joints.

2. Structural design calculations for vaults, signed by a registered engineer.

C. Manufacturer's Certification for Vaults: Written certification that the vault complies with the requirements of this Section.

1.4 QUALITY ASSURANCE

A. **Inspection:** After installation, the CONTRACTOR shall demonstrate that manholes and vaults have been properly installed, level, with tight joints, at the correct elevations and orientations, and that the backfilling has been carried out in accordance with the Contract Documents.

PART 2 -- PRODUCTS

2.1 MANHOLES

A. The CONTRACTOR shall provide precast manhole sections and conical sections conforming to ASTM C 478 and the requirements of this Section. Adjusting rings shall be standard items from the manufacturer of the manhole sections. Minimum wall thickness of rings shall be 4 inches if steel reinforced and 6 inches if not reinforced.

B. Axial length of sections shall be selected to provide the correct total height with the fewest joints.

C. Conical sections shall be designed to support cast iron frames and covers under an H-20 loading, unless indicated otherwise.

D. Where the manhole barrel diameter is greater than 48 inches, a flat slab-transition, either concentric or eccentric, shall be used to transition to 48-inch diameter riser sections. Underside of the transition shall be at least 7-feet above the top of the bench.

E. **Design Criteria:** Manhole walls, transitions, conical sections, and base shall be designed per ASTM C 478 for the depths indicated and the following:

1. AASHTO H-20 loading applied to the cover.

2. Unit weight of soil of 125 pcf located above all portions of the manhole.

3. Lateral soil pressure based on saturated soil acting on an empty manhole. See project Geotechnical Report data.

4. Internal fluid pressure based on unit weight of 63 pcf with manhole filled from invert to cover with no balancing external soil pressure.

5. Dead load of manhole sections fully supported by the base and transition.

6. Additional reinforcing steel in walls to transfer stresses at openings.

7. The minimum clear distance between the edges of any 2 wall penetrations shall be 12 inches or 1/2 of the diameter of the smaller penetration, whichever is greater.

F. Joints shall be sealed with O-ring gaskets conforming to ASTM C 443 or preformed mastic sealing gasket **as manufactured by Rannek, Kent Seal**, or equal.

G. Concrete for base and channel formation shall be 4000 psi concrete conforming to Section 03300 - Cast-In-Place Concrete.

H. Barrel section to sewer pipe connections shall be sealed with resilient connectors complying with ASTM C 923. Mechanical devices shall be Type 316 stainless steel.

I. The CONTRACTOR shall verify that all manhole barrel pick holes have been sealed prior to manhole backfilling to prevent infiltration.

J. Manhole Manufacturers, or Equal

1. **Hanson Concrete Products, Inc.**, Milpitas, CA

2. **Teichert Precast**, Sacramento, CA

2.2 FRAMES AND COVERS

A. **Castings:** Castings for manhole frames and covers shall be non-rocking and shall conform to the requirements of ASTM A 48, Class 30. Unless otherwise indicated, cast iron covers and frames shall be heavy traffic type, 30 inches in diameter, with embossed lettering saying "Sewer" as per the detail provided in the Contract Drawings. Frame and cover shall be designed for H-20 traffic loading. All manhole frames shall be secured to

the top of the manhole by provision of a cast-in-place reinforced concrete manhole collar.

B. Castings Manufacturers, or Equal

1. **Alhambra Foundry Co., Ltd.**

2. **Neenah Foundry Co.**

3. **Vulcan Foundry, Inc.**

2.3 VAULTS

A. The CONTRACTOR shall provide precast vaults designed for the indicated applications and of the sizes indicated.

B. The minimum structural member thickness for vaults shall be 5-inches. Cement shall be Type V portland cement as specified in ASTM C 150. The minimum 28-day concrete compressive strength shall be 4,000 psi. All reinforcing steel shall be embedded in the concrete with a minimum clear cover as recommended by ACI 318.

C. Design Loading: All vaults shall be designed for H-20 traffic loading. Lateral loads on vaults in all areas shall be calculated from:

	L	=	90 h, plus surcharge of 240 psf in areas of vehicular traffic
Where	L	=	loading in psf
	h	=	depth of fill in feet

D. Where joints are designed in pre-cast concrete vaults, such joints shall be interlocking to secure proper alignment between members and prevent migration of soil through the joint. Structural sections at joints shall be sized sufficiently to reinforce the section against localized distress during transportation and handling and against excess contact bearing pressures through the joint.

E. Where openings for access to the vault are required, the full clear space opening indicated shall be provided, without obstructions from brackets or supports. For large openings where brackets or supports are designed to protrude into the opening for support of required covers, such brackets or supports shall be designed to be easily removed and replaced with a minimum of effort and without cutting or welding.

F. Covers for access openings shall be provided. Frames for covers shall be fabricated from steel, galvanized after fabrication, and shall be integrally cast into the vault concrete sections. All covers shall be tight fitting to prevent the entrance of dirt and debris. Where edge seams are permitted, no gaps greater than 1/16-inch between edges will be accepted. All covers, except round, heavy-weight, cast iron manhole covers, shall have securing mechanisms to hold the covers firmly in place against the effects of repetitious live loads such as pedestrian or vehicle traffic.

G. Where penetration of the pre-cast concrete vault are required for piping, conduit, or ducts, such penetrations shall be accommodated through pre-cast openings or thin-wall knock-out sections. All openings for penetrations shall be smooth and free of surface

irregularities and without exposed steel reinforcing. Vaults need not be designed to resist thrust from piping passing through the vault.

H. Warning Signs

1. The entrance to every manhole and vault shall be fitted with a permanently affixed (using wedge anchors or powder activated fasteners), plastic warning sign (1-inch high red letters on white background) stating "CAUTION, VENTILATE BEFORE ENTERING." located 4 inches below the top of the manhole or vault. Each sign shall be in accordance with Section 10400 - Identifying Devices.

2. Sign Manufacturer, or Equal

   a. **W.H. Brady Company;**

   b. **Seton Nameplate Corporation.**

PART 3 -- EXECUTION

3.1 GENERAL

A. Pre-cast concrete sections shall be transported and handled with care in accordance with the manufacturer's written recommendations. Where lifting devices are provided in pre-cast sections, such lifting devices shall be used as intended. (Also, see Paragraph 2.1.I). Where no lifting devices are provided, the CONTRACTOR shall follow the manufacturer's recommendations for lifting procedures to provide proper support during lifting.

B. Buried pre-cast concrete manholes and vaults shall be assembled and placed in excavations on properly compacted crushed rock foundations as indicated. Pre-cast concrete manholes and vaults shall be set to grade and oriented to provide the required pipe connections and dimensions and clearances from pipes and other structures.

C. A steel impression ring, sized to match the spigot end of the Lowe manhole barrel section, shall be used to form a groove in the wet cast in place concrete base. A preformed mastic sealing gasket shall be placed in the groove prior to setting the first barrel section.

D. Only pre-cast reinforced concrete grade rings shall be used to adjust the manhole frame to grade.

E. Prior to backfilling, all cracks and voids in pre-cast concrete manholes and vaults shall be filled with non-shrink grout or polyurethane sealant, or both. Around pipe and conduit penetrations, openings shall be sealed with polyurethane sealant. With the authorization of the ENGINEER, grout or a closed-cell flexible insulation may be used as filler material prior to placing a final bed of polyurethane sealant.

- END OF SECTION -

SECTION 02491 - ACTIVATED CARBON ODOR CONTROL CANISTER

PART 1 – GENERAL

1.1 THE REQUIREMENT

A. The CONTRACTOR shall provide an activated carbon odor control canister for installation in sanitary sewer manholes and air release manholes, complete and operable, in accordance with the Contract Documents.

B. The requirements of Section 11000 - Equipment General Provisions apply to the WORK of this Section.

C. Activated carbon odor control canister shall be supplied by a single manufacturer.

1.2 CONTRACTOR SUBMITTALS

A. **Shop Drawings:** The CONTRACTOR shall submit complete Shop Drawings of the activated carbon odor control equipment as a complete system, according to the requirements of Section 01300 - Contractor Submittals. Included in the Shop Drawing submittals shall be complete data on the carbon proposed.

B. **Samples:** A representative sample and specification sheet of the carbon to be used shall be submitted with the submittal documents. Before final acceptance of submittals, a qualified laboratory acceptable to the ENGINEER shall be retained for testwork required to verify H_2S breakthrough capacity and any other parameters indicated, if the ENGINEER deems such testing necessary. Such testing shall be paid for by the CONTRACTOR as part of the WORK.

C. Each lot of activated carbon delivered to the Site shall be accompanied by an analysis sheet of the measured characteristics of the carbon in that lot. Random samples of the delivered carbon will be selected by the ENGINEER for testing to insure product quality. Testing may be made by any testing laboratory acceptable to the ENGINEER. Costs associated with the testing shall be paid for by the CONTRACTOR as part of the WORK.

D. **Manufacturer's Data:** The CONTRACTOR shall require the manufacturer to supply a quarterly analysis of the activated carbon to the OWNER to be reported as "H_2S capacity." This service shall be furnished for one year from startup of the system. The CONTRACTOR shall have the manufacturer furnish 4 appropriate containers and adequate instructions for sample taking and disposition of samples to be submitted to the carbon manufacturer or approved outside laboratories.

E. **O & M Manuals:** The CONTRACTOR shall furnish to the ENGINEER complete operation and maintenance instructions of the activated carbon odor control canister required under paragraph "Technical Manuals" of Section 01300 – Contractor Submittals.

F. **Tools and Spare Parts:** The CONTRACTOR shall supply one complete set of special wrenches or other special tools necessary for the assembly, and dismantling of the equipment. Tools shall be of best quality and furnished in labeled metal tool boxes.

G. The CONTRACTOR shall obtain and submit to the ENGINEER a certificate from the manufacturer listing the nomenclature, composition, and characteristics of the plastic to be supplied with the submittal data.

1.3 QUALITY ASSURANCE

A. The CONTRACTOR shall be responsible for the successful startup of each odor control canister. The CONTRACTOR shall provide necessary facilities, manpower, chemicals, and tools required during this phase of the WORK.

1.4 MANUFACTURER'S SERVICE REPRESENTATIVE

A. The CONTRACTOR for each piece of equipment shall provide the services of a trained, qualified representative of the equipment manufacturer for at least one day after units are put in proper working order, or as otherwise indicated, for the purpose of inspecting the installation and instructing the OWNER's operating personnel.

1.5 CLEANUP

A. After completion and testing the CONTRACTOR shall remove debris and spilt media from the Site and clean the entire system to render it ready for startup.

PART 2 -- PRODUCTS

2.1 GENERAL

A. **Performance:** The activated carbon odor control canisters shall be designed to remove hydrogen sulfide and methyl mercaptan odors emitted from sanitary sewer manholes and air release manholes. The activated carbon shall be applicable to odor control.

2.2 ACTIVATED CARBON ODOR CONTROL CANISTER

A. There shall be furnished modular non-corrosive industrial plastic activated carbon odor control canisters with fittings and dimensions indicated. The activated carbon odor control canisters shall fit inside round manholes ranging from 16" to 37" in diameter.

B. Activated carbon odor control canister shall be a type of passive odor control with no mechanical parts or energy requirements.

2.3 ACTIVATED CARBON

A. Sufficient activated carbon canisters shall be provided to fill the activated carbon odor control canister. The activated carbon shall be granular, derived from bituminous coal or equal, vapor-phase type, suitable for control of sewage treatment odors. The carbon shall have the following performance specifications:

Carbon	
Butane activity, weight %, min	15.6
Iodine number, min	800
Ash, weight %, max	7
Mean particle diameter, min	3.7 mm
Apparent density, g/cc min	0.56
Hardness number, min	97
Moisture, max, percent as packed	4
Maximum head loss at 50 fpm linear velocity, ft	1.0
H_2S breakthrough capacity, min, g H_2S removed/cc carbon	0.09

B. The carbon shall be of a type high in adsorptive capacity for odor-causing compounds.

C. Calculated adsorbed quantities of H_2S and percent of odor units per each activated carbon odor control canister shall also be provided.

D. Carbon shall be regenerated with only clean water.

PART 3 -- EXECUTION

3.1 GENERAL REQUIREMENTS

A. The CONTRACTOR shall install the activated carbon odor control canisters in strict accordance with the manufacturer's published instructions and under the guidance of the manufacturer's field representative.

3.2 WORKMANSHIP

A. **Plastic Items:** The finished laminate shall be free from visual defects such as foreign inclusions, dry spots, air bubbles, pin holes, pimples, delamination, exposed reinforcement, and runoff. The exterior surface shall be smooth, with no sharp projections. The fabricated work shall be identical in surface finish and visual defects.

- END OF SECTION -

SECTION 02557 - REINFORCED CONCRETE PIPE, PVC-LINED (ASTM C76, MODIFIED)

PART 1 -- GENERAL

1.1 THE REQUIREMENT

A. The CONTRACTOR shall provide PVC-lined reinforced concrete pipe, complete in place, in accordance with the Contract Documents.

1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. Commercial Standards

ASTM C 76	Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe
ASTM C 150	Portland Cement
ASTM C 361	Reinforced Concrete Low-Head Pressure Pipe
ASTM D 412	Test Methods for Rubber Properties in Tension
ASTM D 2240	Test Method for Rubber Property -- Durometer Hardness

1.3 CONTRACTOR SUBMITTALS

A. Furnish submittals in accordance with Section 01300 - Contractor Submittals.

B. **Manufacturer's Information:** Drawings to indicate, at relative scale, concrete thickness, reinforcement placements and joint assembly design. Submittals shall also include the pipe size, design D-load for an 0.01-inch crack and ultimate strength, cement type, concrete strength and steel areas.

C. **Certification:** A certified affidavit of compliance for all pipe and other products or materials furnished under this Section. Include results from:

1. Hydrostatic test reports of rubber gasket joints.

2. Three-edge-bearing strength (D-load) test reports.

3. PVC liner test reports.

1.4 QUALITY ASSURANCE

A. **Inspection:** Pipe shall be subject to inspection at the place of manufacture. The CONTRACTOR shall notify the ENGINEER in writing of the manufacturing starting date not less than 14 calendar days prior to the start of any phase of pipe manufacture.

B. **Material Tests:** Unless otherwise indicated, the CONTRACTOR shall be responsible for performing and paying for testing. Materials used in the manufacture of the pipe shall be tested in accordance with ASTM C 76. The ENGINEER shall have the right to witness all testing conducted by the CONTRACTOR; provided, that the CONTRACTOR's schedule will not delayed for the convenience of the ENGINEER. In addition to those tests specifically required, the ENGINEER may request additional

samples of any material for testing by the OWNER. The additional samples shall be furnished as part of the WORK.

C. Pipe Tests

1. Strength: Pipe selected by the ENGINEER shall be tested at the factory for the edge bearing strength for an 0.01-inch crack per ASTM C 497. Pipe of each diameter and D-load may be selected. The test loading may be terminated without producing an 0.01-inch crack if or when the test loading has reached 110 percent of the indicated D-load strength requirement.

2. Hydrostatic test of rubber gasket joints: Up to 6 assembled joints shall be tested at the factory if requested by the ENGINEER. Suitable bulkheads shall be installed at both ends of the test section, and the section shall be filled with water and left to acclimate for up to 2 weeks. At the beginning of the test, the hydrostatic pressure shall be increased to 5 psi, and observations shall be made after 20 minutes. No cracks shall appear, and no water shall drip off the pipe. Damp spots and water drops on the surface will not be cause for rejection.

3. For PVC-lined pipe, PVC liner sheets, joints, corner, and weld strips shall have the following physical properties when tested at 77 degrees F plus and minus 5 degrees F:

Property	Initial	Exposure
Tensile strength	2200 psi min.	2100 psi min.
Elongation at break	200 percent min.	200 percent min.
Shore Durometer, Type D	within 1 sec. 50-60 within 10 sec. 35-50	plus and minus 5(2) plus and minus 5(2)
Weight change	-----	plus and minus 1.5 percent(2)
Note: (1)For 112 days in chemical solutions listed below. (2)With respect to initial test result.		

a. Tensile and elongation specimens shall be prepared and tested in accordance with ASTM D 412 using Die B.

b. Indentation hardness test shall be in accordance with ASTM D 2240 using a Type D durometer except that a single thickness of material will be used.

c. Weight change and indentation hardness specimens shall be 1-inch by 3-inch samples of the sheet thickness.

d. Specimens may be taken from sheet and strip at any time prior to final acceptance of the WORK.

4. PVC liner sheets, joints, corner, and weld strips shall resist the following chemicals:

Chemical Solution	Concentration
Sulfuric acid	20 percent[1]
Sodium hydroxide	5 percent
Ammonium hydroxide	5 percent[1]
Nitric acid	1 percent[1]
Ferric chloride	1 percent
Soap	0.1 percent
Detergent (linear alkyl benzyl sulfonate or LAS)	0.1 percent
Bacteriological	BOD not less than 700 ppm

a. After conditioning to constant weight at 110 degrees F, test specimens shall be exposed to each of the above solutions for a period of 112 days at 77 degrees F plus and minus 5 degrees F.

b. At 28-day intervals, test specimens shall be removed from each of the chemical solutions and tested. If any specimen fails to meet the 112-day requirements before completion of the 112-day exposure, the material will be subject to rejection.

5. PVC-liner locking extensions embedded in concrete shall withstand a test pull of at least 100 pounds per linear inch, applied perpendicular to the concrete surface for a period of one minute, without rupture of the locking extensions or withdrawal from embedment. This test shall be made at a temperature of 70 to 80 degrees F, inclusive.

6. Shop-welded joints, used to fuse individual sections of PVC-liner together, shall be at least equal to the minimum requirements of the PVC-liner for thickness, corrosion resistance, and impermeability. Welds shall show no cracks or separations and shall be tested for tensile strength. Tensile strength measured across the welded joint in accordance with ASTM D 412 using Die B shall be at least 2000 psi. Test temperature shall be 77 degrees F plus and minus 5 degrees F, and the measured minimum width and thickness of the reduced section shall be used.

7. PVC-liner shall be shop-tested for holes with a spark tester set to provide from 15,000 to 20,000 volts. Sheets having holes shall be satisfactorily repaired in the shop prior to shipment from the liner manufacturer's plant. Repairs shall be made by welders qualified in accordance with the following requirements.

D. PVC-Liner Welder Qualifications:

1. Each PVC-liner welder shall pass a qualification welding test before doing any welding. Requalification may be required at any time deemed necessary by the

ENGINEER. Test welds shall be made in the presence of the ENGINEER and shall consist of the following:

a. Two pieces of liner, at least 15 inches long and 9 inches wide shall be lapped 1-1/2 inches and held in a vertical position.

b. A welding strip shall be positioned over the edge of the lap and welded to both pieces of liner. Each end of the welding strip shall extend at least 2 inches beyond the liner to provide tabs.

2. The weld specimen will be tested by the OWNER as follows:

a. Each welding strip tab, tested separately, shall be subjected to a 10-pound pull perpendicular to the face of the liner with the liner secured firmly in place. There shall be no separation between the welding strip and liner.

b. Three test specimens shall be cut from the welded sample and tested in tension across the welds. If none of these specimens fail when tested as indicated, the weld will be considered satisfactory.

c. If one specimen fails to pass the tension test, a retest will be permitted. The retest shall consist of testing three additional specimens cut from the original welded sample. If all three of the retest specimens pass the test, the weld will be considered satisfactory.

PART 2 -- PRODUCTS

2.1 GENERAL

A. PVC-lined reinforced concrete pipe shall conform to the requirements of ASTM C 76 as modified below:

1. Pipe shall be Class III, Wall "C" minimum. Walls "A" and "B" shall not be acceptable.

2. Pipe shall be fabricated by the vertically cast process which shall be wet cast, vibrated, and steam- or water-cured. Pipe manufactured by the dry cast method is unacceptable. For steam curing, the forms shall not be removed for a minimum of 6 hours. For water curing, the minimum period for removal of forms is 24 hours. Form oils or release agents shall not contain any material or substances as would penetrate or otherwise retard concrete set at the formed surface.

3. Pipe for use in single pass (direct jacked) tunnels shall be flush bell only.

2.2 MATERIALS

A. **General:** Materials shall comply with Section 6 of ASTM C 76 as modified below.

B. **Cement:** Cement used in the manufacture of reinforced concrete pipe shall be Type II in conformance with ASTM C 150.

C. **Admixtures:** No admixture shall be used unless otherwise accepted by the ENGINEER.

D. Rubber Gaskets

1. Rubber gaskets shall be solid, circular cross section natural rubber, synthetic rubber, or a combination of both. The entire gaskets shall be dense, homogenous, and free from porosity, blisters, pitting, and other imperfections.

2. Gaskets shall have the following properties:

Parameter	ASTM Test Standards	Value
Tensile strength, min., psi	D 412	2300
Elongation at break, min, percent	D 412	350
Hardness, Shore A durometer, min/max	D 2240	40/60
Compression set, max, percent	D 395	20

E. **PVC-Liner:** PVC-liner shall be **Amerplate T-Lock** as manufactured **by Ameron Protective Lining Division**, Brea, Calif., or equal. The liner shall be installed in the top 270 degrees of the pipe interior surface. Pipe used for pump station wet wells shall have liner installed for the full 360 degree pipe circumference.

1. The material used in the liner and in all joints, corners, and welding strips shall be a combination of polyvinyl chloride resin, pigments, and plasticizers, especially compounded to remain flexible. Polyvinyl chloride resin shall constitute not less than 99 percent by weight of the resin used in the formulation. Copolymer resins will not be permitted. Liner color shall be white.

2. All PVC liner sheets, including locking extensions, all joints, corners, and welding strips, shall be free of cracks, cleavages, or other defects adversely affecting the protective characteristics of the material.

3. Minimum thicknesses of sheet with integral locking extensions, plain sheet, joint strip, and weld strip shall be 0.065, 0.094, 0.075, and 0.094 inches, respectively. Locking extensions shall be approximately 2-1/2 inches apart and shall be at least 0.375 inches high.

4. Pipe lining shall be supplied as pipe-size sheets, fabricated by shop-welding the basic size sheets. Shop welds shall be made by lapping sheets a minimum of 1/2-inch and applying heat and pressure to the lap to produce a continuous welded joint.

5. Sheets shall have transverse strap channels cut in the locking extensions so that the strap can be placed into and perpendicular to the locking extensions.

6. These channels shall be not less than 3/4-inch and not more than 1-inch wide and shall be cut so that a maximum of 3/16-inch of the base of the locking extension remains in the base of the strap channel. Strap channels shall be provided at intervals of not less than 15 inches nor more than 20-inches center to center. The

strap channels will not be cut through the final two locking extensions on each edge of the sheet.

7. Transverse flaps shall be provided at the ends of sheets for pipe. Locking extensions shall be removed from flaps so that a maximum of 0.32-inch of the base of the locking extension is left on the sheet.

8. Weld strips shall be approximately 1-inch wide. The edges of weld strips shall be beveled in the manufacturing process. Thickness of weld strip shall be equivalent to that of the liner.

9. Joint strips for pipe shall be 4 inches wide. Thickness of joint strips shall be equivalent to that of the liner.

10. The liner shall be provided with periodic week channels to provide for relief of hydrostatic head due to groundwater that may accumulate behind the liner.

2.3 JOINTS

A. Joint assembly design shall be reinforced concrete bell and spigot type incorporating a fully retained rubber gasket. Pipe 36 inches and larger in diameter shall be provided with a double gasket joint with integral testing tubes at the pipe crown and invert. Provide threaded plastic plugs to seal the tubes after use.

PART 3 -- EXECUTION

3.1 PIPE LAYING

A. **Excavation:** Bell holes shall be excavated at each joint, if pipe has flared bell, to provide full length barrel support of the pipe and to prevent point loading at the bells or couplings.

B. **Fill Material or Trench Support:** Fill material or trench subgrade beneath the pipe shall be compacted in accordance with Section 02200 - Earthwork, and graded to provide a uniform and continuous support beneath the pipe at all points between the bell holes or pipe joints.

C. **Pipe Laying:** Unless otherwise required, pipe shall be laid straight between the changes in alignment and at uniform grade between changes in grade. For pipes with elliptical reinforcement, the pipe shall be placed with the minor axis of the reinforcement in a vertical position.

D. **Joints:** Pipe joints shall be handled and assembled in accordance with the following requirements:

1. Care shall be taken to avoid dragging the spigot on the ground or allowing it to be damaged by contact with gravel, crushed stone, or other hard objects.

2. Faying surfaces shall be cleaned immediately prior to jointing.

3. After the subgrade has been prepared, the rubber gasket shall be placed in the groove on the spigot, and the spigot then entered into the bell of the adjoining pipe and forced into position. Care shall be taken to avoid twisting or cutting the gasket

when jointing the pipe. The inside surface of the bell, the gasket groove and the gasket shall be lubricated immediately prior to jointing with a compound recommended by the manufacturer which will facilitate the telescoping of the joint.

4. After the pipe joint has been assembled, proper gasket placement shall be checked with a feeler gage furnished by the pipe manufacturer for such testing. Where joint placement is found to be improper, the tested pipe section shall be first removed, a new gasket installed, the joint reassembled, and the gasket placement rechecked.

3.2 PVC-LINER INSTALLATION

A. General

1. Installation of the lining, including pre-heating of sheets in cold weather and the welding of all joints, shall be done in accordance with the recommendations of the manufacturer.

2. The lining shall be installed with the locking extensions running parallel with the longitudinal axis of the pipe.

3. The lining shall be held snugly in place against inner forms by means of steel banding straps or other means recommended by the manufacturer. Banding straps must be located in the pre-cut strap channels to prevent crushing or tilting of the locking extensions.

4. If banding strips are used, a steel channel, angle, or bar may be inserted along the edge locking extension of each liner sheet for concrete pipe or cast-in-place structures. Steel channel, angle, or bar shall be of sufficient stiffness to hold the longitudinal edges of the lining snugly against the form. These may be removed after the concrete is vibrated into place.

5. Locking extensions shall terminate not more than 1-1/2-inch from the end of the inside surface of the pipe section. Joint flaps, when used, shall extend approximately 4 inches beyond the end of the inside surfaces.

6. Concrete poured against lining shall be vibrated, spaded, or compacted in a careful manner to protect the lining and produce a dense, homogenous concrete, securely anchoring the locking extensions into the concrete.

7. In removing forms, care shall be taken to protect the lining from damage. Sharp instruments shall not be used to pry forms from lined surfaces. When forms are removed, any nails that remain in the lining shall be pulled without tearing the lining, and the resulting holes clearly marked. Form tie holes shall be marked before ties are broken off and areas of serious abrasion or damage shall be marked.

8. Nail and tie holes and cut, torn, and seriously abraded areas in the lining shall be patched. Patches made entirely with welding strip shall be fused to the liner over the entire patch area. Larger patches may consist of smooth liner sheet applied over the damaged area with adhesive. Edges must be covered with welding strip fused to the patch and the sound lining adjoining the damaged area.

9. Hot joint compounds, such as coal tar, shall not be poured or applied to the lining.

10. The CONTRACTOR shall take all necessary measures to prevent damage to installed lining from equipment and materials used in or taken through the WORK.

B. Application to Concrete Pipe - Special Requirements:

1. The lining shall be set flush with the inner edge of the bell or spigot end of a pipe section and shall extend to the opposite end or to approximately 4 inches beyond the opposite end, depending upon the type of lining joint to be made with the adjoining concrete pipe.

2. Wherever concrete pipe or cast-in-place structures protected with lining join structures not so lined (such as brick structures, concrete, pipe, or cast-in-place structures with clay lining or clay pipe), the lining shall be extended over and around the end of the pipe and back into the structure for not less than 4 inches. This protecting cap may be molded or fabricated from the lining material but need not be locked into the pipe.

3. Where a pipe lateral (not of plastic-lined concrete) is installed through lined concrete pipe, the seal between the lined portion and the lateral shall be made by the method prescribed for cast-in-place structures under this Section.

4. Lined concrete pipe may be cured by standard curing methods.

5. Care shall be exercised in handling, transporting, and placing lined pipe to prevent damage to the lining. No interior hooks or slings shall be used in lifting pipe. All handling operations shall be done with an exterior sling or with a suitable forklift.

6. On pipe having a 360 degree liner coverage, the longitudinal edges of the sheet shall be butt welded.

7. No pipe with damaged lining will be accepted until and unless the damage has been repaired to the satisfaction of the ENGINEER.

C. Field Joints in Lining for Concrete Pipe

1. The joint between sections of lined pipe shall be prepared in the following manner. The inside joint shall be filled and carefully pointed with non-shrink grout in accordance with Section 03315 - Grout, in such a manner that the grout shall not, at any point, extend into the pipe beyond a straight line connecting the surfaces of the adjacent pipe sections. No lining joint shall be made until after the trench has been backfilled and consolidated. Pipe joints shall be dry before lining joints are made.

2. Grout and other foreign material shall be removed from lining surfaces adjacent to the pipe joint, leaving them clean and dry.

3. Field joints in the lining at pipe joints may be either of the following described types:

Type P-1	The joint shall be made with a separate 4-inch joint strip and two welding strips. The 4-inch joint strip shall be centered over the joint, tack-welded to the lining, then welded along each edge to adjacent liner sheets with a 1-inch weld strip. The width of the space between adjacent sheets shall not exceed 2-inches. The 4-inch joint strip shall lap over each

	sheet a minimum of 1-inch.
Type P-2	The joint shall be made with a joint flap with locking extensions removed and extending approximately 4-inches beyond the pipe end. The joint flap shall overlap the lining in the adjacent pipe section a minimum of 1-inch and be tack welded in place prior to welding. The field joint shall be completed by welding the flap to the lining of the adjacent pipe using a 1-inch welding strip. Care shall be taken to protect the flap from damage. Excessive tension and distortion in bending back the flap to expose the pipe joint during laying and joint grouting shall be avoided. The joint flap or strip on beveled pipe shall be trimmed to a width (measured from the end of the spigot) of approximately 4 inches for the entire circumferential length of the lining. Welding of joints shall be in strict conformance with the specifications and instructions of the lining manufacturer. Welding shall fuse both sheets together to provide a continuous joint equal in corrosion resistance and permeability to the liner plate. Hot-air welding guns shall provide effluent air to the sheets to be joined at a temperature between 500 and 600 degrees Fahrenheit. Welding guns shall be held approximately 1/2-inch from and moved back and forth over the junction of the two materials to be joined. The gun shall be moved slowly enough as the weld progresses to cause a small bead of molten material to be visible along both edges of the weld strip The following special requirement shall apply when the liner coverage is 360 degrees. When groundwater is encountered, the lining joint shall not be made until pumping of groundwater has been discontinued for at least three days and no visible leakage is evident at the joint.

D. Application to Cast-in-Place Concrete Structures - Special Requirements (where required)

1. Liner sheets shall be closely fitted and properly secured to the inner forms. Sheets shall be cut to fit curved and warped surfaces using a minimum number of separate pieces. If liner joints are to be Type C-3 joints as described below, the adjacent sheets shall be butted with not more than 0.125 inches opening between the sheets. A welding strip fusion-welded on the back of butt joints or other means acceptable to the ENGINEER shall be used to prevent wet concrete from flowing around the edges.

2. Unless otherwise indicated, the lining shall be returned 4 inches at the surface of contact between the concrete structure and items not of concrete (including manhole frames, gate guides, clay pipe, or brick manholes, and clay or cast-iron pipes). The same procedure shall be followed at joints where the type of protective lining is changed or the new work is built to joint existing unlined concrete. At each return, the return liner shall be sealed to the item in contact with the plastic-lined concrete using **Amerplate Adhesive System,** or equal. If the liner cannot be sealed with this adhesive because of the joint at the return being too wide or rough or because of safety regulations, the joint space shall be densely caulked with lead wool or other approved caulking material to a depth of 2 inches.

E. Joints in Lining for Cast-in-Place Concrete Structures (where required)

1. Lining at joints shall be free of all grout and other foreign material and shall be clean and dry before joints are made.

2. Field joints in the lining shall be of the following described types, used as prescribed:

Type C-1	The joint shall be made with a separate 4-inch joint strip and 2 welding strips. The 4-inch joint strip shall be centered over the joint, tack-welded to the liner, then welded along each edge to adjacent sheets with 1-inch weld strips. The width of the space between adjacent sheets shall not exceed 2-inches. The 4-inch joint strip shall lap over each sheet a minimum of 1-inch. It may be used at any transverse or longitudinal joint.
Type C-2	The joint shall be made by lapping sheets not less than 1-inch. One welding strip is required. The upstream sheet shall overlap the one downstream. The lap shall be tack-welded into place prior to welding.
Type C-3	The joint shall be made by applying one welding strip on the back of the butt joint or by some other method approved by the ENGINEER to prevent wet concrete from getting under the sheet. After the forms have been stripped, a second welding strip shall be applied over the butt joint on the face of the sheet. Welding is to be in strict conformance with the specifications of the lining manufacturer and this Section.

F. Testing and Repairing Damaged Surfaces

1. After the pipe is installed in the trench, surfaces covered with lining, including welds, shall be tested with an approved electrical hole detector (**Tinker and Rasor Model No. AP-W with power pack**) with the instrument set at 20,000 volts, minimum.

2. Welds shall be physically tested by a probing method. Patches over holes or repairs to the liner wherever damage has occurred, shall be in accordance with the requirements of this Section.

3. Each transverse welding strip which extends to a lower edge of the liner will be tested by the ENGINEER. The welding strips shall extend 2 inches below the liner to provide a tab. A 10-pound pull will be applied to each tab. The force will be applied perpendicular to the face of the structure by means of a spring balance. Liner adjoining the welding strip will be held against the concrete during application of the force. The 10-pound pull will be maintained if a weld failure develops, until no further separation occurs. Defective welds will be retested after repairs have been made. Tabs shall be trimmed away neatly by the installer of the liner after the welding strip has passed inspection. Inspection shall be made within 2 days after joint has been repaired.

- END OF SECTION -

SECTION 02565 - DUCTILE IRON PIPE (AWWA C151, MODIFIED)

PART 1 -- GENERAL

1.1 THE REQUIREMENT

A. The CONTRACTOR shall provide polyethylene lined and tape coated ductile iron pipe and appurtenant work, complete in place, in accordance with the Contract Documents.

1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. **Commercial Standards**

AWWA C104	Cement-Mortar Lining for Ductile-Iron Pipe and Fittings for Water
AWWA C110	Ductile-Iron and Gray-Iron Fittings, 3 in through 48 in for Water
AWWA C111	Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings
AWWA C115	Flanged Ductile-Iron Pipe with Ductile-Iron or Gray-Iron Threaded Flanges
AWWA C116	Protective Fusion-Bonded Epoxy Coatings for the Interior and Exterior Surfaces of Ductile-Iron and Gray-Iron Fittings for Water Supply Service.
AWWA C150	Thickness Design of Ductile-Iron Pipe
AWWA C151	Ductile-Iron Pipe, Centrifugally Cast for Water
AWWA C153	Ductile-Iron Compact Fittings. for Water Service
AWWA C209	Cold-Applied Tape Coatings for the Exterior of Special Sections, Connections, and Fittings for Steel Water Pipelines
AWWA C600	Installation of Ductile Iron Water Mains and Their Appurtenances
AWWA C606	Grooved and Shouldered Joints
ASTM C 150	Portland Cement

1.3 CONTRACTOR SUBMITTALS

A. Furnish Shop Drawings of pipe and fittings in accordance with SP-12 of the Special Provisions, the requirements of the referenced standards and the following supplemental requirements as applicable:

1. Certified dimensional drawings of all valves, fittings, and appurtenances.

2. For all pipe, line layout and marking diagrams which indicate the specific number of each fitting and the location and the direction of each fitting in the completed line. In addition, the line layouts shall include: The pipe station and invert elevation at all changes in grade or horizontal alignment; all elements of curves and bends, both in horizontal and vertical alignment; and the limits of each reach of restrained joints, or of concrete encasement.

B. **Certifications:** The CONTRACTOR shall furnish a certified affidavit of compliance for all pipe and other products or materials furnished under this Section and as specified in the referenced standards and the following supplemental requirements:

1. Physical and chemical properties.

2. Hydrostatic test reports.

C. The CONTRACTOR shall be responsible for performing and paying for sampling and testing as necessary for the certifications.

1.4 QUALITY ASSURANCE

A. **Tests:** Except as modified herein, all materials used in the manufacture of the pipe shall be tested in accordance with the requirements of the referenced standards as applicable.

B. The CONTRACTOR shall perform said material tests at no additional cost to the OWNER. The ENGINEER shall have the right to witness all testing conducted by the CONTRACTOR; provided, that the CONTRACTOR's schedule is not delayed for the convenience of the ENGINEER.

C. In addition to those tests specifically required, the ENGINEER may request additional samples of any material including lining and coating samples for testing by the OWNER. The additional samples shall be furnished as a part of the WORK.

D. **Inspection:** Pipe shall be subject to inspection at the place of manufacture in accordance with the provisions of the referenced standards, as supplemented by the requirements herein. The CONTRACTOR shall notify the ENGINEER in writing of the manufacturing starting date not less than 14 calendar days prior to the start of any phase of the pipe manufacture.

E. During the manufacture of the pipe, the ENGINEER shall be given access to all areas where manufacturing is in process and shall be permitted to make all inspections necessary to confirm compliance with the Specifications.

PART 2 -- PRODUCTS

2.1 PIPE GENERAL

A. Composite polyethylene-lined and cold-applied tape coated ductile iron pipe shall conform to AWWA C151, and C209, subject to the supplemental requirements in this Section. Composite polyethylene lining shall be American Ductile Iron Pipe PolybondPlus or approved equal, with polyethylene lining thickness as recommended by the manufacturer. The pipe shall be 8-inch inside diameter, pressure class 350, and shall be provided complete with rubber gaskets, specials, and fittings as required under the Contract Documents.

B. **Markings:** The CONTRACTOR shall legibly mark materials in accordance with the laying schedule and marking diagram. Each fitting shall be marked at each end with top field centerline.

C. **Handling and Storage:** The pipe shall be handled as a minimum at the 1/3 points by use of wide slings, padded cradles, or other devices designed and constructed to

prevent damage to the pipe coating/exterior. The use of chains, hooks, or other equipment that might injure the pipe coating/exterior will not be permitted. Stockpiled pipe shall be supported on padded skids, sand or earth berms free of rock exceeding 3 inches in diameter, sand bags, or suitable means so that the coating will not be damaged. The pipe shall not be rolled and shall be secured to prevent accidental rolling

D. **Laying Lengths:** Normal pipe laying lengths shall be 20 ft.

E. **Finish:** The pipe shall have smooth dense interior surfaces and shall be free from fractures, excessive interior surface crazing, and roughness.

F. **Bonding and Electrical Conductivity:** All pipe joints shall be bonded for electrical conductivity. The CONTRACTOR shall furnish and install all materials required for joint bonding. Joint bonds shall be exothermically welded to the pipe barrel.

G. **Closures and Correction Pieces:** Closures and correction pieces shall be provided as required so that closures may be made due to different headings in the pipe laying operation and so that correction may be made to adjust the pipe laying to conform to pipe stationing on the Drawings. The locations of correction pieces and closure assemblies are shown on the Drawings. Any change in location or number of said items shall only be as accepted by the ENGINEER.

2.2 SPECIALS AND FITTINGS

A. Fittings for ductile iron pipe shall conform to the requirements of AWWA C153 or AWWA C110 and shall have a minimum pressure rating of 350 psi. Ductile iron fittings larger than 48 inches shall conform to AWWA C153.

2.3 DESIGN OF PIPE

A. The pipe shall be designed, manufactured, tested, inspected, and marked according to AWWA C150 and C 151 except where modified by this Section.

B. **Pipe Dimensions:** The pipe shall be of the diameter and class indicated.

C. **Fitting Dimensions:** The fittings shall be of the diameter and class indicated.

D. **Joint Design:** Ductile iron pipe and fittings shall be furnished with mechanical joints, push-on joints, flanged joints, or restrained joints as required.

1. Mechanical and push-on joints shall conform to AWWA C111.

2. Flanged joints shall conform to AWWA C115. Where threaded flanges are provided, the pipe wall thickness under the cut threads shall not be less than the calculated net thickness required for the pressure class of the pipe.

3. Restrained joints shall be **"Flex-Ring"** restrained joint by **American Ductile Iron Pipe**, **"TR FLEX"** restrained joint by **U.S. Pipe**, or equal.

4. Joint restraining devices that impart point loads and/or wedging action on the pipe wall as a means of joint restraint shall not be allowed unless there are no other options for joint restraint available. Under such circumstances, the CONTRACTOR may propose such devices provided the following conditions are met and the request is made as a substitution:

a. A formal request for substitution is submitted stating the location(s) where the devices are intended to be used and a statement from the device manufacturer and the pipe manufacturer that the proposed device is appropriate for the intended installation and rated at least for the class of the pipe being supplied.

b. A statement from the pipe manufacturer is provided accepting the use of the retaining devices and indicating that the use of such devices will in no way affect the warranty of the pipe and/or the performance of the pipe.

c. The manufacturer of the device and the pipe manufacturer jointly provide instruction on the proper installation of the device to the personnel installing the units and provide certification to the OWNER that the installers are adequately trained in the installation of the units and that all warranties are in full affect for the project.

d. The devices shall be **MegaLug Model 1100** as manufactured by **EBAA Iron** or equal.

E. For bell-and-spigot ends with rubber gaskets, the clearance between the bells and spigots shall be such that when combined with the gasket groove configuration and the gasket itself, will provide watertight joints under all operating conditions when properly installed. The CONTRACTOR shall require the pipe manufacturer to submit details complete with significant dimensions and tolerances and also to submit performance data indicating that the proposed joint has performed satisfactorily under similar conditions. In the absence of a history of field performance, the results of a test program shall be submitted.

F. Pipe gaskets shall be suitable for raw sewage service.

2.4 EXTERIOR PROTECTION OF PIPE

A. **Exterior Coating of Exposed Piping:** The exterior surfaces of pipe which will be exposed to the atmosphere inside structures or above ground shall be thoroughly cleaned and then given a shop coat of rust-inhibitive primer, epoxy paint and finish, conforming to the requirements of Section 09800 – Protective Coating.

B. **Exterior Coating of Buried Piping:** The exterior coating shall be System 101 Cold Applied Tape as specified in Section 09800.

PART 3 -- EXECUTION

3.1 INSTALLATION OF PIPE

A. The CONTRACTOR shall inspect each pipe and fitting prior to installation to insure that there are no damaged portions of the pipe. Pipe damaged prior to Substantial Completion shall be repaired or replaced by the CONTRACTOR.

B. Before placement of pipe in the trench, each pipe or fitting shall be thoroughly cleaned of any foreign substance which may have collected thereon and shall be kept clean at all times thereafter. For this purpose, the openings of all pipes and fittings in the trench shall be closed during any interruption to the WORK.

C. **Pipe Laying:** The pipe shall be installed in accordance with AWWA C600.

D. Pipe shall be laid directly on the bedding material. No blocking will be permitted, and the bedding shall be such that it forms a continuous, solid bearing for the full length of the pipe. Excavations shall be made as needed to facilitate removal of handling devices after the pipe is laid. Bell holes shall be formed at the ends of the pipe to prevent point loading at the bells or couplings. Excavation shall be made as needed outside the normal trench section at field joints to permit adequate access to the joints for field connection operations and for application of coating on field joints.

E. Each section of pipe shall be laid in the order and position shown on the laying schedule. Each section shall be laid to the set line and grade, within approximately one inch plus or minus.

F. Where necessary to raise or lower the pipe due to unforeseen obstructions or other causes, the ENGINEER may change the alignment and/or the grades. Such change shall be made by the deflection of joints, by the use of bevel adapters, or by the use of additional fittings. However, in no case shall the deflection in the joint exceed 75 percent of the maximum deflection recommended by the pipe manufacturer. No joint shall be misfit any amount that will be detrimental to the strength and water tightness of the finished joint.

G. Except for short runs that may be permitted by the ENGINEER, pipes shall be laid uphill on grades exceeding 10 percent. Pipe that is laid on a downhill grade shall be blocked and held in place until sufficient support is furnished by the following pipe to prevent movement. Bends shall be properly installed as indicated.

H. **Cold Weather Protection:** No pipe shall be installed upon a foundation into which frost has penetrated or at any time that there is a danger of the formation of ice or penetration of frost at the bottom of the excavation before backfilling occurs.

I. **Pipe and Specials Protection:** The openings of all pipe and specials shall be protected with suitable bulkheads to prevent unauthorized access by persons, animals, water or any undesirable substance. At all times, means shall be provided to prevent the pipe from floating.

J. **Pipe Cleanup:** As pipe laying progresses, the CONTRACTOR shall keep the pipe interior free of all debris. The CONTRACTOR shall completely clean the interior of the pipe of all sand, dirt, mortar splatter, and any other debris following completion of pipe laying and shall perform any necessary interior repairs prior to testing and disinfecting the completed pipeline.

3.2 RUBBER GASKETED JOINTS

A. **Rubber Gasketed Joints:** Immediately before jointing pipe, the bell end of the pipe shall be thoroughly cleaned, and a clean rubber gasket shall be placed in the bell groove. The spigot end of the pipe and the inside surface of the gasket shall be carefully cleaned and lubricated. The lubricant shall be suitable for lubricating the parts of the joint for assembly and be a compound listed as in compliance with NSF Standard 61. The lubricant shall be nontoxic, shall not support the growth of bacteria, and shall have no deleterious effects on the gasket material. The spigot end of the pipe section shall then be inserted into the bell of the previously laid joint and telescoped into its proper position. Tilting of the pipe to insert the spigot into the bell will not be permitted.

3.3 DIELECTRIC COATING FOR JOINTS

A. **General:** The exterior joint recesses shall be thoroughly wiped clean and all water, loose scale, dirt, and other foreign material shall be removed from the surface of the pipe.

B. **Joint Coating of Dielectric-Coated Pipe:** Joints for dielectric-coated pipe shall be primed and wrapped with 2 thicknesses of 6-inch wide elastomeric joint tape, Type II per AWWA C209. The total thickness of the tape wrap shall be at least 70 mils and shall be installed free of wrinkles with all laps bonded. Primer and joint tape shall be compatible with the line pipe coating.

C. The ENGINEER will test all dielectric-coated joints with an electrical holiday detector capable of at least a 12,000-volt output, which shall be furnished by the CONTRACTOR. The tests will be made using a voltage of 6,000 to 7,000 volts. Every holiday shall be repaired by the CONTRACTOR at no expense to the OWNER.

D. **Coating Repair:** Coating repair shall be made using tape and primer conforming to AWWA C209. When visual inspection shows a portion of the tape-wrap system has sustained physical damage, the damaged area shall be subjected to an electrical holiday test of 6,000 to 7,000 volts.

E. **Coating of Fittings and Specials:** Coatings shall be the same as for the straight pipe.

F. **Joint Bonding:** All pipe joints shall be provided with joint bonding cables as per Paragraphs 2.1.F and 3.5.

3.4 INSTALLATION OF PIPE APPURTENANCES

A. **Protection of Appurtenances:** Where the joining pipe is dielectric-coated, buried appurtenances shall be coated in kind.

B. **Installation of Valves:** Valves shall be handled in a manner to prevent any injury or damage to any part of the valve. Joints shall be thoroughly cleaned and prepared prior to installation. The CONTRACTOR shall adjust all stem packing and operate each valve prior to installation to insure proper operation.

C. Valves shall be installed so that the valve stems are plumb and in the location indicated.

3.5 CORROSION CONTROL

A. **Joint Bonding:** Except where otherwise indicated, all buried pipe joints shall be bonded. The pipe shall be cleaned to bare bright metal at the point where the bond is installed. And the bonding cable attached with an exothermic weld.

- END OF SECTION -

SECTION 02567 - CORRUGATED METAL PIPE (AASHTO M36, MODIFIED)

PART 1 -- GENERAL

1.1 THE REQUIREMENT

A. The CONTRACTOR shall provide corrugated metal pipe (CMP) and appurtenant work, complete in place, in accordance with the Contract Documents.

B. Corrugated metal pipe shall include round pipe, pipe arch, and underdrain pipe, both corrugated steel and corrugated aluminum, coated and uncoated, with or without a paved invert, and including fittings, couplings, and related accessories.

C. This Specification Section shall be used in cases where it is necessary to remove and replace /relocate sections of existing CMP to install new project pipelines and other facilities.

1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. **Commercial Standards**:

AASHTO M36	Specification for Metallic (Zinc or Aluminum) Coated Corrugated Steel Culverts and Underdrains
AASHTO M190	Specification for Bituminous Coated Corrugated Metal Culvert Pipe and Pipe Arches
AASHTO M196	Specification for Corrugated Aluminum Alloy Culverts and Underdrains
AASHTO M243	Specification for Field-Applied Coating of Corrugated Plate for Pipe, Pipe Arches, and Arches
AASHTO M246	Specification for Precoated Galvanized Steel Sheet for Culverts and Underdrains

1.3 CONTRACTOR SUBMITTALS

A. Shop drawings and catalog data submittals shall be made in accordance with Section 01300 - Contractor Submittals.

B. A manufacturer's or fabricator's Certificate of Compliance shall be furnished stating that samples representing each lot have been tested and inspected in accordance with the Contract Documents and have been found to meet the requirements for the material described.

PART 2 -- PRODUCTS

2.1 CORRUGATED STEEL PIPE, PIPE ARCH, AND UNDERDRAIN

A. Corrugated steel pipe, pipe arch, and underdrain and coupling bands and fittings for each type, shall conform to the requirements of AASHTO M36, and shall be fabricated from either zinc-coated steel sheet or aluminum-coated steel sheet, as specified herein.

B. Zinc-coated steel sheet, if specified, shall be further coated by pressing inert mineral fibers into the molten zinc on both surfaces of the sheet and then coating the sheet with a bituminous saturant. After fabrication, fiber-bonded pipe and pipe arch shall be fully bituminous-coated in accordance with AASHTO M190. Fabricated pipe and pipe arches shall be free from blisters, unsaturated spots, cracks in the bonding, unbonded areas and other defects.

2.2 CORRUGATED ALUMINUM PIPE, PIPE ARCH, AND UNDERDRAIN

A. Corrugated aluminum pipe, pipe arch, underdrain and coupling bands and fittings for each type, shall conform to the requirements of AASHTO M196 and the Contract Documents.

2.3 COATINGS

A. Coatings shall be applied to one or both pipe surfaces, as specified herein. Any appearance of pinholes, blisters, cracks, or lack of bond shall be cause for rejection.

B. Hot-applied bituminous coating shall be applied to both interior and exterior surfaces and shall conform to the requirements of AASHTO M190, Type A. Minimum coating thickness shall be 0.05 inches.

C. Cold-applied asphalt mastic coating shall conform to the requirements of AASHTO M243, except that asbestos fiber shall not be used. Minimum coating thickness shall be 0.05 inches.

D. Polymeric coating shall conform to the requirements of AASHTO M246 and may be plant-applied after pipe fabrication. Minimum coating thickness shall be 0.010 inches.

2.4 LININGS

A. Linings shall be applied to the interior of the pipe so as to produce a smooth surface.

B. Hot-applied bituminous linings shall conform to the requirements of AASHTO M190, Type D. Minimum lining thickness shall be 1/8-inch over the crest of the inside corrugations.

C. Concrete linings shall be plant-applied to produce a homogeneous, nonsegregated smooth lining with a minimum thickness of 1/8-inch over the crest of the inside corrugations.

2.5 PAVED INVERT

A. Paving material shall cover at least 25 percent of the periphery of round pipe and 40 percent of the periphery of pipe arches.

B. Hot-applied bituminous paving shall conform to the requirements of AASHTO M190, Type C.

C. Concrete paving shall be pumped concrete or pneumatically-placed concrete with a 28-day compressive strength of 3,000 psi. The concrete shall be placed to the thickness specified after the pipe has been backfilled.

2.6 UNDERDRAINS

A. The pipe for underdrains shall be of the full-circle type, and perforations in the pipe may be drilled or punched. Sleeve-type couplings may be substituted for band couplers. The couplings may be either plastic or galvanized steel, suitable for holding the pipe firmly in alignment without the use of sealing compounds or gaskets.

2.7 REQUIREMENTS

A. Corrugated metal pipe shall match the existing CMP with respect to type of pipe, pipe material, size, wall thickness, corrugation, type of coating, type of lining, and type of paved invert.

PART 3 – EXECUTION

3.1 INSTALLATION

A. Pipeline trench excavation shall be in accordance with the requirements of Section 02200 - Earthwork, including the situation where pipelines are to be installed in embankment or structure fills.

B. Pipe bedding shall be in accordance with the requirements of Section 02200 - Earthwork, and shall have a thickness of 8 inches under the pipe, unless otherwise shown.

C. All pipe shall be transported, stored, and handled with care. It shall not be rolled or dragged over gravel or rock, and during placement, shall be prevented from striking rock or other hard objects. Special care shall be taken in handling and placing coated pipe to avoid damaging the coating.

D. Pipe laying shall begin at the downstream end of the line and proceed upstream. Pipe shall be laid carefully and true to line and grade. Pipe shall be placed with longitudinal seams at the sides and with outside laps of circumferential joints upgrade.

E. Pipe sections shall be laid in the trench with a maximum spacing between sections of 1-1/2 inches. Connecting bands shall be placed with clamping angles and bolts at top of the pipe. The pipe coupling corrugations or projections shall properly engage the pipe sections before bolts are tightened. Care shall be taken to ensure that dirt or other particles do not get between the outside of the pipe and the coupling. For watertight joints, the band and gasket material shall be placed in accordance with the manufacturer's recommendations.

F. Aluminum pipe and aluminized steel pipe shall not be in contact with reinforcing steel or structural steel members. Where aluminum pipe and aluminized steel pipe are to be embedded in concrete, or where concrete or slurry backfill is required, the pipe shall be coated with asphalt mastic.

G. Paved inverts shall be placed and centered on the bottom of the trench. Any damage to the protective lining and coating shall be repaired prior to the backfilling around the pipe.

H. Pipe trench backfill shall be in accordance with the requirements of Section 02200 - Earthwork. Particular care shall be taken to assure that specified compaction is attained under the haunches of the pipe.

- END OF SECTION -

SECTION 02586 - FIBERGLASS REINFORCED POLYESTER MORTAR PIPE (ASTM D 3262, MODIFIED)

PART 1 -- GENERAL

1.1 WORK OF THIS SECTION

A. The WORK of this Section includes providing centrifugally cast fiberglass-reinforced polyester mortar-type pipe, complete, for carrier pipe grouted inside a primary-lined tunnel.

B. These Specifications apply to FRP mortar pipe to be used for the construction of sanitary sewer and by the microtunneling method.

1.2 STANDARD SPECIFICATIONS

A. Except as otherwise indicated in this Section of the Specifications, the CONTRACTOR shall comply with the latest adopted edition of the Standard Specifications, as described in the Special Provisions.

1.3 SPECIFICATIONS AND STANDARDS

A. Except as other wise indicated, the current editions of the following apply to the WORK of this Section:

ASTM D 2412	Standard Test Method for Determination of External Loading Characteristics of Plastic Pipe by Parallel Plate Loading
ASTM D 3262	"Fiberglass" (Glass Fiber Reinforced Thermosetting Resin) Sewer Pipe
ASTM D 3681	Standard Test Method for Chemical Resistance of Reinforced Thermosetting Resin Pipe in a Deflected Condition
ASTM D 4161	"Fiberglass" (Glass Fiber Reinforced Thermosetting Resin) Pipe Joints Using Flexible Elastomeric Seals
ASTM F 477	Elastomeric Seals (Gaskets) for Joining Plastic Pipe

1.4 SHOP DRAWINGS AND SAMPLES

A. The following shall be submitted in compliance with Section 01300.

1. Product data including details, size, thickness, and length of pipe, joints, gasket, and grout bushings.

2. Material properties and strength of pipe and gaskets.

3. Manufacturer's certification that the proposed piping system, including internal resin liner and gasket material are appropriate for the intended service.

4. Pipe design analysis: If computer calculations are used, include example calculations to show the logic employed.

5. Manufacturer's written instructions for handling transporting, storage, and installation of pipe.

6. Test Reports: Submit reports from tests in accordance with ASTM D 3262, ASTM D 3681, and ASTM D 4161.

1.5 FACTORY INSPECTION AND TESTING

A. All pipe shall be subject to inspection at the place of manufacture. The CONTRACTOR shall notify the ENGINEER in writing of the manufacturing start date not less than 7 days prior to the start of manufacture.

B. **Testing:** Manufacturer shall furnish results from qualification tests of:

1. Pipe of the same dimensions and composition, in accordance with ASTM D 3262.

2. Joints of the same size and type, in accordance with ASTM D 4161.

1.6 FIELD TESTING

A. Field testing shall conform to the requirements of Section 01655 .

PART 2 -- PRODUCTS

2.1 MATERIALS

A. **Resin Systems:** The manufacturer shall use only polyester resin systems with a proven history of satisfactory performance in the intended application for this project. The historical data shall be collected from applications of a composite material of similar construction and composition as the proposed product.

B. **Glass Reinforcements:** The reinforcing glass fibers used to manufacture the pipe and fittings shall be of highest quality commercial grade glass filaments with binder and sizing compatible with impregnating resins.

C. **Fillers:** Sand shall be minimum 98 percent silica, kiln dried and graded.

D. **Additives:** Resin additives, such as pigments, dyes, and other coloring agents, if used, shall in no way be detrimental to the performance of the product nor impair visual inspection of the finished products.

E. **Rubber Gaskets:** Gaskets shall be in accordance with ASTM F 477 and be suitable for the service intended. Gaskets shall either be affixed to the pipe by means of a suitable adhesive or shall be installed in such a manner so as to prevent the gasket from rolling out of the pre-cut groove.

F. The internal liner resin shall be suitable for sewer pipe service and shall be highly resistant to exposure to sulfuric acid as produced by biological activity from hydrogen sulfide gases. Pipe shall meet or exceed requirements of ASTM D 3681.

2.2 PRODUCTS

A. Pipe and Fittings

1. Pipe and fittings shall conform to ASTM D 3262 for gravity service, and shall be manufactured by a centrifugal casting process.

2. Diameters: Unless indicated otherwise, the nominal size and actual outside diameter of the pipes shall be in accordance with Table 3 of ASTM D 3262.

3. Pipe shall be supplied in nominal lengths in accordance with ASTM 3262 1.55 inches.

4. Wall Thickness: The minimum wall thickness shall be the greater of (1) or (2) the thickness required to satisfy the maximum allowable jacking load as recommended by the pipe manufacturer with a minimum safety factor shall be 2.5. The minimum thickness at any single point shall not be less than 90 percent of the minimum thickness. Walls shall not have stiffening ribs or rings.

5. End Squareness: Pipe ends shall be square to the pipe axis.

6. Stiffness class of gravity pipe shall satisfy design requirements, but shall not be less than 36 psi when tested in accordance with ASTM D 2412. Stiffness class in a jacking operation shall be as required by jacking method and shall satisfy design requirements.

7. Grout bushings shall be installed at the factory.

B. **Joints:** Joints shall be sleeve couplings meeting the requirements of ASTM D 4161 and as appropriate for jacking operations. Elastomeric gaskets shall be the sole means of achieving watertightness.

2.3 PIPE MANUFACTURER, or Equal

A. **Hobas Pipe USA, Inc.**

PART 3 – EXECUTION

3.1 DELIVERY, STORAGE, AND HANDLING

A. **Handling and Storage:** All pipe handling and storage shall be in strict accordance with the pipe manufacturer's recommendations.

3.2 INSTALLATION OF PIPE

A. **Transport to Position:** Pipe shall be transported from storage to position in the jacking pit according to the pipe manufacturer's recommendations to avoid damage.

B. Pipe shall be placed on guides with spigot end first.

C. Jacking forces shall be applied evenly to the pipe wall end, not the integral straight bell or sleeve. Pushing forces shall not exceed the manufacturer's recommendations with a jacking load safety factor of 3.0.

D. Any pipe damaged during handling and storage or by transport or jacking operations shall be repaired according to the manufacturer's recommendation or removed from the Site and replaced at the ENGINEER's option. The CONSTRUCTION MANAGER'S decision regarding rejection shall be final. Rejected pipe shall be clearly and indelibly marked to prevent confusion with pipe in subsequent shipments.

3.3 GROUTING

A. **Lubrication/Grouting Ports.** Each pipe shall be provided with lubrication/grouting ports to enable lubricating and/or grouting the annular space outside of the pipe. Ports shall include leak tight threaded plastic plugs for installation upon completion.

- END OF SECTION -

SECTION 02587 – POLYMER CONCRETE PIPE

PART 1 -- GENERAL

1.1 THE REQUIREMENT

A. The CONTRACTOR shall construct all polymer concrete sewer pipelines complete, including connection to existing and new structures, all in accordance with the Contract Documents. The size of the polymer concrete pipe to be furnished shall be as shown on the plans.

B. These Specifications apply to Polymer Concrete pipe to be used for the construction of gravity sanitary sewer and related structures by the microtunneling/jacking method

1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. **Commercial Standards**

ASTM D4161	"Fiberglass" (glass-fiber-reinforced thermosetting-resin) pipe joints using flexible elastomeric seals.
ASTM D6783	Standard specification for polymer concrete pipe.
ASTM F477	Specification for elastomeric seals (gaskets) for joining plastic pipe.

1.3 CONTRACTOR SUBMITTALS

A. The CONTRACTOR shall furnish Submittals in accordance with Section 01300 including certificates to the ENGINEER guaranteeing that the pipe furnished hereunder is in compliance with the requirements of these Specifications.

1.4 QUALITY ASSURANCE

A. Inspection: Pipe shall be subject to inspection at the place of manufacture. The CONTRACTOR shall notify the ENGINEER in writing of the manufacturing starting date not less than 14 calendar days prior to the start of any phase of pipe manufacture.

PART 2 -- PRODUCTS

2.1 PIPE MATERIALS

A. All pipes, joints, and fittings shall be manufactured in accordance with D6783 and associated ASTM standards. A minimum allowable compressive strength of 10,000 psi is required for pipe to be used for microtunneling, however CONTRACTOR shall be solely responsible for determination of compressive strength required for its microtunneling operation.

B. Pipe strength shall be designed to withstand a D-Load of 1100 lb/ft/ft using a factor of safety of 1.25.

C. Materials and manufacturer shall be in accordance with ASTM D6783. Elastomeric sealing gaskets shall conform to the requirements of ASTM F477.

D. Minimum Wall Thickness and Allowable Jacking Loads for Jacking Pipe: The minimum pipe wall thickness shall be as needed to support the anticipated jacking forces with a safety factor of 3 at the joints. The allowable jacking forces for the pipe shall be as determined by the CONTRACTOR for the geotechnical conditions presented in the Geotechnical Report.

E. Tolerances: Tolerances for pipe diameter, length, straightness, roundness and squareness of ends, shall be in accordance with ASTM D6783.

F. Diameter. The pipe shall have a nominal inside diameter as shown on the plans or indicated in the Specifications.

G. Joints. Joints shall be field connected and shall consist of a seat, an elastomeric sealing element, a sleeve, and a compression ring.

1. Seat. The seat is either a formed or ground recess on the pipe ends.

2. Elastomeric sealing element. The elastomeric sealing element is an elastomeric gasket whose configuration and location may vary with pipe diameter and will provide a water tight joint at allowed deflection angles and after compression from tunneling operations.

3. Sleeve. The sleeve is an element which bridges between pipe sections. The sleeve shall be made of fiberglass or titanium alloy which in conjunction with the sealing element forms a joint which meets the performance requirements of ASTM D4161. Composite sleeve shall be corrosion resistive in continuous service with a pH of 1 to 10. Sleeves shall be flush to outside diameter of the pipe.

4. Compression Disc. The compression disc is a flat disc that conforms to the remaining ends of the pipe after the joint is formed. Its purpose is to distribute the jacking forces developed during pipeline installation. The width of the compression disc shall not exceed the maximum wall thickness of the pipe at the joint, nor shall it extend into the flow line or inhibit the installation of the sleeve into the spigot end of the connecting pipe. Compression discs shall be factory fabricated and installed.

H. Marking. Each pipe section shall be marked by both ends inside and outside to identify the manufacturer, manufacturer number (identifies factory location, date of manufacture, shift, and sequence), nominal diameter, D load, ASTM number and designation, and lot number.

I. Pipe Acceptance or Rejection. The pipe shall be free of cracks, holes, delaminations, foreign inclusions, blisters, or other defect that would, due to their nature, degree, or extent, have a deleterious effect on the pipe performance as determined by the ENGINEER. Prior to installation, damaged pipe shall be either repaired or field cut to remove the damaged portion as approved by the ENGINEER. For testing purposes, a production lot shall consist of all pipe having the same lot marking number, but shall not exceed a total of 50 pipes. Pipe length, wall thickness, joint dimensions and D load shall be verified by inspection and testing for each lot.

J. Lubrication/Grouting Ports. Each pipe shall be provided with lubrication/grouting ports to enable lubricating and/or grouting the annular space outside of the pipe. Ports shall include leak tight threaded plastic plugs for installation upon completion.

PART 3 -- EXECUTION

3.1 INSTALLATION

A. When pipe is installed using microtunneling equipment, pipe shall be installed in compliance with the provisions of Section 02345 – Microtunneling.

B. Pipe installed by open cut trench method shall be installed in accordance with the manufacturer's recommendations and as specified and shown.

- END OF SECTION -

SECTION 02593 – POLYBUTYLENE PIPE

WATER SERVICE REPLACEMENT

PART 1 -- GENERAL

1.1 THE REQUIREMENT

A. The CONTRACTOR will encounter ¾" to 2" diameter water services during construction of the new pipelines. Existing water services may be made of copper, galvanized steel, polyvinyl chloride (PVC), high density polyethylene (HDPE) and polybutylene (PB) pipe. The CONTRACTOR shall replace all water services encountered made of PB pipe. The water service shall be replaced from the water main to the water meter box as shown in the Contract Drawings water service details and specified herein. The work shall include all labor, equipment and materials to remove and dispose of the existing service, to replace the service completely and restore the site to its original condition or better.

B. Services located on the opposite side of the water main from the new pipeline trench will not be encountered during trenching work and shall not be replaced.

C. The CONTRACTOR shall replace any missing or damaged components on PB services so that they conform to the water service details. This includes, but is not limited to corporation stops, saddle tees, piping, meter stops, tracer wires and meter boxes shown in the contract drawings and these specifications. The new water service shall be tested and disinfected prior to placing it into service. All of the foregoing shall be performed for the unit price established in the bid schedule, regardless of service diameter.

D. For other types of services (copper, steel, polyethelene, PVC, HDPE, etc.) which shall remain in service, the CONTRACTOR may excavate beneath the water services without an interruption of service, or, the CONTRACTOR may temporarily remove a section of the water service piping to install the new pipeline. If the water service piping is removed or damaged during the construction process the CONTRACTOR shall restore the service per the details in the Contract Drawings and these specifications. Water service piping shall be restored using approved couplings, only. The restored water service shall be tested and disinfected prior to placing it back into service. There shall be no additional compensation for restoring or replacing water services that are not PB.

E. The CONTRACTOR shall provide all piping systems indicated, complete as specified and shown.

1.2 CONTRACTOR SUBMITTALS

A. General: Submittals shall be furnished in accordance with Section 1300 – Submittals.

B. Shop Drawings: Shop Drawings shall contain the following information:

1. Drawings: Layout drawings including all necessary dimensions, details, pipe joints, fittings, specials, bolts and nuts, gaskets, valves, appurtenances, anchors, guides, and material lists. Fabrication drawings shall indicate all spacers, adapters, connectors, fittings, and pipe supports to accommodate the equipment and valves in a complete and functional system.

2. Pipe and Pipe Joints: Submit manufacturer's certification confirming that the recommended products are suitable for potable water service application. Provide details of solvent or heat fusion process.

3. Gasket Material: Submit gasket manufacturer's catalog indicating that the recommended product is suitable for potable water service application.

C. Samples and Testing: Performing and paying for sampling and testing as necessary for certifications are the CONTRACTOR'S responsibility.

D. Certifications

1. All necessary certificates, test reports, and affidavits of compliance shall be obtained by the CONTRACTOR.

2. A certification from the pipe fabricator that all pipes will be manufactured subject to the fabricator's or a recognized Quality Control Program. An outline of the program shall be submitted to the ENGINEER for review prior to the manufacture of any pipe.

PART 2 -- PRODUCTS

2.1 GENERAL

A. Extent of Work: Pipes, fittings, and appurtenances shall be provided in accordance with Division 2 specifications and as indicated. Materials in contact with potable water shall be listed as compliant with NSF Standard 61.

B. Pressure Rating: Piping systems shall be designed for 100 psi operating pressure and 150 psi test pressure.

C. Inspection: Pipe shall be subject to inspection at the place of manufacture. In lieu of inspection the ENGINEER may accept certified testing reports prepared by a qualified independent testing firm and submitted by the manufacturer.

D. Tests: Except where otherwise indicated, materials used in the manufacture of the pipe shall be tested in accordance with NSF, AWWA and ASTM and other applicable specifications and standards.

2.2 MATERIALS

A. The completed water service installation shall include all materials shown in the Contract Drawings water service details. The CONTRACTOR may re-use existing materials that are in good working condition; see Paragraph 1.1.C.

B. 1-inch diameter water services shall be constructed of 1" high density polyethylene pipe only; 2-inch diameter water services shall be constructed of polyvinyl chloride pipe only.

C. A 10 gauge tracer wire shall be installed along the length of each service. If one does not exist, the CONTRACTOR shall install one from the main to the meter box.

D. The meter box shall be placed on a concrete slab base 1" x 12". In unpaved areas the meter box shall be raised 1" above the finished surface.

PART 3 -- EXECUTION

3.1 WATER SYSTEM SHUTDOWN AND CUSTOMER CARE

A. The CONTRACTOR shall not suspend any water service without permission from the ENGINEER. The CONTRACTOR shall submit a System Outage Request form to the ENGINEER a minimum of 2 weeks in advance of shutting off any water main or service.

B. The CONTRACTOR is hereby advised that existing valves within the water distribution system may not provide complete water flow shutoff. In addition, a water valve may or may not be present near the work location. The CONTRACTOR shall plan and conduct it's work accordingly.

C. The CONTRACTOR is also hereby advised that a corporation stop may or may not exist at the water main. The CONTRACTOR shall plan and conduct it's work accordingly. If there is no existing corporation stop, the CONTRACTOR shall provide and install a new corporation stop on the new service.

D. The CONTRACTOR shall provide each user 48-hours written notice (through use of a door hanger, also see Section 01566 Public Information Program and Services) before suspending any water service. The CONTRACTOR shall also contact each user personally 1 hour prior to suspending service.

E. No water service shall be suspended for more than 4 hours. If any water service is unable to be restored within 4 hours, the Contractor shall provide bottled water for each occupant of the residence at a rate of 1/2 gallon per person per hour.

3.2 MATERIAL DELIVERY, STORAGE, AND PROTECTION

A. Piping materials, fittings, valves, and accessories shall be delivered in a clean and undamaged condition and stored off the ground for protection against oxidation caused by ground contact. Defective or damaged materials shall be replaced with new materials.

3.3 WATER SERVICE INSTALLATION

A. Piping, fittings, and appurtenances shall be installed in accordance with the requirements of applicable Sections of Division 2 and Division 15. Care shall be taken to insure that piping flanges, mechanical-type couplings, sleeve-type couplings, flexible connectors, and expansion joints are properly installed.

3.4 TESTING & DISINFECTION

A. All new water system piping and components shall be tested for leakage and disinfection. The CONTRACTOR shall make provisions to prevent backflushing and contamination of the existing water system.

B. Water service tests shall be performed prior to backfilling the trench. The CONTRACTOR shall submit a testing and disinfection plan to the ENGINEER for approval prior to beginning the work.

C. All air shall be removed from the service prior to starting the test. The leakage test shall be performed at 150 psi for a minimum duration of 10 minutes. There shall be no leakage during the test period.

D. Any leaking equipment or defective materials shall be immediately replaced, then the system shall be retested.

E. The trench shall be backfilled and compacted and the pavement restored in accordance with Division 2 requirements and as shown.

- END OF SECTION -

SECTION 02594S – LARGE POLYETHYLENE PRESSURE PIPE (AWWA C906, MODIFIED)

PART 1 -- GENERAL

1.1 THE REQUIREMENT

A. The CONTRACTOR shall provide high density polyethylene pressure pipe, complete and in place, all in accordance with the Contract Documents.

B. **Scope:** Requirements for high density polyethylene water transmission and distribution pipe in sizes 4-inch to 54-inch joined by means of zero leak-rate butt fusion, and mechanical joints, meeting the specifications and requirements of AWWA C 906.

1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. Commercial Standards:

ANSI/AWWA C 906	High Density Polyethylene (HDPE) Pressure Pipe and Fittings
ASTM D 3350	Polyethylene Plastics Pipe and Fittings Materials

1.3 CONTRACTOR SU8MITTALS

A. **Shop Drawings:** The CONTRACTOR shall submit shop drawings of pipe, fittings, and appurtenances in accordance with Section 01300- Contractor Submittals.

B. **Certifications:** The CONTRACTOR shall furnish a certified affidavit of compliance for all pipe and other products or materials furnished under this Section of the Specifications:

1. Material certifications.
2. Hydrostatic proof test reports.
3. Sustained pressure test reports.
4. Burst strength test reports.

C. All expenses incurred in making samples for certification of tests shall be borne by the CONTRACTOR.

1.4 QUALITY ASSURANCE

A. **Inspection:** All pipe shall be subject to inspection at the place of manufacture in accordance with the provisions of the referenced standards as supplemented by the requirements herein. The CONTRACTOR shall notify the ENGINEER in writing of the manufacturing starting date not less than 14 calendar days prior to the start of any phase of the pipe manufacture.

B. During the manufacture of the pipe, the ENGINEER shall be given access to all areas where manufacturing is in process and shall be permitted to make all inspections necessary to confirm compliance with the Specifications.

C. **Tests:** Except as modified herein, materials used in the manufacture of the pipe shall be tested in accordance with the requirements of this Section of the Specifications, as specified in the referenced standards, as applicable.

D. The CONTRACTOR shall perform said material tests in accordance with the requirements of the Contract Documents. The ENGINEER shall have the right to witness all testing conducted by the CONTRACTOR, provided that the CONTRACTOR'S schedule is not delayed for the convenience of the ENGINEER.

E. In addition to those tests specifically required, the ENGINEER may request additional samples of any material for testing by the CONTRACTOR. The additional samples shall be furnished as part of the WORK.

PART 2 -- PRODUCTS

2.1 GENERAL

A. **Materials:** The high density polyethylene pipe and fittings shall be made from prime virgin resins exhibiting a cell classification of PE 345444C as defined in ASTM D 3350 with an established hydrostatic-design basis of 1600 psi for water at 73 degrees F. The resin shall be listed by the PPI (Plastic Pipe Institute) in its pipe-grade registry Technical Report (TR) 4, "Listing of Plastic Pipe Compounds.

B. **Pipe and Fittings:** Pipe OD sizes 4-inch to 24-inch shall be available both in steel pipe sizes (IPS) and ductile iron pipe sizes (DIPS). Pipe OD sizes 26-inch to 54-inch OD shall be available in steel pipe sizes. **The CONTRACTOR shall note that the pipe sizes shown on the Contract drawings are for the pipe <u>internal diameter</u> hence the CONTRACTOR shall select the corresponding outer diameter necessary to provide same.** All pipes shall be suitable for use as a fluid pressure conduit. The net pressure capability shall be 160 psi, DR 11.0. Laying lengths shall be 40 ft standard. The pipe shall be joined by heat fusion, flanges or other proven and accepted mechanical joint system for HDPE pipe as shown on the Drawings. Both pipe and fittings shall be NSF listed by the manufacturer and bear the "NSF-pw" logo or mark.

C. **Marking:** Pipe and fittings shall be marked as prescribed by AWWA C906 and NSF. Pipe markings shall include nominal size, OD base (ie: 12-inch ductile iron pipe sizing, DIPS), dimension ratio, pressure class, AWWA C906, manufacturer's name, manufacturer's production code including day, month, year extruded, and manufacturer's plant and extrusion line, and NSF- pw logo.

D. **Testing:** Each manufacturer shall have an approved in-house QA/QC program providing compliance to the testing specifications and requirements of AWWA Standard C906 for both pipe and fittings.

PART 3 -- EXECUTION

3.1 GENERAL

A. All laying, jointing, and testing for defects and for leakage shall be performed in the presence of the ENGINEER, and shall be subject to approval before acceptance. All material found to be defective will be rejected and the CONTRACTOR shall promptly remove such materials from the Site.

B. Installation shall conform to the requirements of AWWA M23, instructions furnished by the pipe manufacturer, and to the supplementary requirements or modifications herein. Wherever the provisions of this Section and the aforementioned requirements are in conflict, the more stringent provision shall apply.

3.2 HANDLING AND STORAGE

A. **Handling:** Pipe, fittings, and accessories shall be carefully inspected before and after installation and those found defective shall be rejected. Pipe and fittings shall be free from fins and burrs. Before being placed in position, pipe, fittings, and accessories shall be cleaned, and shall be maintained in a clean condition. Proper facilities shall be provided for lowering sections of pipe into trenches. Under no circumstances shall pipe, fittings, or any other material be dropped or dumped into trenches.

B. **Storage:** Pipe shall be stored, if possible, at the Site in unit packages provided by the manufacturer. Caution should be exercised to avoid compression damage or deformation to bell ends of the pipe. Pipe shall be stored in such a way as to prevent sagging or bending and protected from exposure to direct sunlight by covering with an opaque material while permitting adequate air circulation above and around the pipe. Gaskets shall be stored in a cool, dark place out of the direct rays of the sun, preferably in original cartons.

3.3 TRENCHING AND BACKFILL

A. Trench excavation and backfill shall conform to the requirements of Section 02200 - Earthwork, and as specified herein.

3.4 JOINING

A. Prior to installation of any pipe, the manufacturer shall provide training in the recommended butt fusion and saddle fusion procedures, testing procedures, and any other installation methods required by the WORK. Training shall include the CONTRACTOR's installation personnel, an OWNER's representative, the ENGINEER's representative, and any other personnel chosen by the OWNER. Thee CONTRACTOR shall record the names of trained personnel.

B. On every day that butt fusion joints are to be made, the first fusion of the day shall be a test. The test fusion shall be allowed to cool completely, then fusion test straps shall be cut out. Test strap length shall be 12-inches (min) or 30 times the wall thickness with the fused area in the center and width shall be 1-inch (min) or 1.5 times the wall thickness. The CONTRACTOR shall bend the test strap until the ends of the strap touch. If the test strap fails at the joint, the CONTRACTOR shall perform a new test to be cooled completely and bent as before. The CONTRACTOR shall not commence installation of pipe until a test fusion has passed the bent strap test.

3.5 INSTALLATION

A. Pipe shall be graded in straight lines, taking care to avoid the formation of any dips or low points. Pipe shall not be laid when the conditions of trench or weather are unsuitable. At the end of each days work, open ends of pipe shall be closed temporarily with wood blocks or bulkheads.

B. Pipe shall be supported at its proper elevation and grade, care being taken to secure firm and uniform support. Wood support blocking will not be permitted. The full length of

each section of pipe and fittings shall rest solidly on the pipe bed, with recessed excavation to accommodate bells, joints and couplings. Anchors and supports shall be provided where necessary and where indicated on the drawings for fastening work into place. Fittings shall be independently supported.

C. **The CONTRACTOR shall exercise care in installing the pipe to allow for/accommodate thermal expansion and contraction including when connecting to other pipelines or structures. Allow the pipe to reach equilibrium temperature/relax before completing connections.**

D. Joints shall be installed according to manufacturer's recommendations. The CONTRACTOR shall provide fused on HDPE flange with Type 316 stainless steel backup flange for connections to other pipe materials or mechanical piping. Provide HDPE weep ring at connections to structures.

E. Pipe shall only be cut by manufacturer recommended method which will produce a clean, square cut suitable for butt-fusion.

3.6 FIELD TESTING

A. Field testing shall conform to the requirements of Section 01656 – Pressure Pipeline Testing.

- END OF SECTION -

SECTION 02595 - SMALL PVC NONPRESSURE PIPE, RUBBER JOINTS (ASTM D 3034, MODIFIED)

PART 1 -- GENERAL

1.1 THE REQUIREMENT

A. The CONTRACTOR shall provide PVC solid wall nonpressure pipe and appurtenant work for gravity sanitary sewer service, complete and in place, in accordance with the Contract Documents.

B. This Section covers pipe from 4- to 15-inches diameter nominal size.

1.2 CONTRACTOR SUBMITTALS

A. Submittals shall be in accordance with Section 01300 - Contractor Submittals.

B. **Shop Drawings:** The CONTRACTOR shall submit Shop Drawings including details of pipe, joints, bends, special fittings, and piping appurtenances.

C. **Certificates:** The CONTRACTOR shall submit manufacturer's certificate that pipe conforms to these specifications.

PART 2 -- PRODUCTS

2.1 GENERAL

A. Pipe shall be continuously and permanently marked with the manufacturer's name, pipe size, and minimum pipe stiffness in psi.

B. The CONTRACTOR shall also require the manufacturer to mark the date of extrusion on the pipe. This dating shall be done in conjunction with records to be held by the manufacturer for 2 years, covering quality control tests, raw material batch number, and other information deemed necessary by the manufacturer.

2.2 PIPE

A. Pipe shall conform to the requirements of ASTM D 3034 - Type PSM Poly (Vinyl Chloride) (PVC) Sewer Pipe and Fittings, SDR [35]. Material for PVC pipe shall conform to the requirements of ASTM D 1784 - Rigid Poly (Vinyl Chloride) (PVC) Compounds and Chlorinated Poly (Vinyl Chloride) (CPVC) Compounds, for cell classification 12454-B or 12454-C as defined therein. The manufacturer shall test a sample from each batch according to ASTM D 2444 - Test Method for Impact Resistance of Thermoplastic Pipe and Fittings by Means of a Tup (Falling Weight).

B. Joints shall conform to ASTM D 3212 - Joints for Drain and Sewer Plastic Pipe Using Flexible Elastomeric Seals. Elastomeric seals for compression type joints shall conform to the requirements of ASTM F 477 - Elastomeric Seals (Gaskets) for Joining Plastic Pipe or ASTM F 913 - Thermoplastic Elastomeric Seals (Gaskets) for Joining Plastic Pipe.

2.3 FITTINGS

A. All fittings shall conform to the requirements of ASTM D 3034. The ring groove and gasket ring shall be compatible with PVC pipe ends. The flanged fittings shall be compatible with cast-iron or ductile iron pipe fittings.

B. The stiffness of the fittings shall be not less than the stiffness of adjoining pipe.

2.4 BEDDING MATERIAL

A. Unless otherwise indicated, material used for pipe bedding shall conform to Section 02200 - Earthwork.

PART 3 – EXECUTION

3.1 TRENCHING AND BACKFILL

A. Trench excavation and backfill shall conform to the requirements of Section 02200 - Earthwork and the Drawings.

3.2 LAYING PIPE

A. Pipe shall be installed in accordance with the requirements of ASTM D 2321 - Standard Practice for Underground Installation of Thermoplastic Pipe for Sewers and Other Gravity-Flow Applications and as indicated. Pipe sections shall be closely jointed to form a smooth flow line. Immediately before placing each section of pipe in final position for jointings, the bedding for the pipe shall be checked for firmness and uniformity of slope.

B. Bell holes shall be provided and the pipe bedding shall be hand shovel sliced under the pipe haunches to ensure absence of voids.

C. The CONTRACTOR shall exercise care in compacting pipe zone bedding to ensure proper side support for the pipe and passing deflection tests.

D. Handling

1. Handling of the PVC pipe shall be done with implements, tools, and facilities as recommended by the pipe manufacturer to insure that the pipe is not damaged in any manner during storage, transit, loading, unloading, and installation.

2. Pipe shall be inspected both prior to and after installation in the ditch and all defective lengths shall be rejected and immediately removed from the working area.

3. Fittings shall be lowered into trench by means of rope, cable, chain, or other means without damage. Cable, rope, or other devices used for lowering fitting into trench, shall be attached around exterior of fitting for handling. Under no circumstances shall the cable, rope, or other device be attached through the fitting interior for handling or shall pipe or fittings be dropped or dumped into the trench.

E. Cutting and machining of the pipe shall be accomplished in accordance with the pipe manufacturer's standard procedures. Pipe shall not be cut with a cold chisel, standard

iron pipe cutter, or any other method that may fracture the pipe or will produce ragged, uneven edges.

F. All foreign matter or dirt shall be removed from the interior of the pipe before lowering into position in the trench. Pipe shall be kept clean during and after laying. All openings in the pipeline shall be closed with watertight expandable type sewer plugs or PVC test plugs at the end of each day's operation or whenever the pipe openings are left unattended. The use of burlap, wood, or other similar temporary plugs will not be permitted.

G. Adequate protection and maintenance of all underground and surface utility structures, drains, sewers, and other obstructions encountered in the progress of the WORK shall be the CONTRACTOR's responsibility.

H. Where the grade or alignment of the pipe is obstructed by existing utility structures such as conduits, ducts, pipes, branch connections to main sewers, or main drains, the obstruction shall be permanently supported, relocated, removed, or reconstructed by the CONTRACTOR in cooperation with owners of such utility structures. Unless otherwise indicated, protection of existing utility structures shall be the CONTRACTOR's responsibility.

3.3 FIELD JOINTING

A. Each pipe compression type joint shall be joined with a lock-in rubber ring and a ring groove that is designed to resist displacement during pipe insertion.

B. The ring and the ring seat inside the bell shall be wiped clean before the gasket is inserted. A thin film of lubricant shall be applied to the exposed surface of the ring and to the outside of the clean pipe end. Lubricant other than that furnished with the pipe shall not be used. The end of the pipe shall be then forced into the ring to complete the joint.

C. The pipe shall not be deflected either vertically or horizontally in excess of the printed recommendations of the manufacturer of the coupling.

D. Fittings shall be carefully connected to pipe, and joint shall be checked to insure a sound and proper joint.

E. When pipe laying is not in progress, the open ends of the pipe shall be closed to prevent trench water from entering pipe. Adequate backfill shall be deposited on pipe to prevent floating of pipe. Any pipe that has floated shall be removed from the trench, cleaned, and relaid in an acceptable manner. No pipe shall be laid when, in the opinion of the ENGINEER, the trench conditions or weather are unsuitable.

F. When using a trench box or shield the CONTRACTOR shall exercise care not to disjoint or misalign the installed pipeline when advancing the trench box or shield.

3.4 TESTING

A. Field testing of gravity sewer pipe shall consist of deflection and leakage testing and shall conform to the requirements of Section 01655 - Gravity Pipeline Testing.

- END OF SECTION -

SECTION 02597 - PVC PRESSURE PIPE, RUBBER JOINTS (AWWA C900, MODIFIED)

PART 1 -- GENERAL

1.1 THE REQUIREMENT

A. The CONTRACTOR shall provide polyvinyl chloride (PVC) pressure pipe, complete in place, in accordance with the Contract Documents.

1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. Commercial Standards

ANSI/AWWA C104/A21.5	Cement-Mortar Lining for Ductile-Iron Pipe and Fittings for Water
ANSI/AWWA C110/A21.10	Ductile-Iron and Gray-Iron Fittings 3-in Through 48-in for Water and Other Liquids
ANSI/AWWA C111/A21.11	Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings
ANSI/AWWA C600	Installation of Ductile-Iron Water Mains and Appurtenances
ANSI/AWWA C900	Polyvinyl Chloride (PVC) Pressure Pipe 4-in Through 12-in for Water Distribution
ASTM D 2584	Test Method for Ignition Loss of Cured Reinforced Resins
PPI Technical Report TR 3/4	Policies and Procedures for Developing Recommended Hydrostatic Design Stresses for Thermoplastic Pipe Materials
AWWA Manual M23	PVC Pipe - Design and Installation

1.3 CONTRACTOR SUBMITTALS

A. Furnish submittals in accordance with Section 01300 - Contractor Submittals.

B. **Shop Drawings:** Drawings of pipe, fittings, and appurtenances. Design calculations to demonstrate compliance of pipe and fittings with this Section. Manufacturer's literature for metallic locating tape.

C. **Certifications:** A certified affidavit of compliance for pipe and other products or materials under this Section and the following supplemental requirements:

1. Hydrostatic proof test reports.

2. Sustained pressure test reports.

3. Burst strength test reports.

D. The CONTRACTOR shall be responsible for performing and paying for sampling and testing as necessary for the certifications.

1.4 QUALITY ASSURANCE

A. **Inspection:** Pipe shall be subject to inspection at the place of manufacture. The CONTRACTOR shall notify the ENGINEER in writing of the manufacturing starting date not less than 14 calendar days prior to the start of any phase of the pipe manufacture.

B. During manufacture of the pipe, the ENGINEER shall be given access to all areas where manufacturing is in process and shall be permitted to make all inspections necessary to confirm compliance with the Specifications.

C. **Tests:** Materials used in manufacture of the pipe shall be tested in accordance with the requirements of this Section and the referenced standards, as applicable.

D. The CONTRACTOR shall perform said material tests. The ENGINEER shall have the right to witness testing; provided, that the CONTRACTOR'S schedule is not delayed for the convenience of the ENGINEER.

E. In addition to those tests specifically required, the ENGINEER may request additional samples of any material for testing by the DISTIRCT. The additional samples shall be furnished as a part of the WORK.

PART 2 -- PRODUCTS

2.1 GENERAL

A. PVC pressure pipe (4-inch through 12-inch) shall conform to the applicable requirements of ANSI/AWWA C900 subject to additional requirements herein.

2.2 PIPE DESIGN CRITERIA

A. **General:** PVC pressure pipe shall be designed in accordance with the requirements of Appendix A of ANSI/AWWA C900, as applicable, and the supplemental requirements in this Section. Minimum pressure class shall be 150.

B. **Pipe Wall Thickness for Internal Pressure:** The pipe shall be designed with a minimum thickness (t) or dimension ratio (DR) in accordance with paragraph A.3 of the above referenced Appendix A.

C. **Determination of External Loads:** Instead of the equations in paragraph A.4 of the above referenced Appendix A, the dead (earth) loads shall be computed using the following 2 equations for trench or embankment conditions as applicable:

1. Trench Condition:

$$W_d = C_d w B_d^2$$

Where: W_d = Earth load in pounds per linear foot
C_d = Calculation coefficient

Ku'	=	0.13
w	=	130 lb/ft^3
B_d	=	Trench width at top of pipe, feet

2. Positive Projecting Embankment Condition:

$$W_c = C_c w B_c^2$$

Where:	W_c	=	Earth load in pounds per linear foot
	C_c	=	Calculation coefficient (based on $r_{sd}P$ of 0.75)
	Ku	=	0.19
	w	=	130 lb/ft^3
	B_c	=	Outside diameter of pipe, feet

D. Instead of the equations in paragraph A.4, the truck live loads shall be determined using the method recommended by AASHTO in "Standard Specifications for Highway Bridges." For depths of cover less than 10 feet HS-20 live loads shall be added to the earth loads to determine the total load. For depths of cover 3 feet or less, HS-20 live load plus impact shall be included.

E. **Deflection Control:** With reference to paragraph A.5, the deflection of the pipe after installation shall not exceed 0.05 times the inside diameter. If the calculated deflection exceeds 0.05 times the outside diameter the pipe class shall be increased or the quality of the pipe zone backfill shall be improved to achieve a higher modulus of soil reaction, E'. For purposes of calculation, values of E' shall be 1,000 psi with depth of cover of 3 to f feet; 1,500 psi with depth of cover between 5 and 10 feet and 1,500 psi + 100 psi x (Depth of cover below 10 feet).

2.3 PIPE

A. The pipe shall be of the diameter and pressure class indicated, shall be furnished complete with rubber gaskets, and all specials and fittings shall be provided as required in the Contract Documents. The dimensions and pressure classes for Dimension Ratios for large PVC pressure pipe with Cast-Iron Pipe Equivalent O.D.'s shall conform to the requirements of AWWA C900.

B. **Additives and Fillers:** Unless otherwise allowed in alternate qualification procedures of PPI-TR3, compounds which have a Hydrostatic Design Basis (HDB) of 4000 psi at 73.4 degrees F and for water shall not contain additives and fillers that exceed the recommended values in Table 1, Part Y of PPI-TR3 (e.g., allowable content range for calcium carbonate is 0.0-5.0 parts per hundred of resin). If requested by the ENGINEER, the additive and filler content shall be determined using the pyrolysis method as specified in ASTM D 2584.

C. **Joints:** Joints for the buried PVC pipe shall be either an integral bell manufactured on the pipe or a separate coupling both employing a rubber ring joint. The bell and coupling shall be the same thickness as of the pipe barrel, or greater thickness. The sealing ring groove in the coupling shall be of the same design as the groove in cast iron fittings and valves available from local water works supply distributors.

D. **Joint Restraint:** Provide restrained joints at all pipeline angle points and deflections and as shown. Joint restraints shall be as follows:

1. Fully restrain all bell joints using JCM "Sur-Grip Model 420", EDBA Iron "Series 1500" or approved equal.

2. Fully restrain all mechanical joints using JCM "Model 610 Sur-Grip Fitting Restrainer", EBBR Iron "Series 2000 PV" or approved equal.

E. **Joint Deflection:** Deflection at the joint shall not exceed 1.5 degrees or the maximum deflection recommended by the manufacturer. No deflection of the joint shall be allowed for joints that are over-belled or not belled to the stop mark.

2.4 PIPE DESIGN SCHEDULE

Pipe Designation or Pipe Class	Nominal Diameter (in)	Maximum Sustained Pressure, P_w (psi)	Cover Range (feet)	Trench Condition Outside Diam+(ft)	Minimum Compaction (percent)
100-5	4	100	5	OD+2	90
200-10	12	200	5-10	Embank	90

2.5 FITTINGS

A. Fittings shall be ductile iron and shall conform to the requirements of AWWA C110, Class 250. PVC pipe fittings shall be mechanical joint.

B. All fittings shall be lined and coated in accordance with the requirements of Section 09800 - Protective Coating.

C. Each fitting shall be clearly labeled to identify its size and pressure class.

PART 3 -- EXECUTION

3.1 GENERAL

A. Laying, jointing, testing for defects and for leakage shall be performed in the presence of the ENGINEER, and shall be subject to approval before acceptance. Material found to have defects will be rejected and the CONTRACTOR shall promptly remove such defective materials from the Site.

B. Installation shall conform to the requirements of AWWA M23, instructions furnished by the pipe manufacturer, and to the supplementary requirements herein. Wherever the provisions of this Section and the aforementioned requirements are in conflict, the more stringent provision shall apply.

3.2 HANDLING AND STORAGE

A. **Handling:** Pipe, fittings and accessories shall be carefully inspected before and after installation and those found defective shall be rejected. Pipe and fittings shall be free from fins and burrs. Before being placed in position, pipe, fittings, and accessories shall

be cleaned, and shall be maintained in a clean condition. Proper facilities shall be provided for lowering sections of pipe into trenches. Under no circumstances shall pipe, fittings or any other material be dropped or dumped into trenches.

B. **Storage:** Pipe should be stored, if possible, at the Site in unit packages provided by the manufacturer. Caution should be exercised to avoid compression damage or deformation to bell ends of the pipe. Pipe should be stored in such a way as to prevent sagging or bending and be protected from exposure to direct sunlight by covering with an opaque material while permitting adequate air circulation above and around the pipe. Gaskets should be stored in a cool, dark place out of the direct rays of the sun, preferably in original cartons.

3.3 TRENCHING AND BACKFILL

A. Trench excavation and backfill shall conform to the requirements of Section 02200 - Earthwork.

3.4 INSTALLATION

A. Bell-and-spigot pipe shall be laid with the bell end pointing in the direction of laying. Pipe shall be graded in straight lines, taking care to avoid the formation of any dips or low points. Pipe shall not be laid when the conditions of trench or weather are unsuitable. At the end of each day's work, open ends of pipe shall be closed temporarily with wood blocks or bulkheads.

B. Pipe shall be supported at its proper elevation and grade, care being taken to secure firm and uniform support. Wood support blocking will not be permitted. The full length of each section of pipe and fittings shall rest solidly on the pipe bed, with recessed excavation to accommodate bells, joints, and couplings. Anchors and supports shall be provided where indicated and where necessary for fastening work into place. Fittings shall be independently supported.

C. Short lengths of pipe shall be used in and out of each rigid joint or rigid structure. Piping that does not allow sufficient space for proper installation of jointing material shall be replaced by one of proper dimensions. Blocking or wedging between bells and spigots will not be permitted.

D. Joints shall be installed according to manufacturer's recommendations. Trenches shall be kept free of water until joints have been properly made. The maximum combined deflection at any coupling shall be in accordance with the manufacturer's recommendations.

E. Pipe shall be cut by means of saws, power driven abrasive wheels, or pipe cutters, which will produce a square cut. No wedge-type roller cutters will be permitted. After cutting, the end of the pipe shall be beveled using a beveling tool, portable type sander, or abrasive disc.

3.5 INSTALLATION OF COPPER WIRE

A. Polyvinyl chloride pipelines shall be provided with No. 10 AWG bare copper wire laid along the top of the pipe and held in place with ties or hitches of the same kind of wire spaced not more than 13-feet apart.

3.6 SERVICE CONNECTIONS

A. **Service Connections:** Direct tapping will not be permitted. Double strap bronze service clamps shall be used for all service connections. Service clamps shall have a bearing area of sufficient width along the axis of the pipe, so that the pipe will not be distorted when the saddle is made tight. An internal shell cutter shall be used to drill through the corporation stop to minimize PVC shavings, retain the coupon, and reduce stress. Single fluted shell cutters or twist drills are not acceptable. Lubricate the cutting and tapping edges of the tool with cutting lubricant. Make the cuts slowly and use the follower very lightly - do not force cutter through pipe wall. Shell cutter shall have sufficient throat depth to handle the heavy wall PVC pipe. Maximum outlet size permitted with service clamps or saddle is 2-inches.

B. Tapping sleeves and valves shall be used for all outlet sizes greater than 2-inches in diameter. Tapping sleeves shall be assembled and installed in accordance with the manufacturer's recommendations.

3.7 CONNECTIONS TO EXISTING WATERLINES

A. The CONTRACTOR shall locate all underground improvements and install the pipelines to the depths indicated. Where the new work is to be connected to existing pipelines, the CONTRACTOR shall make its arrangements with the serving utility well in advance of the connections, to allow adequate time for dewatering of the existing line, if necessary, and shall expedite the work to minimize water outages to the users. Where sections of existing distribution mains are taken permanently out of service and abandoned in place, the cut ends shall be plugged solid with concrete to a depth of not less than one pipe diameter.

3.8 FIELD TESTING AND DISINFECTION

A. Field testing and disinfection and water mains shall conform to the requirements of Section 1656 - Pressure Pipe Testing.

- END OF SECTION -

SECTION 02630 – MONITORING WELLS

PART 1 – GENERAL

1.1 THE REQUIREMENT

A. **General:** The CONTRACTOR shall construct monitoring wells at the sites shown in the Contract Drawings. Monitoring wells shall be completed with 2-inch diameter PVC casing and screen to the total depth as specified, complete and operable, all in accordance with the requirements of these Contract Documents. This technical specification applies to the construction and testing of wells for monitoring ground water levels at Effluent Disposal Sites (EDS). The purpose of this specification is to document the level of effort expected from the drilling contractor. This specification does not, through omission, excuse the contractor from complying with any laws, rules, and regulations, or standards governing the work being performed.

B. Scope of Work: The work includes furnishing all labor, materials, transportation, tools, supplies, equipment, and appurtenances necessary for the complete and satisfactory construction, and testing, of ground water monitoring wells. Monitoring wells for this project differ only in their depth, as noted below. The design is as follows:

Well Design – EDS Monitoring Wells

Drilling Sites:	West Side: Broderson Site (five cluster wells)
	East Side: 14th, 15th, 16th, and 17th (four wells)
Total Well Depth:	West Side: 40 feet
	East Side: Varies (35 to 90 feet)
Final borehole size:	West Side: 10-inch diameter
	East Side: 8-inch diameter
Completion:	West Side: five cluster wells (three completions per borehole)
	Piezometer A -Wellhead to 11 feet depth blank casing. 11 to 14 feet depth screen with end cap.
	Piezometer B -Wellhead to 24 feet depth blank casing. 24 to 27 feet depth screen with end cap.
	Piezometer C -Wellhead to 37 feet depth blank casing. 37 to 40 feet depth screen with end cap.
	East Side:
	14th Street: Wellhead to 50 feet depth blank casing. 50 to 60 feet depth screen with end cap.
	15th Street: Wellhead to 25 feet depth blank casing.

		25 to 35 feet depth screen with end cap.
	16th Street:	Wellhead to 80 feet depth blank casing. 80 to 90 feet depth screen with end cap.
	17th Street:	Wellhead to 25 feet depth blank casing. 25 to 35 feet depth screen with end cap.
Blank Casing:	2-inch PVC (Schedule 40) water well casing.	
Screen:	2-inch PVC (Schedule 40) with high-density perforations, 0.020-inch slots.	
Gravel Pack:	RMC Lapis Luster #3 sand (8x 20), or approved equal.	
Sanitary Seal:	West Side: Hydrated bentonite chip seal between piezometer screens and 1-2 feet above upper screen. Cement-bentonite grout from 10 feet depth to surface.	
East Side:	2- to 3-foot hydrated bentonite chip seal above filter pack (filter pack brought 2 feet above screen). Cement-bentonite grout from top of chip seal to well box vault.	
Wellhead:	10-inch/8-inch (West Side/Ease Side) traffic-rated well box set in cement, minimum 6" thick and 3' x 3' square (site-specific slope and finish per ENGINEER). Locking well plugs.	
Rig Development:	West Side:	None (dry wells)
	East Side:	Bail (as needed; budget 1 hour)
Cuttings:	West Side:	Spread on-site
	East Side:	Removed from site by CONTRACTOR.

C. **Surveyed Location:** Where specified the CONTRACTOR shall employ the services of a surveyor licensed by the State of California to provide vertical and horizontal locations for well sites.

D. **Well Depths:** The exact depths and lengths for boreholes, casings, and screens will be determined by the ENGINEER on the basis of lithologic logs and geologic sample collection throughout drilling.

E. **Sound Mitigation:** The CONTRACTOR shall provide sound proofing mufflers on equipment, and take whatever other steps necessary during drilling, pumping, and all other work incidental thereto to ensure that noise levels conform to any San Luis Obispo County noise ordinances.

F. **Public Hazard:** The CONTRACTOR shall take necessary measures to limit unauthorized access to drilling sites and minimize public hazards.

G. **Qualified Work Crew:** The WORK shall be performed by a licensed California water well Contractor with equipment which is adequate to complete all phases of well construction. If the CONTRACTOR equipment is not capable of satisfactorily

performing the work provided for in theses specifications, the CONTRACTOR at his own expense shall substitute equipment satisfactory to the ENGINEER.

H. **Permits, Laws, and Standards:** All WORK shall conform with and be completed in full conformance with the FEDP rules and regulations for water wells, or this Specification whichever is greater or more restrictive. T he CONTRACTOR is responsible for obtaining a well application permit prior to drilling and for filing a Well Completion Report at the conclusion of the project. The CONTRACTOR shall comply with all federal, state, or local laws, ordinances, rules and regulations, and standards relating to the performance of work, including the California Water Well Standards (Dept. of Water Resources Bulletins 74-81 and 74-90).

1.2 REFERENCE SPECIFICATIONS, CODES AND STANDARDS

A. **Commercial Standards:**

ASTM D 1785	Standard Specification for Poly Vinyl Chloride (PVC) Plastic Pipe Schedules 40, 80 and 120
ASTM C 150	Specification for Portland Cement
AWWA A 100	Standard for Water Wells
ASTM F 480	Thermoplastic Well Casing Pipe and Couplings Made in SDR, Sch 40 and Sch 80

1.3 CONTRACTOR SUBMITTALS

A. **General:** All CONTRACTOR submittals shall conform to the applicable requirements of the appropriate sections of the Contract Documents and supplementary requirements as specified.

B. **Equipment List:** The CONTRACTOR shall submit a list of equipment proposed for use on the project which shall include manufacturer's load capacities, horsepower, year of manufacture and year of purchase by the present OWNER.

C. **Geologic Samples:** The CONTRACTOR shall collect, label, and store in a protected place near the work site, 2 sets of representative samples of all geological formations encountered during drilling operations. Each sample set shall be clearly labeled to indicate well number, date, time, and the exact depth from which the sample was taken. One set of samples shall be submitted to the ENGINEER upon the completion of drilling operations at the well.

1. During test hole drilling, the CONTRACTOR shall provide the on-site ENGINEER with downhole soil samples. The sampling interval will be every 5 feet beginning at 5 feet depth through the total well depth. The samples collected on odd-foot intervals (5, 15, 25, etc.) will be with a 2-inch O.D. standard penetrometer test (SPT) split spoon sampler, unlined. Samples collected on even-foot intervals (10, 20, 30, etc.) will be with a 3-inch O.D. modified California split spoon sampler, lined with brass sleeves. One brass sleeve per sample will be archived by the ENGINEER.

D. **Drilling Log:** A log of the formations encountered from the surface to the total depth of the well showing each change in formation shall be prepared during drilling operations by the CONTRACTOR. The drilling log shall be available for inspection at all times and one copy shall be submitted to the ENGINEER upon well completion.

E. **Laboratory Report:** The CONTRACTOR shall provide for the analysis of EPA Method 524 parameters in the sample collected from the well sites and shall deliver 2 copies of the laboratory report to the ENGINEER within two weeks following sample collection.

F. **Daily Report:** The CONTRACTOR shall prepare a daily report of all construction activities. One copy of each daily report shall be submitted to the ENGINEER at the close of construction activities each day. These daily reports shall contain dates and weather conditions, borehole numbers, tasks undertaken during the work day, and the times of beginning and ending the tasks, beginning and ending depths of the boreholes, the names of all employees of the CONTRACTOR who were present on the site on each day, and a log of pay items, as outlined in the Bid Schedule, completed during each day.

G. **Gravel Envelope Sample**: The CONTRACTOR shall submit one sample of the materials proposed for use in the gravel envelope prior to placement in the annular space of the well.

1. Gravel Pack: RMC Lapis Luster #3 sand (8x 20), or approved equal.

H. **Final Description:** Final well descriptions shall include the following information: total depth and diameter of borehole; diameter, wall thickness, depth and length of casings and screens installed; type, aperture, and pattern of screen slots; borehole diameters; depths and thickness' of annular seals; graduation of gravel envelope; quantity of gravel initially installed and quantity of gravel added during development activities; quantity of material removed during development operations; and all other pertinent details. The CONTRACTOR shall submit 2 copies of the final description to the ENGINEER.

I. **Surveying:** The CONTRACTOR shall provide 4 copies to the ENGINEER of all surveyed information, to include the initial and final vertical elevations and horizontal locations for the well sites and the final vertical elevations and horizontal locations for Well Sites.

J. **Records Required by Law:** The CONTRACTOR shall maintain all records required by governmental agencies having jurisdiction, and shall submit such records to them as may b e required. Two copies of each record shall be furnished to the ENGINEER.

K. **Drilling Waste Disposal:** The CONTRACTOR shall provide ENGINEER with written notification of the proposed location of drilling waste disposal at the preconstruction conference.

Cuttings:	West Side:	Spread on-site
	East Side:	Removed from site by CONTRACTOR

1.4 QUALITY ASSURANCE

A. **Sand Production:** Sand production during well development shall be recorded on well development records. Well development shall continue until discharge is free from particulate matter and turbidity as judged acceptable by the ENGINEER.

B. **Rejection and Remedy:** The borehole shall be maintained in a condition suitable for well construction and changes in borehole condition shall be remedied immediately or the borehole will be deemed unacceptable and shall be abandoned and a new borehole constructed at the CONTRACTOR's expense.

C. **Maintenance and Open Borehole:** The CONTRACTOR will maintain the straightness of the borehole and prevent sloughing or collapse. If well construction cannot be completed due to the condition of the borehole, the CONTRACTOR shall clean and condition the borehole at his expense. Standby charges incurred during the cleaning of the borehole shall be the CONTRACTOR's responsibility.

D. **Surveying:** Survey information submitted by the CONTRACTOR will be rejected unless it is signed and sealed by a surveyor licensed in the State of California.

1.5 MATERIALS, DELIVERY, STORAGE AND PROTECTION OF MATERIALS

A. **General:** The CONTRACTOR's equipment shall be clean and free from contamination, well maintained, and in good operating condition when delivered to the site and during the entire operation.

1. The equipment shall be of adequate size, strength, horsepower, and capacity to complete the project and shall be of the type successfully utilized for the construction of similar or larger wells within the last 2 years.

2. All equipment shall be provided with safety devices as required by governmental authorities having jurisdiction.

B. **Equipment Use:** Drilling and setting of casing shall be done with the same equipment and no resetting of equipment will be allowed after the hole is drilled until after gravel placement has been completed.

1.6 MOBILIZATION AND OPERATING REQUIREMENTS

A. **Mobilization:** The CONTRACTOR shall mobilize its equipment and personnel to effectively commence its drilling operations within the time limit specified by the Contract Documents. Any improvements necessary for access should be identified by the contractor during the initial site inspection. The CONTRACTOR is responsible for ensuring that site access is satisfactory prior to mobilizing equipment on-site. Arranging for, obtaining, and transporting water for drilling shall be the contractor's responsibility.

B. **Operating Requirements:** All equipment shall be carefully maintained during the CONTRACTOR's operations period and any damage to the well or surrounding property and/or facilities of any nature due to the CONTRACTOR's operations shall be repaired or replaced.

C. **Hours of Operation:** The CONTRACTOR shall perform the WORK specified in the Contract Documents during daylight hours, Monday through Friday, unless otherwise authorized by the ENGINEER.

D. **Noise Control Barriers:** The CONTRACTOR shall furnish, install, and maintain noise control barriers when required by County and local ordinances at the site and shall remove the barriers upon completion of the WORK.

E. **Access to the Well:** At certain intervals, for the purposes of gathering samples and data, the ENGINEER shall require access to the well in close proximity to the drill rig during drilling. The CONTRACTOR shall assist the ENGINEER by providing safe conditions for the collection of information and samples during drilling operations.

F. **Repeat Work:** All work required to be repeated, resulting from the CONTRACTOR's performance, including all additional materials, labor and equipment required, shall be furnished at the expense of the CONTRACTOR and no claim for additional compensation shall be made or be allowed therefore, except as specifically provided herein.

G. **OWNER Notice to Proceed:** If information indicates that completion of a well at the well site is warranted, the OWNER and/or ENGINEER shall instruct the CONTRACTOR to proceed with construction of the well.

H. **Remedial Work:** If remedial work on the well becomes necessary to satisfactorily complete the well as required by the specifications because of accident, loss of tools, defective material, or for any other cause, the CONTRACTOR shall propose a method, in writing, of correction the problem. Suggested remedial methods shall be reviewed and approved by the ENGINEER before work proceeds. Remedial work will be performed at the CONTRACTOR's expense and shall not be grounds for extending the length of the Contract.

I. **Discharge of Development Water:** The CONTRACTOR shall provide all facilities, equipment, and materials necessary for the proper discharge of water during well development. The discharge system shall be designated to the satisfaction of the ENGINEER and so that no erosion results from the discharge. The CONTRACTOR is responsible for conformance to local and State discharge regulations as applicable.

1.7 FINAL CLEANUP

A. **General:** The CONTRACTOR shall thoroughly clean the site after completion of its operations and prior to acceptance of the WORK. All excess drilling fluids, gravel, debris, and other materials utilized during the construction shall be removed and disposed of by the CONTRACTOR and the disposal location and method shall be acceptable to the ENGINEER. Mud sumps and other work excavations shall be filled, compacted, and graded, and the site shall be returned to a condition better or equal to the condition existing prior to the commencement of work. Fill brought to the location and installed in accordance with these specifications shall be graded and smoothed after completion of operations at that location. The specified sites shall be filled and graded to the final grade elevation indicated on the Drawings.

B. **Disposal of Drilling Fluids:** The CONTRACTOR shall provide all facilities equipment and materials necessary for the proper disposal of excess drilling fluids off site to the satisfaction of the ENGINEER.

C. **Equipment Removal:** The CONTRACTOR shall promptly remove its equipment, temporary facilities, and materials, and leave the site immediately following he completion of construction activities.

1.8 ABANDONMENT

A. **Site Abandonment:** If information indicates that the completion of a well at any well site is not warranted, the OWNER reserves the right to terminate all further work at the site. In such an event, the CONTRACTOR will be paid the value of its work completed to that time cased on the unit prices indicated in the bid schedule.

B. **Contractor Abandonment:** Any borehole in which the CONTRATOR voluntarily stops work and/or fails to complete in a satisfactory manner because of loss of tools, casing collapse, casing deformation, or for other causes shall be considered abandoned. The CONTRATOR shall abandon the hole at his own cost and no payment will be made by the OWNER for the abandoned well.

C. **Borehole Abandonment:** If the CONTRACTOR stops work at the request of the OWNER prior to completion of any monitoring well, the CONTRACTOR shall plug the well by filling the borehole with cement grout, and abandon the well in accordance with applicable local, state and federal laws. In the event that the CONTRACTOR is instructed by the OWNER to abandon the well, the CONTRACTOR will be paid the value of its WORK completed to that time, based on the unit prices indicated in the Bid Schedule.

PART 2 -- PRODUCTS

2.1 SCREEN, CASING, AND APPURTENANCES

A. **Temporary Conductor Casing:** The CONTRACTOR may find it necessary to install a temporary conductor casing in order to stabilize the upper portion of the borehole. The CONTRACTOR shall determine the diameter, length and type of conductor casing required. The length of the conductor casing shall not exceed 20 feet without prior approval of the ENGINEER. The conductor casing, if installed, shall be removed prior to well completion. Use of such temporary conductor casing shall not constitute a basis for additional claims for payment.

B. **Blank Well Casing:** The monitoring well casing shall be 2-inch diameter, Schedule 40 PVC waterwell casing with flush treaded ends, conforming to ASTM F 480. Well casing installation shall begin as soon as possible after the borehole is terminated.

1. All casing material delivered to the site will be new. All sections of casing will be threaded for well construction. The well casing and screens will be placed in the correct position and depth or an alternate acceptable to the ENGINEER. The well casing will be suspended from the top and allowed to hang freely in the borehole at all times during well construction.

C. **Well Screen:** The monitoring well screen shall be 0.020 slot, machine slotted, 2-inch diameter Schedule 40 PVC well screen as specified in ASTM D 185. The screen(s) shall be 5 feet in length and shall be attached at the base of the riser pipe by a threaded connector. The base of the screen shall be fitted with a threaded PVC cap.

2.2 DRILLING FLUID

A. **General:** The drilling material used for well construction by the rotary method shall be high-grade clays in common drilling usage approved by the ENGINEER. The drilling fluid shall possess such characteristics as are required to adequately condition the walls

of the hole to prevent caving of the walls as drilling progresses, and to permit recovery of representative samples of cuttings. The CONTRACTOR shall maintain complete control over drilling fluid characteristics during the entire operation of well construction.

B. **Water Source:** Only potable water from a source acceptable to the ENGIENER shall be used in drilling fluids whether employed alone or in combination with drilling additives. Potable water for use in drilling fluids may be obtained from the water distribution system. Any other drilling additives to be used will require acceptance by the ENGINEER.

C. **Holding Tanks:** The CONTRACTOR shall provide holding tanks for handling the drilling fluid. The CONTRACTOR shall provide adequate protection for the public at all times. Upon completion of the drilling activities, drilling mud and cuttings from the well shall be removed from the site and disposed of in accordance with state and county regulations by the CONTRACTOR. The ground surface shall be restored to its original condition or better.

D. **De-Sanding:** The CONTRACTOR shall provide de-sanding units of sufficient size to effectively separate sediment of sand size or greater from the drilling fluid prior to recirculation into the borehole during drilling.

2.3 WATER SAMPLE

A. **General:** The CONTRACTOR shall provide a clean, non-turbid water sample for laboratory analysis from the completed well at well sites.

2.4 FILTER PACK

A. **General:** The annular space around the screen shall be filled with a filter pack material to a depth 5 feet higher than the top of the screen. This filter pack material shall consist of well rounded, water-worn 8-20 silica sand, washed clean of silt, dirt and foreign matter. A dispersive agent shall be washed into the well annular space with the gravel pack through a tremie pipe. Hexametaphosphate or sodium polyphosphate solution approved by the ENGINEER shall be used. A fine sand cap shall be placed on top of the filter pack.

B. The filter pack will consist of clean, mostly rounded to sub-rounded silica sand, graded to the specifications listed in the Scope of Work. If the filter pack does not come in scaled, factory-labeled bags, a recent sieve analysis of the pack must be provided. The on-site geologist has the right to reject a filter pack if the bags are not sealed and labeled per the specification, or if the sieve analysis is unsatisfactory. The pack may also be rejected if the grains are mostly angular to highly angular, or if the sand has more than a trace of impurities, especially of calcium carbonate (such as shell fragments). The filter pack shall be protected from contamination during storage.

C. The rate of sand placement shall not exceed 1.5 feet per minute, and placement of gravel shall proceed without interruption until completion. A weighted tape shall be used to monitor sand placement and ensure no bridging. The filter pack will terminate approximately 2 feet above the top of the screen.

2.5 CEMENT

A. **Well Pad:** Cement used for well pad construction shall be standard brand Portland cement conforming to ASTM C 150 for Type II or Type V.

B. **Casing Sealing Material:** Material used in sealing of the casing shall consist of a neat cement ground using Type II Portland cement conforming to ASTM C 150. Neat-cement ground shall contain not more than 5.2 gallons of water per 94 lb sack of cement. Grout materials shall be in conformance with Chapter 40E-3 F.A.C.

1. **Additives:** Additives may be mixed with the sealing material to speed setting time or to expand the material. They shall not exceed the following:

a. 2 percent, be weight, calcium chloride; and

b. not more than 4 percent by weight, bentonite.

2.6 WELL HEAD

A. **General:** Each of the monitoring wells constructed shall be completed inside painted manholes set to ground level.

B. **Manhole:** The well head shall be completed inside a 12-inch diameter by 12-inch deep manhole the top of which is to be flush with ground level. The manhole shall be equipped with a 12-inch diameter lockable lid. The manhole lid shall be prime coated then finish coated with a rust resistant white epoxy paint. Two 1-1/2-inch diameter drain holes shall be cut in the manholes at approximately 10 inches down from the top. The drain holes shall be permanently covered with a wire mesh.

2.7 FILL MATERIAL

A. Fill material shall be suitable to the site ENGINEER and should be composed of selected or processed clean, fine earth, or sand, free from grass, roots, brush, or other vegetation.

PART 3 -- EXECUTION

3.1 GENERAL

A. **Site Locations:** The CONTRACTOR will locate the well sites using the coordinates indicated on the Contract Drawings.

1. Drilling Sites: West Side: Broderson Site (five cluster wells)

East Side: 12th, 14th, 15th, 16th, and 18th Streets (five wells)

3.2 BOREHOLES

A. **Drilling Method:** The well shall be drilled using the mud rotary process in which the walls of the drill hole are held in place at all times with a circulating fluid. The work shall be performed by a competent crew with equipment which is adequate to complete all phases of well construction.

B. **Drilling:** A nominal 6-inch borehole will be drilled between land surface and the total depth of the monitoring well. Well depths will be determined by the ENGINEER. The total borehole depth in each well shall include 1-foot of overdrill to allow for any sediment accumulation during construction.

C. **Cuttings Collection:** At 5 foot intervals and at changes of formations the CONTRACTOR shall collect representative cuttings samples in order to provide an indication of the sequence of geological formations penetrated. The CONTRACTOR shall take a large representative sample of the cuttings from each sample interval and new formations, and shall label and preserve each sample in a sturdy container. All sample containers shall be labeled to indicate well number, date, time, and exact depth from which the sample was taken and stored in a manner to prevent damage or loss.

1. Drill cuttings must be contained and removed from the East Side sites (residential right-of-way areas). On the West Side, the cuttings may be spread near the well.

3.3 WELL CONSTRUCTION

A. **General:** The CONTRACTOR shall provide a 2-inch diameter PVC monitoring well consisting of 5 feet of 2-inch diameter 0.020-inch slotted PVC well screen at the base of 2-inch diameter Schedule 40 PVC casing to the total depth of the borehole as determined by the ENGINEER.

B. **Installation of Well Casing:** When the drilling operation has been completed, blank casing and well screen will be installed. The lengths and intervals of each casing type will be determined by the ENGINEER.

C. **Tension:** The well assembly shall be suspended in tension from the surface by means of a suitable clamp. The bottom of the well assembly shall be at a sufficient distance above the bottom of the pilot hole as to ensure that none of the casing will be supported from the bottom of the hole.

D. **Failure to Complete:** If the well assembly cannot be landed in the correct position or at a depth acceptable to the ENGINEER, the CONTRACTOR shall construct another well immediately adjacent to the original location and complete this well in accordance with the Contract Documents at no additional cost to the OWNER.

E. **Casing Collapse:** If the casing should collapse prior to well completion, it shall be withdrawn and replaced at the CONTRACTOR's expense.

F. **Well Screen:** The well screen shall be properly secured to the bottom of the casing as determined by the ENGINEER.

G. **Installation of Filter Pack:** Prior to placement of the filter pack, the drilling fluid shall be thinned with clean water. Gravel, as specified, shall be installed in the annular space between the borehole wall and the casing with a construction tremie pipe. Filter pack gravel shall be carefully installed to ensure complete filling of the annular space from the bottom of the hole to a depth of 5 feet above the well screen or as specified by the ENGINEER. During gravel packing placement, the freefall distance between the gravel in place and the end of the construction tremie pipe shall not exceed 5 feet. The volume of gravel used shall not be less than one calculated volume of the annular space between the casing and the wall of the borehole as determined by the ENGINER. The CONTRACTOR shall supply the devices required for measuring the gravel. A fine sand

cap shall be installed after the placement of the gravel pack, to a thickness of not less than one foot.

1. The filter pack will consist of clean, mostly rounded to sub-rounded silica sand, graded to the specifications listed in the Scope of Work. If the filter pack does not come in scaled, factory-labeled bags, a recent sieve analysis of the pack must be provided. The on-site geologist has the right to reject a filter pack if the bags are not sealed and labeled per the specification, or if the sieve analysis is unsatisfactory. The pack may also be rejected if the grains are mostly angular to highly angular, or if the sand has more than a trace of impurities, especially of calcium carbonate (such as shell fragments). The filter pack shall be protected from contamination during storage.The rate of sand placement shall not exceed 1.5 feet per minute, and placement of gravel shall proceed without interruption until completion. A weighted tape shall be used to monitor sand placement and ensure no bridging. The filter pack will terminate approximately 2 feet above the top of the screen.

H. **Sanitary Seal:** Upon completion of the filter pack installation operations, a cement ground seal shall be placed in the annulus between the borehole wall and the well casing from immediately above the sand pack to the surface or as determined by the ENGINEER. The specific grouting method to be employed by the CONTRACTOR shall be acceptable to the ENGINEER.

1. A cement-bentonite grout sanitary well seal shall be tremmied into the annular space between the casing and borehole from the top of the hydrated bentonite chip seal to surface, in accordance with State of California Water Well Standards and as directed by the County of San Louis Obispo Environmental Health Division (waiver for 10-foot seals required). A hydrated bentonite chip seal will be used between piezometer screens in the West Side cluster wells, and immediately above the filter pack to isolate the grout seal.

3.4 WELL DEVELOPMENT

A. **General:** After the well is complete in accordance with the requirements of the Contract Documents, the CONTRACTOR shall notify the ENGINEER and shall make the necessary arrangement for conducting the well development.

B. **Development Time:** The CONTRACTOR shall proceed with the development of the well and continue for approximately 2 hours until all sand and mud have been removed as approved by the ENGINEER. Upon completion of this operation, the well shall be cleaned of all accumulations of mud, sand, rock or sediment to the full depth of the well.

1. The well shall be developed by bailer. Well development shall continue until the bailed water is clear of sand, silt, and mud, and the well is open to total depth.

3.5 WELLHEAD COMPLETION

A. **Manhole:** Upon completion of all work connected with well construction and development, monitor wells shall be capped with a 2-inch PVC cap and completed inside a 12-inch diameter by 12-inch deep manhole with a lockable lid. The top of the well riser pipe shall be positioned 6 inches below the top of the locking lid.

B. **Concrete Slab:** Each monitoring well shall be completed in a 3 foot by 3 foot square concrete surface slab centered around the well and manhole The slab shall be reinforced with a minimum of 4 pieces of No. 3 rebar set parallel with the edges of the slab. The completed slab shall slope a minimum of 1/4-inch per foot toward the edge of the slab and shall be finished to final grade as specified in the Contract Drawings.

1. Well Pad: The well pad shall be constructed of concrete, 6-inch minimum pad thickness, 3-foot by 3-foot in area. Slope and finish will be site specific at the discretion of the on-site geologist (i.e. raised pad in open space, or sloping to meet flush with grade in residential right-of-way).

C. **Final Inspection:** The ENGINEER will inspect the site and wellhead prior to releasing the CONTRACTOR from the job. All trash, extra materials, and cuttings generated by the contractor must be off the site, and the wellhead must be properly secured.

- END OF SECTION -

SECTION 02634 – HARVEST WELLS

PART 1 -- GENERAL

1.1 THE REQUIREMENT

A. The CONTRACTOR shall construct, test, and disinfect harvest wells and all appurtenant work, complete and operable, all in accordance with the requirements of the Contract Documents. This technical specification applies to the construction and testing of ground water supply wells. The purpose of this specification is to document the level of effort expected from the drilling contractor. This specification does not, through omission, excuse the contractor from complying with any laws, rules and regulations, or standards governing the work being performed.

B. The work shall be performed by a licensed California water well Contractor with equipment which is adequate to complete all phases of well construction and rehabilitation. If the CONTRACTOR's equipment is not capable of satisfactorily performing the work provided for in these specifications, the CONTRACTOR at his own expense shall substitute equipment satisfactory to the ENGINEER.

C. The CONTRACTOR shall furnish sound proofing barriers, provide mufflers on equipment, and take whatever other steps necessary during drilling, pumping, testing, and all other work incidental thereto to ensure that noise levels conform to San Luis Obispo County noise ordinances. The CONTRACTOR will take necessary measures to limit access to drilling sites to minimize public hazards.

D. All work shall conform with and be completed by a licensed California water well Contractor in full conformance with the State of California rules and regulations for water wells, or this Specification whichever is greater and more restrictive.

E. Scope of Work The work includes furnishing all labor, materials, transportation, tools, supplies, equipment, and appurtenances necessary for the complete and satisfactory construction, and testing, of water supply wells. West Side and East Side Harvest wells differ only in the depth and test pump requirements, as noted below. The design and testing parameters are as follows:

1. Well Design – Harvest Wells

Drilling sites:	West Side: Loma Harvest Well, Palisades Harvest Well East Side: East Paso Harvest Well
Conductor casing:	none
Total test hole depth:	West Side: 220 feet East Side: 160 feet
Geophysics:	e-log (spontaneous potential, long and short normal, single point).
Total well depth:	West Side: 200 feet East Side: 140 feet
Final borehole size:	16-inch nominal diameter

Completion:	West Side: Wellhead to 90 feet depth blank casing. 90 to 190 feet depth screen (length of screen is 100 feet). 190 to 200 feet blank casing with casing shoe. East Side: Wellhead to 60 feet depth blank casing. 60 to 130 feet depth screen (length of screen is 70 steel feet). 130 to 140 feet blank casing with casing shoe. Centralizers: Every 60 lineal feet up, beginning from the bottom of screen.
Blank Casing:	8-inch PVC (ASTM F480, SDR-21) water well casting.
Screen:	8-inch PVC (ASTM F480, SDR-21) high-density perforations, 0.030-inch slots.
Gravel pack:	RMC Lapis Luster #2/12 sand (12 x 20), or approved equal. Install 2-inch diameter galvanized gravel fill tube.
Sanitary Seal:	Install 50-foot cement seal in accordance with County of San Louis Obispo Environmental Health Division requirements.
Wellhead:	Provide 6' x 6' x 6' reinforced concrete well pad (sloped to drain away from casing). Cover well with PVC slip cap and set screws.
Rig development:	2 hours
Pump development:	8 hours
Pump tests:	<u>West Side:</u> 3-hour step test (assume 150, 200, and 250 gpm) 24-hour constant discharge (assume 200 gpm) <u>East Side:</u> 3-hour step test (assume 80, 120, 160 gpm) 24-hour constant discharge (assume 120 gpm)
Cuttings/mud:	Removed from site by the CONTRACTOR.

2. Preparation and Mobilization

   a. Clear site and establish vertical and horizontal control.

b. Mobilize drilling equipment.

c. Construct temporary drilling pad (i.e. gravel base).

d. Install surface casing, as specified.

1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. **Codes:** All codes, as referenced herein, are specified in Section 01090, "Reference Standards." Without limiting the generality of other requirements of these specifications, all work specified herein shall conform to or exceed the requirements of the applicable codes and standards relating to the referenced portions of the following documents only to the extent that the requirements therein are not in conflict with the provisions of this section. Where such documents have been adopted as a code or ordinance by the public agency having jurisdiction, such code or ordinance shall take precedence.

B. **Permits, Laws, and Standards** The CONTRACTOR is responsible for obtaining a well application permit prior to drilling and for filing a Well Completion Report at the conclusion of the project. The CONTRACTOR shall comply with all federal, state, or local laws, ordinances, rules and regulations, and standards relating to the performance of work, including the California Water Well Standards (Dept. of Water Resources Bulletins 74-81 and 74-90) and any applicable noise ordinance.

C. **Commercial Standards:**

ANSI/AWWA C654	Disinfection of Wells.
ASTM C 150	Specification for Portland Cement.
AWWA A100	Standard for Water Wells.
API Spec. 10D	Specification for Bow-Spring Casing Centralizers.

1.3 CONTRACTOR SUBMITTALS

A. **General:** All CONTRACTOR submittals shall conform to the applicable requirements of Section 01300 - Contractor Submittals and the supplementary requirements specified. All measurements for depths shall be referenced to existing ground surface at each well site.

B. **Equipment List:** The CONTRACTOR shall submit a list of the equipment proposed on the project. The list shall include manufacturer's load capacities, horsepower, year of manufacture, year of purchase, and any other pertinent information, as requested by the Engineer.

C. **Material and Supplier's List.** The CONTRACTOR shall submit a complete list of all proposed vendors and suppliers, along with corresponding material specifications to be used in the work.

D. **Subcontractor's List.** The CONTRACTOR shall submit a complete list of all proposed subcontractors to be used in the work. The CONTRACTOR may be required to submit additional information or a resume of qualifications for any of the subcontractors proposed.

E. **Horizontal and Vertical Control:** The CONTRACTOR shall establish on site vertical and horizontal control by a licensed land surveyor in the State of California. The CONTRACTOR shall submit five (5) copies of the certified topographic survey to the ENGINEER prior to initiating drilling activities.

F. **Daily Log:** The CONTRACTOR shall maintain a detailed daily log of events for his activities at each rig on the site, during well construction and testing.

1. The report forms should include information on bit assembly and drill string, drilling mud and additives, fluid losses, water- and fluid- level changes, footage drilled and formations encountered, and cementing operations. In addition, information relative to maintenance and repair time along with details of repair, and presence of CONTRACTOR's personnel and sub-contractor, and other pertinent data as may be required by the ENGINEER.

2. One legible form suitable for photocopying shall be submitted to the ENGINEER on a daily basis.

G. **Mill Certificates:** Casing mill certificates shall be submitted to the ENGINEER for all casings, one week prior to the installation of the casing in the ground.

H. **Geological Samples:** The CONTRACTOR shall collect, label, and store, in sturdy containers in a well protected place near the drilling site, samples of all geological formations encountered in ten foot increments during drilling operations. Each sample shall be clearly labeled and indicate well number, time, and the exact depth from which the sample was taken. One set of samples should be collected.

I. **Geophysical Logging:** The CONTRACTOR shall submit 4 field copies of all geophysical logs to the ENGINEER within 24 hours following logging activities, and one electronic copy provided within 10 days of logging. For each geophysical log suite performed, the ENGINEER may request the CONTRACTOR to obtain a brief descriptive report from the service company interpreting the results of the log or logs. These completed reports must be submitted to the ENGINEER within 72 hours of completion of logging. The logs to be performed are listed in Part 3 Execution, Paragraph 3.8.

J. **Video Survey:** The CONTRACTOR shall submit to the ENGINEER two (2) copies of the video television survey on the day the well is surveyed, and four additional copies of each survey within one week of running the survey. Video surveys shall be recorded on video recording tape.

K. **Laboratory Analyses:** The CONTRACTOR shall submit 2 copies of the laboratory report, for the analyses of the water quality samples collected during reverse air drilling and pump tests within 30 days of receipt of samples by the laboratory.

L. **Calibration Data:**

1. Inclination tools and geophysical logs: Each downhole instrument used in testing the wells during construction shall demonstrate acceptable calibration before use. Where possible, this calibration record shall be included on the output of the test or on the log.

M. **Development and Test Records:** Development and test records shall be recorded on an hourly basis, showing production rates, static water level, pumping level, drawdown,

production of sand, and all other pertinent information concerning development, and testing methods.

N. **Permits:** The CONTRACTOR shall apply for all necessary drilling and testing permits with local and state regulatory agencies,

O. **Plumbness and Alignment Tests:** The contractor shall guarantee that the well, when completed, shall be sufficiently straight and plumb to permit the free installation and operation of submersible and turbine pumps regularly built for the installed well casing diameter to a depth acceptable to the project inspector.

P. **Final Description:** The final well descriptions shall show the following: diameter, wall thickness, depths, and lengths of casings installed; borehole diameters; cemented casings; depths and thicknesses of annular seals; and all other pertinent details, and shall be submitted to the ENGINEER prior to acceptance of the well.

Q. **Records Required by Law:** The CONTRACTOR shall maintain all records required by governmental agencies having jurisdiction, and shall submit such records to them as may be required. Two copies of all such material shall also be furnished to the ENGINEER.

R. **Resumes:** Resumes of key personnel will be submitted to the ENGINEER.

S. **Record Drawings:** Record drawings shall be submitted in accordance with relevant section of the technical specifications and Drawings.

T. **Completion Report Required:** A Water Well completion Report (Form 0124) must be filled with the appropriate agencies within 30 days of well completion.

U. **Drilling Waste Disposal:** The CONTRACTOR shall provide ENGINEER with notification of drilling waste disposal location.

1.4 QUALITY ASSURANCE

A. **Subcontractor's List:** Each subcontractor listed shall be approved by the ENGINEER. The ENGINEER reserves the right to disapprove the use of any subcontractor proposed.

B. **Geophysical Logs:** Geophysical logs shall be performed by a company experienced in the performance of such logs. Each log shall be recorded using a depth measurement that is accurate to within 0.1 feet using a resolution of approximately 1/50th of the greatest deviation of the quantity measured over the entire log. Each log shall include a repeat section at a depth determined by the ENGINEER.

C. **Guarantee:** The CONTRACTOR Guarantees that the work performed under this section of the Contract, and the workmanship, materials and equipment supplied or used in the execution of the work, are free from defects or flaws and are furnished in strict accordance with the Contract Documents in every respect. The CONTRACTOR further guarantees that the performance test requirements of the Contract Documents shall be fulfilled. The CONTRACTOR shall repair, correct, or replace all damage to the work covered by failures under the guarantee. The guarantee shall remain in effect for a period of 5 years from the date of final acceptance by the OWNER.

D. **Sand Production:** Sand production during development shall be recorded on pump development and testing records. Sand production, shall be qualified as measured by a Rossum sand content tester or equivalent centrifugal sand separating meter as

described in the Journal of the American Water Works Association, Vol. 46, No. 2, February 1954.

E. **Water Production Test:** The CONTRACTOR shall demonstrate to the ENGINEER that the producing zone yields water as described in Part 3 Execution, Paragraph 3.6. The CONTRACTOR shall furnish two copies of each test's record and result.

1.5 MATERIALS DELIVERY, STORAGE, AND PROTECTION OF MATERIALS

A. **General:** All materials shall be delivered in an undamaged condition and stored to provide protection against damage. All defective or damages materials shall be replaced with new materials at the CONTRACTOR's expense.

B. **Storage Area:** The CONTRACTOR shall prepare an area, within the limits of a location approved by the ENGINEER, for the storage of materials required for this work.

1.6 CONTRACTOR'S EQUIPMENT

A. **General:** The CONTRACTOR's equipment shall be clean, well maintained, and in good operating condition when delivered to the site, and during the entire operation.

1. The equipment shall be of adequate size, strength, horsepower, and capacity for the project and shall be of the type successfully utilized by the CONTRACTOR for the construction of similar or larger wells within the last 2 years.

2. All equipment shall be provided with safety devices as required by governmental authorities having jurisdiction.

B. **Equipment Use:** Reaming and setting of casing shall be done with the same equipment and no resetting of equipment will be allowed after the hole is reamed. The equipment shall be provided with all reasonably possible sound deadening devices.

1.7 MOBILIZATION, PERSONNEL AND OPERATING REQUIREMENTS

A. **Mobilization:** The CONTRACTOR shall mobilize its equipment and personnel to effectively commence its drilling operations within the time limit specified. Any improvements necessary for access should be identified by the CONTRACTOR during the initial site inspection. The CONTRACTOR is responsible for ensuring that site access is satisfactory prior to mobilizing equipment on-site. Arranging for, obtaining, and transporting water for drilling shall be the CONTRACTOR's responsibility.

B. Work is in residential areas. The CONTRACTOR shall be responsible for site security. The work area shall be temporarily fenced and the test hole shall be covered to prevent unauthorized access when CONTRACTOR is not present on site.

C. **Personnel Requirements:** The CONTRACTOR shall furnish capable personnel, experienced in the work required by these specifications. In addition, the following shall apply:

1. The personnel shall be subject to the ENGINEER's approval.

2. The CONTRACTOR, in addition to providing the services of skilled and experienced drillers in the type of formations expected, shall also provide an adequate number of competent helpers.

a. The drillers shall be capable of keeping good and clean well logs, and reports of the drilling, developing and pump testing operations as instructed by the ENGINEER.

b. The drillers also shall be capable of recognizing and making lithologic classifications of the formations to be encountered during the work. Drillers should be experienced and competent in drilling fluids, additives, and maintenance.

c. Drillers and helpers should know how to collect and handle representative formation and water samples as required by the ENGINEER, as described in these Technical Specifications.

D. **Equipment Operation:** All equipment shall be carefully maintained during the CONTRACTOR's operations and any damage to the well or surrounding property and/or facilities of any nature due to the CONTRACTOR's operations shall be repaired or replaced.

E. **Service Companies:** Where possible, the CONTRACTOR shall utilize the skills of a specialist service company, expert in the type of service for which they are employed. The name and the background of the company and the individuals providing the services shall be submitted to the ENGINEER for approval prior to beginning work. The ENGINEER reserves the right to reject any service company. At a minimum, service companies shall be employed for the following:

1. Geophysical Logging.

2. Cementing.

F. **Water Samples:** The CONTRACTOR will be required to collect water samples during construction activities for analysis by a State of California certified laboratory.

1. Receptacles. Samples for which laboratory analysis is required, shall be collected in specially designated and approved sample containers to be provided to the CONTRACTOR by a State of California certified laboratory approved by the ENGINEER for the specific parameters required by these specification documents.

2. Labeling. The sample containers shall be clearly labeled with the well identification, and the depth interval below ground surface from which the sample was collected and the time and date of sample collection.

3. Delivery. The CONTRACTOR shall collect the samples, store them in the appropriate manner as instructed by the laboratory, and deliver them to the laboratory in accordance with the laboratory's instructions.

4. Chain of Custody. Chain of Custody forms shall be completed for all water samples. Copies of the Chain of Custody forms shall be submitted to the ENGINEER within ten days of final delivery of the samples to the laboratory. All persons handling the samples shall be required to sign the Chain of Custody form.

5. Sample Collection. For the background samples to be collected after completion of well construction, the CONTRACTOR shall use the approved laboratory

field sampling services approved by the ENGINEER to collect the water samples and transmit them to their laboratory.

6. Holding Times. The CONTRACTOR shall be apprised of applicable water sampling holding times for the samples for which he is responsible and assure that the samples are transmitted to the laboratory within these time periods. For samples collected by the laboratory the CONTRACTOR shall be responsible to the ENGINEER for the performance of the sub-contractor's service analyzing the samples within established holding times.

7. Cuttings and Fluid Disposal. It shall be the CONTRACTOR's responsibility to arrange for an approved disposal site for both drill cuttings and fluid from drilling that complies with all applicable regulations. No drilling operations can commence without an approved disposal site. The CONTRACTOR shall be responsible for providing and maintaining all necessary tank trucks, dump trucks, pipe, pumps and equipment necessary to pump and haul excess pad drainage, drilling fluid, drill cuttings and development water to a pre-determined disposal site in accordance with federal, state, and local regulations, or subcontract with firm capable of providing these services when necessary.

G. **Access to Well:** At certain intervals, for the purposes of gathering samples and test data, the ENGINEER shall require access to the well in close proximity to the drill rig. The CONTRACTOR shall assist the ENGINEER in this activity, providing safe conditions for the collection of information and samples during drilling and testing operations.

H. **Field Relocation:** During construction, it is expected that minor relocation of proposed facilities may be necessary. Such relocations will only be made at the direction of the ENGINEER. If existing structures are encountered that prevent construction as shown, the CONTRACTOR shall notify the ENGINEER prior to continuing the work, so the necessary field revisions can be made.

I. **Standby Time:** The ENGINEER may order the CONTRACTOR to stop his operations so that extra work not included in the specifications may be performed. The ENGINEER will advise the CONTRACTOR when he proposes to do this and will schedule his request so it causes the minimum of delay. The CONTRACTOR will be reimbursed for all approved standby time at hourly rates, which will be listed in the Bid Proposal form. All extra work must be approved in advance by the ENGINEER, in writing.

J. **Construction Safety Program:** The CONTRACTOR shall comply with the OSHA regulations contained in 29CFR Section 1910 for General Industry Regulations and 29CFR Section 1926 for Construction Regulations.

K. **Safety Equipment:** At all times, the CONTRACTOR must provide safety equipment, as required by all applicable Federal and State regulations.

L. **Accident Reports:** One copy of the CONTRACTOR's accident report form should be submitted to the ENGINEER within 24 hours of the occurrence of any accident in connection with the work.

M. **Repeat Work:** All work required to be repeated, resulting from the CONTRACTOR's performance, including all additional materials, labor and equipment required, shall be furnished at the expense of the CONTRACTOR and no claim for additional

compensation shall be made or be allowed therefore, except as specifically provided herein.

N. **Protection of Water Quality:** The CONTRACTOR and his sub-contractors shall take all necessary precautions to prevent contaminated water, gasoline, or other hazardous substances from entering the well, either through the wells or through seepage from ground surface. The CONTRACTOR shall maintain precautions during and after construction of the well and until acceptance of the wells by the OWNER. If the CONTRACTOR fails to prevent contaminants from entering the groundwater, remedial action as required by the governing regulatory agencies shall be performed by the CONTRACTOR at the sole expense of the CONTRACTOR.

1.8 SITE CLEANUP, PRESERVATION AND RESTORATION

A. **Unused Materials and Equipment.** During construction, the CONTRACTOR shall regularly remove from the site all accumulated debris and surplus materials of any kind which results from his operations. Unused tools or equipment shall be stored at the CONTRACTOR's yard or base of operations for the project.

B. **Periodic Cleaning.** The CONTRACTOR shall perform clean-up work on a regular basis and as frequently as requested by the ENGINEER.

1. Basic site restoration in an area shall be accomplished immediately following installation or substantial completion of the required facilities in that area. Also, such work shall be performed, when requested by the ENGINEER, if partially completed facilities must remain incomplete for some time period due to unforseen circumstances.

2. If the CONTRACTOR fails to perform periodic clean-up and basic restoration of the site to the ENGINEER's satisfaction, he may, upon five days written notice to the CONTRACTOR, employ such labor and equipment as he deems necessary for the purpose.

C. **Work Completion.** Upon completion of work at the site, the CONTRACTOR shall promptly remove all his equipment and unused materials. The CONTRACTOR shall dismantle any temporary structures erected for his purposes that are not part of the final product. The CONTRACTOR shall promptly effect minor repairs and leave the site in a manner acceptable to the ENGINEER, within one month after the completion of drilling and testing.

1.9 WELL ABANDONMENT AND REMEDIAL WORK

A. **Abandonment of Well by CONTRACTOR:** If, at any time the CONTRACTOR voluntarily stops work, and/or fails to complete a hole in a satisfactory manner in accordance with governing regulations of the Contract Documents, the hole will be considered abandoned. The CONTRACTOR shall not be paid for all or part of a hole declared as abandoned by the OWNER.

1. The cost of properly plugging and sealing a well or hole, in accordance with applicable local, state, or federal regulations, shall be borne by the CONTRACTOR. In addition, if a well or part thereof, does not have mechanical integrity as defined by the appropriate regulatory authorities, it must be restored prior to abandonment of the well.

2. Under conditions where post-abandonment monitoring requirements are imposed by regulation as a direct result of the CONTRACTOR's abandonment of the well, or hole, the cost of this monitoring also must be borne by the CONTRACTOR.

3. All salvageable material furnished by the CONTRACTOR may be removed and remain his property.

4. The CONTRACTOR shall propose his method of abandonment of the well or hole in writing to the OWNER. The ENGINEER and OWNER shall review the method of abandonment, and accept the plan in writing before work can proceed. At all times all work on the well must be in accordance with all applicable local, state, and federal regulations.

B. **Abandonment:** If information indicates that the completion of a well at a pilot hole site is not warranted, the OWNER reserves the right to terminate all further work at the site. In such an event, the CONTRACTOR will be paid the value of its work completed to that time based on unit prices indicated in the Bidding Schedule.

1. The CONTRACTOR shall be required to abandon the pilot hole as directed by the OWNER in accordance with regulations formulated by governmental agencies having such jurisdiction.

2. The OWNER reserves the right upon termination of work at the site to have the CONTRACTOR move to another site selected by the OWNER within Los Osos and to drill another pilot hole.

C. **Remedial Work:** If it becomes necessary to perform remedial work prior to final acceptance, on the well in order for it to meet either regulatory requirements or the Contract Documents, or both, due to defective materials, accident, loss of equipment or equipment malfunction, or for any other cause directly attributable to the CONTRACTOR's actions, the CONTRACTOR shall bear the entire cost of the remediation, including any necessary Engineering costs to meet regulatory requirements. In the event of a problem, the ENGINEER shall be notified immediately, and the following shall apply:

1. The CONTRACTOR shall propose a method of correcting the problem, in writing to the OWNER. The ENGINEER and OWNER shall review the method of corrective action, and accept the plan in writing before work can proceed.

2. At all times all work on the well must be in accordance with all applicable local, state, and federal regulations.

PART 2 -- PRODUCTS

2.1 TEMPORARY DRILLING PAD

TEST HOLE DRILLING

A. A pilot hole shall be drilled to the total depth listed in the Scope of Work. During test hole drilling, the contractor shall keep the following minimum records:

1.0 A descriptive log of the formation materials with depths at which each change in materials occur.

2.0 The penetration rate of each drill pipe section, reported in minutes per joint.

3.0 Collect representative formation samples in labeled containers at regular 10-foot intervals.

4.0 Record the drill bits used (type and size) and any notable events, such as loss of circulation, hole instability, voids, etc.

5.0 A mud condition log

2.2 DRILLING EQUIPMENT

A. Provide direct – circulation mud rotary drilling equipment capable of completing the wells as shown on the Drawings and described in the Specifications.

2.3 DRILLING FLUID

A. **Rotary Method:** Material for drilling fluid for well construction by the rotary method shall be high-grade, bentonite clays in common drilling usage. The drilling fluid shall possess such characteristics as are required to adequately condition the walls of the hole to prevent caving of the walls as drilling progresses, and to permit recovery of representative samples of cuttings.

1. Only fresh water from the designated source (per Water Supply specified in Section 01510 Temporary Utilities), shall be used in drilling fluids whether employed alone or in a combination with drilling additives. Any other drilling additives to be used will require acceptance by the ENGINEER.

2. The CONTRACTOR shall maintain complete control over drilling fluid characteristics during the entire operation of well construction.

B. **Drilling Fluid Additives:**

1. Some mud drilling conditioning polymers be permitted during drilling. All additives shall be approved prior to use by the ENGINEER.

2. Provide equipment for measuring drilling fluid properties including a marsh funnel and a fluid density balance. Provide lithologic sampling bags or containers and water sample containers.

2.4 GEOPHYSICAL LOGGING

A. Provide continuous-recording geophysical logging equipment capable of running:

1. Long and short normal electric and spontaneous potential

2. Caliper

3. Fluid Resistivity

2.5 CASING AND APPURTENANCES

A. **Final Casing:** The final casing shall be 16-inch OD with a minimum wall thickness of 0.500 inches and shall be carbon steel meeting the requirements of ASTM A53 grade B, or API 5L grade B. The casing shall be factory assembled in not less than 20-foot lengths. The ends of each joint shall be machine bevelled perpendicular to the casing axis to ensure the straightness of each assembled section. Casing joints shall be welded in accordance with ANSI/AWS D1.1. All final casing material shall be new and no used or rusted casing will be accepted.

B. **Casing Guides:**

1. One at 10 feet above the bottom end of the casing.

2. Every 60 Lineal feet.

2.6 CEMENT

A. **General:** Material used for sealing the casing shall consist of a neat cement grout using Type II Portland cement conforming to ASTM C 150. Neat cement grout shall contain not more than 5 gal of water per 94-lb sack of cement.

B. **Sanitary Seal:** A sanitary seal shall be pumped into the annular space between the casing and borehole to a depth of 50 feet, in accordance with State of California Water Well Standards and as directed by the County of San Louis Obispo Environmental Health Division.

2.7 FILTER PACK

A. Material shall be 2/12 (12 X 20) sand, well graded, and free from debris. The amount of filter pack and placement method shall be approved by the ENGINEER.

B. Gravel Fill Tube: A 2-inch diameter galvanized steel gravel fill tube shall be installed into the top of the gravel pack. It shall extend approximately 4 inches above the well pad finish grade, and be fitted with a threaded cap.

2.8 WELLHEAD

A. Wellhead Capping and Valves: Wellhead capping and valves shall be installed in accordance with the Specifications and Drawings.

B. **Well Pad:** The well pad shall be of ¼-inch rebar-reinforced, 6-inch minimum pad thickness, 6-foot by 6-foot in area, and sloping at approximately ¼-inch per foot away from the well casing at the center of the well pad.

2.9 PUMPS AND DEVELOPMENT EQUIPMENT

A. The CONTRACTOR shall furnish and operate a test pump assembly for tests on the well. The pump shall be capable of pumping 250 gpm against up to 75 psi of pressure. The pump assembly shall also include a gate valve to regulate the flow rate during the tests. The pump shall be set to a depth of up to 160 feet below pad surface.

B. Furnish all necessary and adequately sized compressors, piping tools, pumps and any other equipment to develop the well by air lift methods and to pump test well as required.

C. The CONTRACTOR shall furnish and install discharge piping for the pumping unit used in well development of sufficient size and length to conduct water to the den water handling tanks together with an in-line meter with 6-digit, straight reading totalizer, registering in units of 100 gallons, together with a rate of flow indicator dial, which reads in units of gallons per minute and is suitable for the expected flow range. All water removed from the well during pump development shall be pumped into the tanks. No standby time will be allowed to clean tank system of sediments.

PART 3 -- EXECUTION

3.1 DRILLING

A. **Drilling Methods:** The well shall be drilled using the direct rotary mud process in which the walls of the drill hole are held in place at all times with a circulating fluid. The work shall be performed by a competent crew with equipment which is adequate to complete all phases of well construction. Drill cuttings and drilling fluids must be contained and removed from the site and disposed of properly at the contractor's expense.

1. Mud Rotary Method. Shall be used through the unconsolidated formatting to a depth of up to approximately 220 feet.

2. Drill bore holes of the dimensions and through each interval as determined by the ENGINEER and prepare borehole for geophysical logging. Boreholes shall be drilled to allow installation of casing straight and plumb as specified.

B. A mud program is required. Only high-grade products shall be used in the make-up of the drilling fluid. The purpose of the mud program is to prevent formation invasion by drilling fluid and to reduce the potential for other downhole problems. Solids control is very important to limiting water loss and the desanding equipment should be capable of handling about 1-1/2 times the anticipated maximum pumping volume, with fines removal down to about 25 microns.

1. The contractor shall either provide and follow a mud program designed by a qualified Mud Engineer or shall follow the mud program described below. The program involves maintaining mud values within specified limits and checking/adjusting mud values at least once every 4 hours during drilling. The program may be modified if necessary during drilling, however, the reasons for any modification to the program should be noted. Sufficient time for proper monitoring and conditioning of the drilling mud every morning and as needed during drilling should be taken and will be expected. The basic monitoring components of the mud program are as follows

a. Drilling fluid pH should be between 8.5-9 units. Adjust make-up water pH with soda ash before adding bentonite. pH strips are acceptable for testing.

b. Mud weight should be less than 9.0 pounds per gallon. A mud balance is required.

c. Mud viscosity should generally be between 35-50 seconds. Viscosity should <u>only</u> be as high as needed to clean out hole. A marsh funnel viscometer is required.

d. Sand content should be less than 2 percent. An Imhoff cone or equivalent is required.

2. A mud conditioning polymer for shielding formation clays from hydrating is recommended (i.e. Drispac, Hydro Drill, Uni-Drill, or the equivalent product). The polymer should be added after all other mud adjustments are made in the morning, very slowly, while circulating. Mud viscosity increases due to the polymer should be taken into consideration when adding bentonite. The basic procedure for daily mud monitoring/adjusting is as follows:

a. Circulate mud in the morning. If greater volume is needed, add clean water first. Pre-treat make-up water with about 6 ounces of soda ash per 300 gallons.

b. Check fluid pH. Adjust using soda ash (to increase) or clean water (to decrease).

c. Check mud viscosity. Add bentonite to increase. Allow for about 10 seconds of increased viscosity for polymer, if used.

d. Check sand content. If too high, circulate through desanding cones and recheck.

e. Check mud weight. If too high, add clean water and return to step 2.b.

f. Add polymer last. Polymer should be added very slowly and used sparingly. Check final viscosity.

g. Recheck mud values every 4 hours during drilling. All mud values and product quantities used should be recorded in a log.

C. **Formation Samples:** At 10-foot intervals and at changes of formations, the CONTRACTOR shall collect representative formation samples in order to provide an indication and classification of geological formations penetrated. The CONTRACTOR shall take a large representative sample of the cuttings from the interval or new formation, and shall label and preserve each sample in a sturdy container. All sample containers shall be labeled to indicate well number, date, time, and the exact depth from which the sample was taken and stored in a manner to prevent damage or loss.

3.2 CASINGS

A. **Tension:** The casing shall be suspended in tension from the surface by means of a landing clamp. The bottom of the casing shall be at a sufficient distance above the bottom of the reamed hole as to insure that none of the casing will be supported from the bottom of the hole.

B. **Failure to Complete:** If the casing cannot be landed in the correct position or at a depth acceptable to the ENGINEER, the CONTRACTOR shall construct another well immediately adjacent to the original location and complete this well in accordance with the Contract Documents at no additional cost to the OWNER. The abandoned hole shall be sealed in accordance with all State of California regulations.

C. **Collapsed Casing:** If the casing should collapse for any reason prior to well completion, it shall be withdrawn and replaced at the CONTRACTOR's expense.

D. **Centralizers:** All casing in the well shall be centralized in the borehole using strap-type centralizers or other methods acceptable to the ENGINEER.

E. **Final Casings:** Centralizers in all other casings and tubings will be placed as follows:

1. One at 10 feet above the bottom end of the casing.

2. One at 20 feet above the bottom centralizer of across the first welded joint.

3. A 60 foot interval thereafter.

F. **Alignment:** All centralizers shall be in perfect vertical alignment, one above the other in order to permit the passage of at least one tremie pipe alongside the casing to the bottom of the borehole.

G. **Installation of Well Casing**: Well casing installation shall begin as soon as possible after the final reaming pass. A Bill of Lading containing the material specification for the casing supplied to the project, including blank and screened sections, shall be submitted to the project inspector. All casing material delivered to the site will be new.

1. All sections of casing will be joined by PVC cement and set screws. The well casing nd screens will be placed in the correct position and depth or an alternate acceptable to the project inspector. Casing centralizers will be clamped at intervals no less than 60 feet. The well casing will be suspended from the top and allowed to hang freely in the borehole at all times during well construction. Plumbness and Alignment

2. The contractor shall guarantee that the well, when completed, shall be sufficiently straight and plumb to permit the free installation and operation of submersible and turbine pumps regularly built for the installed well casing diameter to a depth acceptable to the project inspector.

3.3 CEMENT

A. **General:** The cement shall be pumped as a slurry of thoroughly mixed components in stages that are designed to fill the annular space without exceeding the collapse pressure of the casing pipe to which the cement is applied. It is the CONTRACTOR's responsibility to conduct the cementing operations in such a manner that the burst strengths of the casing (with safety factor) are not exceeded and casing failure does not occur.

3.4 FILTERPACK PLACEMENT

A. Filter Pack Placement The filter pack will consist of clean, mostly rounded to sub-rounded silica sand, graded to the specifications listed in the Scope of Work. A recent sieve analysis of the product being used must be provided to the project inspector. The project inspector has the right to reject a filter pack if the sieve analysis is unsatisfactory or not representative of the actual delivered load, if the grains are mostly angular to highly angular, or if the sane has more than a trace of impurities, especially of calcium carbonate (such as shell fragments). The filter pack shall be protected from contamination during storage. If stored on site, the filter pack shall be placed on new plastic sheeting (visqueen) and covered with new plastic sheeting.

B. Prior to placement of the gravel pack into the annular space, the drilling fluid shall be thinned with clean water. The contractor should maintain circulation in the hole from the time the thinning of the mud begins to the time when the gravel pack is completely in place. The rate of gravel placement shall not exceed 1.5 feet per minute, and placement of gravel shall proceed without interruption until completion.

3.5 WELL DEVELOPMENT

A. After well has been completely constructed in accordance with the requirements of the Contract Documents, the CONTRACTOR shall notify the ENGINEER and shall make the necessary arrangements for well development, and product testing.

B. The CONTRACTOR shall be entitled to a decision in writing from the ENGINEER as to final well design within two working days of the completion of test hole drilling and e-log. The preliminary design listed in the Scope of Work may be significantly changed, or the test hole may be abandoned.

C. Borehole reaming may commence at any time following the decision to complete a well, however, the final pass cannot be started until all materials to case and gravel pack the well are on-site or secured at the CONTRACTOR's yard (ENGINEER approval required).

D. The well shall be initially developed by airlifting opposite the screened sections beginning with the shallowest section. Each section shall be worked for a minimum of three passes before moving to the next section. Upon completion of airlift development, the well shall be cleaned of all mud, sand, and sediment. The gravel pack shall be checked and added to, if necessary.

E. The CONTRACTOR shall furnish, install, and operate a well pump with sufficient capacity to meet the Scope of Work requirements. Up to 100 feet of discharge line should be available for use (as necessary) at no extra cost. A water flow meter is required. A sampling tap and a Rossum sand tester must be furnished.

F. Well development shall consist of cycles of pumping and surging until the discharged water is clear of sand, silt, and mud and until there is no further increase in specific capacity. Well development water shall be contained in portable tanks for disposal off-site at contractor's expense. At the conclusion of well development, a sand test shall be performed. Sand content shall average not more than 5 mg/l for a complete pumping cycle of two hours duration when pumping at the anticipated design capacity.

1. If pump development is employed, initial pumping rate shall be restricted and as the water clears shall be gradually increased until the maximum rate is reached. The maximum rate will be determined by the ENGINEER after consideration of the drawdown and discharge characteristics of the respective zone. At frequent intervals the pump shall be stopped and the water in the well shall be allowed to surge back through the pump bowls or drill pipe and through the open area beneath the casing.

2. The cycle of circulation or pumping shall be repeated until the discharge water is clear of sand, silt and mud and until there is no increase in specific density (discharge per foot of drawdown) in the well. The well shall be thoroughly developed so that it will produce a reasonable maximum capacity based on the consideration of depth and nature of the water-bearing formations, and so that it will not produce a composite amount of fine sands in excess of that specified.

3. Upon completion of the development operations, the CONTRACTOR shall demonstrate that the bottom of the well is clear of all sand, mud, and other foreign material.

3.6 **WELL PUMPING TESTS:** The CONTRACTOR shall operate the pump, collect water level data, and monitor discharge rates to conform to the testing program requirements supplied by the ENGINEER. At least one CONTRACTOR employee must be on-site at all times during the testing. Where a constant discharge test is required, there shall be an 8-hour minimum resting period with no pumping prior to the test. Discharge water shall not be allowed to flow onto adjacent properties or roads without approval from the ENGINEER. Following completion of the pump development and pumping tests, the contractor will clean the well of all sand, silt, and mud accumulated at the bottom.

A. The pumping equipment and pump setting shall be the same as used for well development pumping.

1. Pumping tests conducted for the well shall include: a step-drawdown test with increasing discharge rate, and a continuous, constant rate, time-drawdown test. A period of time is required for pump shut down and water level recovery between the well development and the tests and between the step-drawdown and constant rate pumping test.

2. The pumping rate shall be increased by increments determined by the ENGINEER until the well has been tested at maximum capacity. The test duration and pumping rates will be determined by the ENGINEER. During the test, the CONTRACTOR shall record the time, pumping level, and discharge at 5-minute intervals. When the test is completed, the pump shall be stopped and the water level in the well allowed to recover.

   a. Constant-Rate Pumping Test: A continuous, constant-rate, time-drawdown test shall commence after the water level in the well has recovered from the step-drawdown test for at least 8 hours, or until recovery levels are approved by the ENGINEER. The rate of pumping will be determined by the ENGINEER. The CONTRACTOR shall assure that the pumping rate selected remains constant throughout the test. The test duration shall be 24 hours. When the test is completed and the pump stopped, the CONTRACTOR shall not remove the test pump from the well for a period of approximately 12 hours.

3. The CONTRACTOR shall record the discharge rate each time the pumping water level is measured. In addition to these measurements, the ENGINEER may require the CONTRACTOR to periodically record the temperature of the discharge water or collect water samples.

4. Supervision by the CONTRACTOR of constant rate pumping tests shall be maintained on a continuous basis by qualified personnel.

5. If either test is aborted or interrupted for any reason, the test shall be stopped, the water level allowed to recover, and the test restarted.

6. After the test pump has been removed, the CONTRACTOR shall remove any accumulated sediment from the well.

3.7 DISINFECTION

A. The CONTRACTOR shall provide for disinfection of the well immediately after test pumping of the well has been completed. The CONTRACTOR shall carry out adequate cleaning procedures immediately preceding disinfection where evidence indicates that normal well construction and development work have not adequately cleaned the well. All sand, silt, and mud shall be removed from the well.

1. **Bacterial Evaluation:** The disinfected well shall be tested for the presence of coliform in accordance with ANSI/AWWA C654. The results shall be submitted to the ENGINEER. If bacterial evaluation fails, disinfection and testing shall be repeated until the results indicate a pass.

3.8 GEOPHYSICAL LOGS

A. Geophysical logs shall be performed following drilling and borehole preparation. The logging intervals shall be the total length of the borehole unless otherwise directed by ENGINEER. Each log must be run in a continuous fashion to be acceptable.

B. Down-hole geophysical logs listed in the Scope of Work will be performed by a qualified geophysical logging company as soon as possible upon completion of the test hole and removal of the drill pipe. The drilling contractor will be responsible for coordinating the arrival time of the geophysical logging truck to minimize delay and for providing an open borehole for logging to the total test hole depth. The scale for the log shall be 1 inch = 20 feet. Four hard copies and one electronic copy on 3.5-inch diskette shall be provided to the ENGINEER.

C. The CONTRACTOR is responsible for conditioning the borehole prior to logging to remove any drill cuttings and to prevent formation collapse. The CONTRACTOR shall clean the hole and rerun logs if logging attempt at the CONTRACTOR's expense fail to survey within 5 feet of the bottom of the hole.

D. The CONTRACTOR will provide adequate access for geophysical logging during pumping tests. No additional compensation will be granted for removal and reinstallation of pumps to facilitate logging.

E. Geophysical logs will be performed according to the following schedule during testing of the well:

3.9 FINAL INSPECTION

A. The project inspector will inspect the site and wellhead prior to releasing the contractor from the job. All trash, extra materials, cuttings and drilling fluids generated by the contractor must be off the site, and the wellhead must be properly secured.

- END OF SECTION -

SECTION 02831 – CHAIN LINK FENCING AND GATES

PART 1 -- GENERAL

1.1 THE REQUIREMENT

A. The CONTRACTOR shall provide chain link fencing and gates and appurtenant WORK, complete and operable, in accordance with the Contract Documents.

B. **Single Manufacturer**: Chain link fencing, gates, accessories, fittings, and fastenings shall be products of a single manufacturer.

1.2 CONTRACTOR SUBMITTALS

A. General: Furnish submittals in accordance with Section 01300 - Contractor Submittals.

B. Shop Drawings

1. Manufacturer's technical data, product specifications, standard details, certified product test results, installation instructions and general recommendations.

2. Scale layout of fencing, gates, and accessories. Drawings shall show fence height, post layout, including sizes and sections; post setting and bracing configuration, details of gates and corner construction, barbed wire support arms; and other accessories which may be necessary.

3. Color charts accurately illustrating the full range of standard colors available from the manufacturer.

C. Samples: Samples of proposed fence components, at least 12 inches long, to illustrate the selected color and finish.

PART 2 -- PRODUCTS

2.1 GENERAL

A. Dimensions indicated herein for roll-formed pipe and H-sections are outside dimensions, excluding coatings.

B. Fence fabric height shall be 8 feet unless otherwise indicated.

C. Fencing materials shall be hot-dip galvanized after fabrication.

D. PVC coatings, if indicated, shall be the color indicated. Selected by the ENGINEER from the manufacturer's standard colors. PVC coatings shall be made from virgin PVC resin with plasticizer, stabilizers, and ultraviolet inhibitor. Coatings shall have a tensile strength of 2500 psi, maximum elongation of 200 percent, and a shore durometer hardness of 40 to 46.

E. Fencing shall be topped with 3 lines of barbed wire on single, 45 degree supporting arms, sloped outward.

2.2 STEEL FABRIC

A. Fence fabric shall be No. 9 gauge steel wire, 2-inch mesh, with top selvages knuckled and bottom selvages twisted and barbed.

B. **Fabric Finish**: Fabric shall be galvanized in conformance with ASTM A 392 - Zinc-Coated Steel Chain Link Fence Fabric, Class II, with not less than 2.0 ounces zinc per square foot of coated surface.

C. **Fabric Finish**: Fabric shall be galvanized according to ASTM A 392 - Zinc-Coated Steel Chain Link Fence Fabric, Class I, with not less than 1.2 ounces zinc per square foot of coated surface, followed by as thermally bonded polyvinyl chloride coating at least 7 mils thick.

   1. PVC coating shall comply with ASTM F 668 - Poly (Vinyl Chloride)(PVC) - Coated Steel Chain Link Fence Fabric, Class 2, except that the wire core shall measure 9 gauge prior to application of coating.

2.3 FRAMING AND ACCESSORIES

A. **Steel Framework, General**: Unless otherwise indicated, framework components shall be fabricated of galvanized steel conforming to ASTM A 53 - Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded and Seamless, or ASTM A 123 - Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products, with not less than 1.8 ounces zinc per square feet of coated surface.

   1. Fittings and accessories shall be galvanized in accordance with ASTM A 153 - Zinc Coating (Hot-Dip) on Iron and Steel Hardware, with zinc weights per Table I of that standard, except that no coating shall be less than 1.8-ounce zinc per square foot of coated surface.

   2. After galvanizing, framework, fittings, and accessories shall be finished with manufacturer's standard thermally bonded PVC finish, not less than 10 mils thick.

B. **End, Corner and Pull Posts**: Posts shall be one-piece without circumferential welds, 3-inch schedule 40 pipe, 5.79 pounds per linear foot.

C. **Line Posts**: Line posts shall be spaced no more than 10-feet on center and shall be 2-1/4-inch "H" column section, 4.1-pounds per linear foot, or schedule 40, 2-1/2-inch pipe, 3.65-pounds per linear foot.

D. **Gate Posts**: Gate posts shall be 4-inch schedule 40 pipe, 9.1-pounds per linear foot.

E. **Top Rail**: Top railing shall be provided in manufacturer's longest lengths, with expansion type couplings, approximately 6 inches long, for each joint. Fence design shall provide positive, secure attachment of top rail to each gate post, corner post, pull post and end post. Top rail and braces shall be 1-5/8 inch schedule 40 pipe, 2.27-pounds per linear foot, or 1-1/2-inch "H" column section, 2.00-pounds per linear foot.

F. **Tension Wire**: Tension wire shall be located at the bottom of the fabric and shall consist of No. 7 gauge coated coil spring wire of metal and finish to match fabric. Tension wire shall be interlaced with the fabric or attached to the fabric along the extreme bottom of the fence. Tension wire attachment shall be with fabric tie wires at a spacing of no more than 24 inches apart.

G. **Fabric Tie Wires**: Fabric tie wires shall be No. 9 gauge galvanized steel wire of the same finish as the fabric. Aluminum ties shall not be used. Ties shall be spaced 14 inches apart on posts and 24 inches apart on rails.

H. **Post Brace Assembly**: Post brace assembly shall be manufacturer's standard adjustable brace assembly provided at each end post, gate post and at both sides of each corner post and intermediate brace post. Material used for brace shall be same as top rail. Truss bracing between line posts shall be achieved with 0.375-inch diameter rod and adjustable tensioner.

I. **Post Tops**: Post tops shall be weather-tight closure caps, designed for containment of top rail and positive permanent attachment to post. One cap shall be provided for each post.

J. **Stretcher Bars**: Stretcher bars shall be one-piece lengths equal to the full height of the fabric, with minimum cross-section of 3/16-inch by 3-1/2-inch. One stretcher bar shall be provided for each gate and end post, and 2 for each corner and intermediate brace post.

K. **Stretcher Bar Bands**: Stretcher bar bands shall be one-piece fabrications designed to secure stretcher bars to end, corner, intermediate brace, and gate posts. Bands shall have a minimum cross-section of 1/8-inch by 3/4-inch. Stretcher bar bands shall be spaced no more than 15 inches on center.

L. **Barbed Wire Supporting Arms**: Supporting arms shall be manufacturer's standard fabrication, of metal and finish to match fence framework, with provision for anchorage to each post and attachment of three rows of barbed wire to each arm. Supporting arms may be either attached to posts or integral with post top weather cap. Supporting arm shall be single 45-degree arm type and shall be capable of withstanding 250 pounds of downward pull at outermost end.

M. **Barbed Wire**: Barbed wire shall be 2-strand, No. 12-1/2 gauge zinc-coated steel or iron wire with four-point, 14-gauge barbs spaced no more than 5 inches apart.

2.4 GATES

A. **Fabrication**: Perimeter frames of gates shall be fabricated from same metal and finish as fence framework. Gate frames shall be assembled by welding or with fittings and rivets for rigid, secure connections. Welds shall be ground smooth. Gate frames and any ungalvanized hardware, shall be hot-dip galvanized after fabrication. Horizontal and vertical members shall be provided to ensure proper gate operation and attachment of fabric, hardware and shall be hot-dip galvanized after fabrication.

1. Fabric for gates shall match fence fabric, unless otherwise indicated. Fabric shall be installed with stretcher bars at all perimeter edges. Stretcher bars shall be attached to gate frame with stretcher bar bands spaced no more than 15 inches on center.

2. Each gate shall be diagonally cross-braced with a 3/8-inch diameter adjustable length truss rod to ensure frame rigidity without sag or twist.

3. Where barbed wire is indicated above gates, vertical members shall be extended and fabricated as required to receive barbed wire supporting arms.

B. **Swing Gates**: Perimeter frames of swing gates shall be constructed of the same pipe or "H" column members as the top rails and shall be fabricated by welding. Welds shall be ground smooth prior to hot-dip galvanizing.

1. Hardware and accessories shall be provided for each gate, galvanized in conformance with ASTM A 153, and in accordance with the following:

   a. Hinges: Hinges shall be of size and material to suit gate size, non-lift-off type, offset to permit 180-degree gate opening. Three hinges shall be provided for each leaf 6-feet or more in height. Two hinges shall be provided for each leaf less than 6 feet in height.

   b. Latch: Latch shall be forked type or plunger-bar type, permitting operation from either side of the gate, with padlock eye as an integral part of the latch.

   c. Keeper: Keeper shall be provided which automatically engages the gate leaf and holds it in the open position until it is manually released.

   d. Double Gates: Gate stops shall be provided for double gates, consisting of mushroom type flush plate with anchors, set in concrete, and designed to engage center drop rod or plunger bar. Locking device and padlock eyes shall be provided as an integral part of the latch, permitting both gate leaves to be locked with a single padlock.

C. **Sliding Gates**: Sliding gates shall be track guided type, engineered and designed specifically for the opening size and opening direction. Construction and coating shall be the same as for swing gates. The gate components shall be engineered for proper frame and bracing size, and shall be provided complete with all necessary overhead framing, supports, guides, stays, bracing, track foundations, hardware, heavy duty rollers with roller or ball bearings, and accessories as required. Hanger sheaves shall be heavy duty type with roller or ball bearings.

1. Sliding gates shall be engineered for a wind load of at least 25 lb/sq.ft and maximum deflection of 1/160 of the full span with a 200 lb live load at the free end.

2.5 RELATED ITEMS

A. **Concrete:** Concrete shall be provided according to Section 03300 - Cast-In-Place Concrete.

B. Nuts, bolts and screws shall be steel, minimum size 3/8-inch diameter, hot-dip galvanized after fabrication.

C. PVC slats shall be a PVC material similar to the PVC fabric coating or high density virgin polyethylene slats with an ultraviolet inhibitor. The slats shall be a tubular shape with a nominal wall thickness of 0.03-inch and be installed with a retaining channel top and bottom. The color shall be as indicated or as selected by the ENGINEER.

2.6 MANUFACTURERS

A. **Manufacturer's Qualifications**: Chain link fencing and gates shall be products of a single manufacturer which has been successfully engaged in the production of such items for a period of at least 5 years.

B. **Installer's Qualifications**: Installation of the chain link fence shall be by the manufacturer or by a firm accepted and licensed by the manufacturer.

C. Manufacturers, or equal

1. **American Fence Corp.;**

2. **Anchor Fence, Inc.;**

3. **United States Steel.**

PART 3 -- EXECUTION

3.1 INSPECTION

A. Prior to commencing installation, require Installer to inspect all areas and conditions within which WORK of this Section will be performed. Dimensions and clearances shall be verified. Final grading shall be completed and all earth, brush, or other obstructions which interfere with the proper alignment and construction of fencing shall be removed.

3.2 INSTALLATION

A. **General**: Unless otherwise indicated, all posts shall be set in concrete. Gate and related posts, corner posts, and other critical elements shall be provided with concrete foundations which are designed by an engineer to safely accommodate the loads to which they will be subjected. The CONTRACTOR shall review the Project Geotechnical Report to obtain soils information required for design.

B. **Excavation**: Holes for posts shall be drilled or hand excavated to the diameters and spacings indicated, in firm, undisturbed or compacted soil. Post foundations which are not designed by an engineer shall comply with the following:

1. Holes shall be excavated to a diameter not less than 12 inches or not less than 5 times the largest dimension of the item being anchored, whichever is larger.

2. Depth for holes shall be not less than 40 inches; excavated approximately 4 inches lower than the post bottom, with bottom of posts set not less than 36 inches below finish grade surface.

C. **Setting Posts**: Line posts shall be spaced at not more than 10-foot intervals, measured from center to center of the posts, parallel to the ground slope. Posts shall be set plumb and shall be centered in holes, 4 inches above the bottom of the excavation, with posts extending not less than 36 inches below finish grade surface.

1. Corner posts shall be installed where changes in the fence lines equal or exceed 15 degrees, measured horizontally.

2. Each post shall be properly aligned vertically and its top aligned parallel to the ground slope. Posts shall be maintained in proper position during placement and finishing operations.

D. Concrete

1. Concrete for footings may be placed without forms, providing the ground is firm enough to permit excavation to neat line dimensions. Prior to placing concrete, the earth around the hole shall be thoroughly moistened.

2. Encasement concrete for footings shall be placed immediately after mixing in a manner such that there will be no concentration of the large aggregates. The concrete shall be consolidated by tamping or vibrating.

3. Concrete footings shall have a neat appearance and shall be extended 2 inches above grade and troweled to a crown to shed water.

4. A minimum of 7 days shall elapse after placing the concrete footings before the fence fabric or barbed wire is fastened to the posts.

E. **Bracing**: Bracing shall be provided at all ends, corners, gates, and intermediate brace posts. Corner posts and intermediate brace posts shall be braced in both directions. Horizontal brace rails shall be set midway between the top rail and the ground, running from the corner, end, intermediate brace or gate post to the first line post. Diagonal tension members shall connect tautly between posts below horizontal braces.

1. Braces shall be so installed that posts remain plumb when diagonal rod is under proper tension.

F. **Intermediate Brace Posts**: Where straight runs of fencing exceed 500-feet, intermediate brace posts shall be installed, spaced equally between ends or corners; with additional posts provided as required, such that the spacing between intermediate brace posts does not exceed 500-feet. Intermediate brace posts shall be equivalent in size to corner posts and shall be braced with horizontal brace rails and diagonal tension members in both directions.

G. **Top Rails**: Top rails shall be run continuously through post caps, bending to radius for curved runs. Expansion couplings shall be provided as recommended by the fencing manufacturer.

H. **Center Rails**: Center rails shall be provided where indicated. Rails shall be installed in one piece, between posts and flush with posts on fabric side, using special offset fittings where necessary.

I. **Tension Wire**: Continuous bottom tension wire shall be stretched tight with turnbuckles at end, gate, intermediate, and corner posts. Tension wire shall be installed on a straight grade between posts, with approximately 2 inches of space between finish grade and bottom selvage, unless otherwise indicated. Tension wire shall be tied to each post with not less than 6 gauge galvanized wire.

J. Fabric

1. Chain-link fabric shall be fastened on the secured side of the posts.

2. Fabric shall be stretched and securely fastened to posts. Between posts, top and bottom edges of the fabric shall be fastened to the top rail and bottom tension wire, respectively.

3. Fabric shall be stretched and anchored in such a manner that it remains in tension after the pulling force is released.

K. **Tie Wires**: Tie wire shall be bent to conform to the diameter of the pipe to which it is attached, clasping pipe and fabric firmly with ends twisted at least 2 full turns. Ends of wire shall be bent back to minimize hazard to persons or clothing.

1. Fabric shall be tied to line posts with tie wires spaced at 12 inches on center.

2. Fabric shall be tied to rails and braces with tie wires spaced at 24 inches on center.

3. Fabric shall be tied to tension wires, with hog rings spaced 24 inches on center.

L. **Stretcher Bars**: Fabric shall be fastened to end, corner, intermediate brace, and gate posts with stretcher bars. Bars shall be threaded through or clamped to fabric at 4 inches on center and secured to posts with stretcher bar bands spaced no more than 14 inches on center.

M. **Fasteners:** Nuts for tension bands and hardware bolts shall be installed on the side of fence opposite the fabric side. Ends of bolts shall be peened or the threads scored to prevent removal of nuts.

N. Galvanized coating damaged during construction of the fencing shall be repaired by application of **Galvo-Weld**; **Galvinox**; or equal.

O. Damage to PVC coating shall be repaired with material equivalent in color and thickness to the original coating.

3.3 GROUNDING

A. 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 the crossing.

B. Fences, gates and appurtenances enclosing electrical equipment areas, gas yards, or other hazardous areas shall be electrically continuous and grounded.

C. 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 grade.

1. Where driving is impracticable, electrodes shall be buried a minimum of 12 inches deep and radically from the fence. Top of electrode shall be not less than 2-feet or more than 8-feet from the fence.

D. Ground conductor shall be clamped to the fence and electrodes with bronze grounding clamps so as 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.

- END OF SECTION -

SECTION 02900 - LANDSCAPING

PART 1 -- GENERAL

1.1 THE REQUIREMENT

A. The CONTRACTOR shall apply grass seeding and sodding, complete and in place, in accordance with the Contract Documents.

B. Seeding and sodding materials and installation and maintenance methods shall be compatible with Central California Coastal conditions and specified permit requirements, if any.

1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. Federal Specifications:

FS O-F-241D	Fertilizer, Mixed, Commercial.

B. Commercial Standards:

ANSI/ASTM D 422	Method for Particle-Size Analysis of Soils.

1.3 CONTRACTOR SUBMITTALS

A. Furnish submittals in accordance with Section 01300-Contractor Submittals for approval.

B. **Materials List:** A list of all materials to be used in the turfing and seeding operations together with the source of those materials. The list shall include mulches, soil amendments, seed mixtures, sod species, and erosion control blanketing. Manufacturer's literature showing physical characteristics, applications, and installation instrumentation shall be included.

C. **Schedules:** The following work plans, before work is started.

1. Delivery schedule at least 10 days prior to the intended date of the first delivery.

2. Pesticide Treatment Plan, giving proposed sequence of pesticide treatment work, before work is started. The pesticide trade name, chemical composition, formulation, concentration, application rate of active ingredients and methods of application for all materials furnished, and the name and state license number of the state-certified applicator shall be included.

3. Turfing Operation. A list of seeding and mulching equipment to be used in performance of turfing operation, descriptive data, and calibration tests.

4. Plant Establishment Period. Written calendar time period for the beginning of the plant and turf establishment period. When there is more than one establishment period, the boundaries of the planted and turf areas covered for each period shall be described.

D. Reports

1. 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.

2. Reports for the following materials shall be included.

   a. Topsoil: For pH, chemical analysis, mechanical-analysis and particle size.

   b. Fertilizer: For chemical analysis and composition percent.

   c. Pesticide Material: For EPA registration number and registered uses.

   d. Seed: For mixture, percent pure live seed, minimum percent germination and hard seed, maximum percent weed content, date tested and state certification.

   e. Sod: For species, mixture percentage, percent purity, field location and state certification.

   f. Percolation Test

E. **Certificates:** Certificates of compliance that materials meet the indicated requirements prior to the delivery of materials.

F. Records:

1. Plant Establishment Period

2. Maintenance Report

3. Maintenance Instructions

1.4 CLEANUP

A. Upon completion of all seeding/sodding operations, the portion of the Site used for a work or storage area by the CONTRACTOR shall be cleaned of all debris, superfluous materials, equipment, and garbage.

B. Walks and pavement shall be swept or washed clean upon completion of the WORK of this Section.

1.5 MAINTENANCE OF LANDSCAPING PLANTING PRIOR TO ACCEPTANCE OF PROJECT

A. **General:** The CONTRACTOR shall be responsible for protecting, watering, fertilizing, and maintaining turf and seeded areas until final acceptance of the WORK.

B. At time of acceptance, turf areas shall be totally established with no bare spots, mowed a minimum of 4 times, and the grass shall be at least 1-1/4 to 2 inches in height.

C. Upon completion of seeding/sodding, the entire planted area shall be soaked to saturation by a fine spray. The new planting shall be kept watered by the sprinkling system on the Site during dry weather or whenever necessary for proper establishment of the turf. Care shall be taken to avoid excessive washing or puddling on the surface and any such damage caused thereby shall be repaired by the CONTRACTOR.

D. **Protection:** The CONTRACTOR shall provide adequate protection to all newly seeded/sodded areas including the installation of approved temporary fences to prevent trespassing and damage, as well as erosion control, until the end of the one-year correction period.

E. The CONTRACTOR shall replace any materials or equipment it has damaged or which has been damaged by its employees or subcontractors.

F. Partial utilization of the project shall not relieve the CONTRACTOR of any of the requirements of this Section

G. **Mowing of Turf Areas:** First mowing of turf areas shall begin as soon as the grass has reached a height of 3 inches and subsequent mowing shall be at least once a week, or as often as necessary to maintain turf areas at a uniform height of 1-1/2 to 2 inches.

H. Turf areas shall be fertilized every 3 weeks with 6 lb of 16-16-8 commercial fertilizer per 1000 sq ft for the first 7 weeks and fertilized thereafter once each 5 months prior to acceptance and during maintenance and correction period.

I. Maintenance shall include, in addition to the foregoing, cleaning, edging, the repair of erosion, and other maintenance work. Sidewalks and other paved areas shall be kept clean while planting and maintenance are in progress.

1.6 FINAL INSPECTION AND GUARANTEE

A. Inspection of seeded/sodded areas will be made at final acceptance

B. Written notice requesting inspection shall be submitted to the ENGINEER at least 10 days prior to the anticipated inspection date.

C. Any delay in completing the WORK of this Section beyond a single season will be cause for extending the correction of defects period an equal time.

D. The CONTRACTOR shall, without additional expense to the OWNER, replace seeding and sodding which develops defects or dies during the correction period.

PART 2 -- PRODUCTS

2.1 GENERAL

A. Materials for soil conditioning and weed abatement shall be first-grade, commercial quality and shall have certificates indicating the source of material, analysis, quantity, or weight attached to each sack or container or furnished with each delivery. Delivery certificates shall be given to the ENGINEER as each shipment of material is delivered. A list of the materials used, together with typical certificates of each material, shall be submitted to the ENGINEER prior to final acceptance.

2.2 TOPSOIL

A. Topsoil shall be the existing soil stripped to the depth indicated and stockpiled at a location directed by the ENGINEER in accordance with Section 02200 - Earthwork.

B. Additional topsoil, if needed, shall comply with the following:

1. Topsoil shall be obtained from naturally drained areas and shall be fertile, friable loam suitable for plant growth. Topsoil shall be subject to inspection and approval at the source of supply and upon delivery.

2. Topsoil shall be of uniform quality, free from subsoil, stiff or lumpy clay, hard clods, hardpan, rocks, disintegrated debris, plants, roots, seeds, and any other materials that would be toxic or harmful to plant growth. Topsoil shall contain no noxious weeds or noxious weed seeds.

3. Topsoil shall contain at least 6 percent organic matter as determined by loss of weight after ignition of dried (moisture-free) samples in accordance with current methods of the Association of Official Agricultural Chemists.

4. The acidity range of the topsoil shall be (pH 5.5 to pH 7.5). The salinity level shall be less than 3 millimhos/cm.

5. Clay, as determined by the Bouyoucous hydrometer or by the decantation method, shall not exceed 60 percent of the topsoil material.

6. Mechanical analysis shall be performed and shall conform to ANSI/ASTM D 422.

C. Soil Test

1. Topsoil history: A 3-year history of the herbicide(s) used and crops grown on the topsoil shall be provided by the CONTRACTOR. The history shall also be provided to the laboratory performing the soil test.]

2. Topsoil tests: The topsoil shall be tested for pH, particle size, salt levels, chemical analysis, and mechanical analysis, by an independent testing company or agency which uses [Washington State University/University of Idaho] recommended procedures. The soil samples for the soil tests shall be of a quantity and locations so an accurate soil test representative of the soil(s) can be performed. The independent testing company or agency shall outline the soil testing procedures. The ENGINEER will have the right to be present at the time the samples are taken.

3. Topsoil recommendation: The independent test company performing soil test shall establish the quantities and type of soil amendments and fertilizer (initial and maintenance) that the CONTRACTOR shall add to topsoil. The CONTRACTOR shall obtain approval of topsoil and soil amendments by the ENGINEER prior to the beginning of work.

2.3 FERTILIZER AND ADDITIVES

A. Fertilizer shall be furnished in bags or other standard containers with name, weight, and guaranteed analysis of contents clearly marked thereon.

B. Chemical fertilizers shall be a mixed commercial fertilizer conforming to FS O-F-241D, Type I, with percentages of nitrogen, phosphoric acid, and potash at [5-10-5 or 6-10-4]. The combined N-P-K content shall be the following percentages of total weight: [5] percent nitrogen, [10] percent phosphoric acid and [5] percent potash. Fertilizers shall be uniform in composition, dry, and free flowing.

C. Animal fertilizer shall be well-rotted cattle manure, free from sawdust, shaving or refuse of any kind, and shall contain not more than 25 percent straw or litter by volume.

D. Lime shall be dolomitic limestone containing not less than 85 percent of total carbonates. Limestone shall be ground to such fineness that 100 percent will pass a No. 200 sieve.

E. Agricultural gypsum shall be approved standard brand agricultural calcium sulfate ($CaSO_4$) as applied to soils and shall contain 19 percent combined sulfur.

2.4 MULCH

A. **Wood Cellulose Fiber:** Mulch shall not contain any growth or germination-inhibiting factors and shall be dyed an appropriate color to aid visual monitoring during application. Composition on air-dry weight basis: 9 to 15 percent moisture and pH range from 4.5 to 6.0.

B. Straw mulch or native hay for a soil/seed stabilizer shall be clean hay or straw applied at a rate of 3 tons per acre. Mulch shall be crimped into soil with a mulch crimper. Spacing on the blades of the mulch crimper shall be 6 inches minimum and 9 inches maximum. Blades shall be sufficiently weighted to penetrate the ground 3 inches.

2.5 SEED MIXTURES

A. All seed shall conform with applicable County, State of [Idaho], and Federal regulations. Seed shall be mixed by the seed supplier. The CONTRACTOR shall furnish the seed supplier's guaranteed germination of each variety listed in the seed mixture. Grass seed shall not be delivered to the Site until samples have been approved by the ENGINEER. Approval of samples, however, shall not affect the right of the ENGINEER to reject seed upon or after delivery. Seed which has become wet, moldy, or otherwise damaged prior to use will not be accepted.

B. Seed shall be delivered in strong, clearly marked bags not exceeding 50 pounds each.

C. Grass seed shall be fresh, clean, and new-crop seed composed of the following varieties mixed in the proportions by weight as indicated. Seed shall be tested for compliance with the minimum percentage of purity and germination requirements. All rates specified shall be pure live seed (PLS).

D. The seed mixture shall not contain more than 5 percent weeds or other species that are not required.

E. Any deviation of the indicated seed mixture composition shall be approved by the ENGINEER prior to delivery to the Site.

F. The CONTRACTOR is warned that this seed mixture is composed of native grass and grass-like species, but some lead time may be necessary to locate a distributor and have the seed mix prepared.

SEED MIXTURE			
Common Names	**By Weight (percent)**	**Proportion Purity (percent)**	**Germination (percent)**
Type 1: Application rate of 25 lb/acre			
Baron Kentucky Blue Grass	100	90	90
Type 2: Application rate of 30 lb/acre			
Buffalo Grass	33	90	90
Creeping Red Fescue	25	90	90
Fuccinellia	25	90	90
Penn Fine Rye Grass	17	90	90
Type 3: Application rate of 30 lb/acre			
Western Wheat Grass	33	90	90
Fairway Crested Wheat Grass	33	90	90
Buffalo Grass	34	90	90

2.6 SOD GRASS

A. The sod shall be relatively free of thatch, diseases, nematodes, soil-borne insects, weeds or undesirable plants, stones larger than 1-inch in any dimension, woody plant roots and other material detrimental to a healthy stand of turf. Sod that has become dry, moldy, or yellow from heating, or has irregularly shaped pieces of sod and torn or uneven ends shall be rejected.

B. Sod shall be machine cut to a uniform thickness of 1-1/4 inches within a tolerance of 1/4 inch, excluding top growth and thatch. Measurement for thickness shall exclude top growth and thatch.

C. Sod shall contain at least 85 percent permanent grass suitable to the climate in which it is to be placed; not more than 25 percent nursing grass; not more than 10 percent weed and undesirable grasses, and shall be of good texture, free from obnoxious roots, stones and foreign materials.

D. The sod shall be nursery grown Kentucky Bluegrass or Red Fescue sod. It shall be uniformly cut approximately 3/4-inch or more thick and shall be well rooted, 2-year old growth of permanent and desirable grasses indigenous to this general location. The sod shall be practically free from weeds and undesirable grasses.

2.7 FERTILIZER

A. Fertilizer shall be furnished in bags or other standard containers with name, weight, and guarantee analysis of contents clearly marked thereon. Fertilizer containers shall not exceed 50 pounds each.

B. Chemical fertilizers shall be mixed commercial slow-release fertilizer with percentages of nitrogen, phosphoric acid, and potash at 16-16-16. The combined N-P-K content shall be the following percentages of total weight: 16 percent nitrogen, 16 percent phosphoric acid and 16 percent potash. Fertilizers shall be uniform in composition, dry, and free flowing.

2.8 EROSION CONTROL MATERIAL

A. **Soil Erosion Control Blanket:** Blanket shall be machine-produced mat of wood excelsior formed from a web of interlocking wood fibers, covered on one side with either knitted straw blanket-like mat-construction, covered with biodegradable plastic mesh, or interwoven with biodegradable thread, plastic netting or twisted kraft paper cord netting.

B. **Soil Erosion Control Fabric:** Control fabric shall be knitted construction of polypropylene yarn with uniform mesh openings of 314 per 1-inch square with strips of biodegradable paper. Filler paper strips shall last 6 to 8 months.

C. **Soil Erosion Control Net:** Control net shall be heavy, twisted jute mesh weighing approximately 1.22 pounds per linear yard and 4 feet wide with mesh openings of approximately 1 inch square.

D. **Anchors:** Erosion control anchors shall be as recommended by the manufacturer.

2.9 PESTICIDE

A. Pesticide shall be insecticide, herbicide, fungicide, nematocide, rodenticide, and miticide. Pesticide material shall be labeled for use and applied only as registered by EPA and approved.

B. Herbicide shall contain maximum 54 percent alyphosate as an active ingredient. The herbicide shall not contain a surfactant. The herbicide shall allow seeding/sodding to take place 3 days after application of the herbicide.

PART 3 -- EXECUTION

3.1 GENERAL

A. Delivery of seed and fertilizer may begin only after samples and tests have been approved by the ENGINEER. Seed and fertilizer furnished shall not be different from the approved sample.

B. Seeding shall not be performed at any time when it may be impaired by climatic conditions.

3.2 SOIL PREPARATION

A. The seeding shall not begin until the CONTRACTOR has repaired all areas of settlement, erosion, rutting, etc. and the soils have been placed, compacted, and contoured to finish grade. The ENGINEER shall be notified of areas which prevent the planting work from being executed.

B. After removal of waste materials in the planting areas, such as weeds, roots, rocks 6-inches and larger, construction materials, etc., the seeding subgrade shall be scarified and pulverized to a depth of not less than 6 inches and all surface irregularities removed.

C. Areas requiring grading by the CONTRACTOR including adjacent transition areas shall be uniformly level or sloping between finish elevations to within 0.10-ft above or below required finish elevations.

D. Any unusual subsoil condition that will require special treatment shall be reported to the ENGINEER.

E. **Topsoil:** Topsoil shall be distributed uniformly and spread evenly to a minimum thickness of 4 inches on subgrade for turf areas. Subgrade shall be ripped or disked to a depth of 8 to 12 inches. Topsoil shall be spread so that planting can proceed with little additional soil preparation or tillage. Topsoil shall not be placed when the subgrade is frozen, excessively wet, extremely dry, excessively compacted or in a condition detrimental to the proposed planting or grading.

F. **Fertilizer:** Fertilizer shall be applied at the rate of [400] pounds per acre. Fertilizer shall be incorporated into the soil to a minimum depth of 4 inches and may be incorporated as part of the tillage or hydroseeding operation.

G. Tillage

1. Preparation. Turf areas shall be filled as needed or have surplus soil removed to attain the finished grade. Drainage patterns shall be maintained as indicated on drawings. Turf areas compacted by construction operations shall be completely pulverized by tillage.

2. Turf Area Debris. Lawn areas shall have debris and stones larger than 1-inch in any dimension removed from the surface.

3. Protection. Finished graded areas shall be protected from damage by vehicular or pedestrian traffic and erosion.

4. Finish Grading. Finished grade shall be 1-inch below the adjoining grade of any surfaced area. New surfaces shall be blended to existing. Make minor adjustments of finish grades as directed by the ENGINEER.

H. No seeding shall be done when wind velocity exceeds 4 mph, within 4 hours after rain, or if the surface has been compacted without first loosing the ground.

3.3 APPLICATION OF PESTICIDE MATERIAL

A. When pesticide becomes necessary to remove a disease or pest, a state-certified applicator shall apply required pesticide in accordance with State EPA label restrictions and recommendations. Hydraulic equipment for the liquid application of pesticides shall consist of a leak-proof tank, positive agitation methods, controlled application pressure, and metering gauges. A pesticide treatment plan shall be furnished to the ENGINEER as indicated above.

3.4 BROADCAST SEEDING

A. Broadcast seeding shall be performed where indicated or as directed in the field by the ENGINEER.

B. The soil shall be prepared per soil preparation instructions. The ENGINEER will inspect and approve the soil preparation prior to commencing with seeding and fertilizing. The

CONTRACTOR shall prepare only enough ground that can be planted within 24 hours thereafter.

C. Fertilizer shall be evenly applied to the prepared ground at a rate of 350 pounds per acre. Fertilizing shall be completed prior to seeding.

D. Sow seed at the application rates indicated above. Equal quantities of seed shall be sown in two directions at right angles to each other to produce an even distribution of seed over the entire area.

E. The seed shall then be covered with a fine layer of soil to a depth not greater than 1/4-inch.

F. Critical areas within 12 feet of streams or other water bodies shall be mechanically or hand raked to cover seed prior to mulching or installation of erosion control fabric. ENGINEER may designate in the field other areas that require raking.

G. Flat, seeded areas shall be evenly covered with a weed-free straw mulch at the rate of [2,000] pounds per acre. Areas with slopes steeper than 4 horizontal to 1 vertical shall be covered with the indicated erosion control matting.

H. Broadcast seeding method shall be utilized between September 1 and October 30 or between April 1 and June 1.

I. Mechanical application (hydroseeding) is acceptable. The CONTRACTOR shall notify the ENGINEER of proposed method, mulch, and type of equipment to be used and shall receive approval before beginning this operation.

3.5 HYDROSEEDING

A. **General:** Areas labeled turf shall be hydroseeded or drill seeded if flat and larger than 1/2 acre.

B. **Equipment:** Mixing shall be performed in a tank. The tank shall have a built-in continuous agitation and circulation system, of sufficient operating capacity to produce a homogenous slurry of mulch, stabilizer, seed, fertilizer and water in the designated unit proportions for a minimum coverage of one-half acre. The tank shall have a discharge system which will permit attachment of at least 500 feet of hose extensions, a change of elevation of 150 feet in height from tank to discharge nozzle, and still retain enough pressure to apply the slurry to the areas at a continuous and uniform rate.

C. **Proportions:** Proportions per acre shall be as follows:

1. Mulch, 2,500 pounds

2. Seed, proportioned to mixture of seed as specified herein

3. Stabilizer, 120 pounds

4. Fertilizer, 350 pounds

5. Water, 3,000 gallons

D. Application

1. With agitation system operating at part speed, water shall be added to the tank and good recirculation shall be established. Materials shall be added in such a manner that they are uniformly blended into the mixture.

2. When the tank is 1/3 filled with water, add the following materials in the sequence listed:

Sequence	Material
1	Stabilizer, 1/2 acre requirement
2	Three 50-pounds bales mulch
3	Seed, 1/2 acre requirement
4	Fertilizer, 1/2 acre requirement

a. Agitate mixture at full speed when the tank is half filled with water.

b. Add remainder of mulch requirement before tank is 3/4 full.

c. Slurry distribution shall begin immediately. Application of slurry shall be done only when rain is not anticipated for at least three days after slurry application.

d. The entire tank of each batch of slurry shall be emptied and the slurry evenly applied to areas to be hydroseeded within a 2-hour period following the mixing of each slurry batch. Slurry batches not applied during this time will be rejected.

3.6 DRILL SEEDING

A. Flat areas larger than 1/2 acre in size that are designated for seeding in the Contract Documents shall be seeded by drilling.

B. **Seeding:** Seed shall be uniformly drilled to an average depth of 1/4- to 1/2-inch at the rate specified using equipment having drills not more than 6-1/2 inches apart. Row markers shall be used with the drill seeder. Drill seeding shall take place 3 days after application of herbicide.

C. **Rolling:** Immediately after seeding, the entire area shall be firmed with a roller not exceeding 90 pounds for each foot of roller width. Areas seeded with drills equipped with rollers shall not be rolled.

D. **Water:** Watering shall be started within 4 days after completing the seeded area. Water shall be applied at a rate sufficient to ensure moist soil conditions to a minimum depth of 2 inches. Run-off and puddling shall be prevented.

3.7 SOD PLACEMENT

A. **Sodding Period:** Sod shall be placed from March 30 to June 1 for spring planting and from September 15 to November 1 for fall planting.

B. Areas shall be sodded as indicated. Adequate soil moisture shall be ensured prior to sodding by spraying water on the area to be sodded and wetting the soil to a minimum depth of 1 inch.

C. **Placing Sod:** Rows of sod shall be placed parallel to and tightly against each other. joints shall be staggered laterally. The sod strips shall not be stretched or overlapped. All joints shall be butted tight. Voids and air drying of roots shall be prevented. On long slopes, sod shall be laid at right angles to slopes. In ditches, sod shall be laid at right angles to the flow of water. When required, the sod shall be anchored by placing anchors a minimum distance of 2 feet on center with a minimum of 2 anchors per sod section.

D. **Finishing:** All air pockets shall be eliminated and a true and even surface shall be provided by tamping or rolling the sod in place. Displacement of the sod shall be assured by knitting of sod to the soil. Frayed edges shall be trimmed and holes or missing corners shall be patched in the sod.

E. **Water Sod:** Watering shall be started immediately after completing each day of sodding. Water shall be applied at a rate of 1-1/2 inches of water per week and at sufficient intervals to ensure moist soil conditions to a minimum depth of 1 inch. Run-off and puddling shall be prevented

3.8 EROSION CONTROL INSTALLATION

A. Erosion control material is required on slopes greater than 4 to 1. Erosion control material shall be installed in accordance with manufacturer's instructions. Placement of the erosion control material shall be accomplished without damage to installed material or without deviation to finished grade.

- END OF SECTION -

SECTION 02910 - TREE PROTECTION AND TRIMMING

PART 1 -- GENERAL

1.1 THE REQUIREMENT

A. **Scope of Work:** The WORK includes labor, equipment, and materials necessary for existing tree protection and trimming.

1.2 QUALITY ASSURANCE

A. **Standards;** Code of Standards of the American Association of Nurserymen and the American Standard for Nursery Stock and national Arbor Standards for Pruning and Guying of Shade Trees.

B. Arrange a preconstruction meeting to review schedule and specification.

1.3 CONTRACTOR SUBMITTALS

A. **Schedule for Work Plan:** Submit detailed schedule and work plan for each part of the WORK.

B. **Chain Link Protection Fencing:** Submit proposed methods and sequence of site preparation to the ENGINEER for review prior to start of WORK.

1.4 PROJECT CONDITIONS

A. Existing Conditions:

1. Carefully examine the site before submitting a bid. Be informed of the site conditions including adjacent properties, utilities and soil conditions.

2. Should the CONTRACTOR find any discrepancies between the Contract Drawings and physical conditions, inform the ENGINEER immediately for clarification.

1.5 PROTECTION

A. Use every precaution to prevent damage and provide protection as necessary to existing plant material. CONTRACTOR shall repair or replace to original condition, any material or work damaged or destroyed to a condition acceptable to the ENGINEER, at no additional cost to the OWNER.

B. The CONTRACTOR shall be responsible for providing additional temporary fencing as necessary during the WORK to protect vegetation.

PART 2 -- PRODUCTS

2.1 CHAIN LINK FENCE FOR TREE PROTECTION

A. **Frame:** ASTM A 120, schedule 40 steel pipe, standard weight, 1-piece without joints.

B. Fabric 2-inch diamond mesh steel wire, interwoven, 11-gage, top salvage twisted tight, bottom salvage knuckle and closed. RS RR-F-191, type 1, zinc-coated steel.

C. **Line Posts:** 1-1/2-inch diameter steel pipe.

D. **Corner and Terminal Posts:** 2.88-inch steel pipe.

E. **Fittings:** Sleeves, bonds, clips, rail ends, tension bars, fasteners and fittings, steel.

F. **Tension Wire:** 6-gage thick steel, single strand.

G. **Top Rail and Post Braces:** 1.5-inch o.d. schedule 40 galvanized pipe.

PART 3 -- EXECUTION

3.1 PREPARATION

A. **Flagging of Existing Trees**: Flag trees to remain and to be removed with a bright colored ribbon. Notify the ENGINEER at least 48 hours prior to commencing of WORK to verify all trees that are flagged.

B. Do not park any vehicles or equipment, nor store any materials or stockpiled soil, nor dispose of building materials, chemicals, petroleum products or other detrimental substances within drip line of trees to remain. Protect trees from flame, smelts and heat. Construction scores to site shall not occur beneath drip line of trees.

3.2 EXISTING TREES TO REMAIN

A. General:

1. Protect root systems from smothering. Restrict foot traffic to prevent excessive compaction of soil over root systems.

2. Individual trees and areas shown to remain shall be protected by orange mesh placed along the drip line. Install mesh before site preparation, grading and clearing and grubbing operations.

3. All plants to remain on-site shall be watered as necessary during entire construction contract.

4. Under no circumstances shall the CONTRACTOR remove existing trees designated to remain for convenience or ease of construction.

5. Prior to installation, stake the location of protection fencing for approval by the ENGINEER. Location stakes or marking shall be placed not greater than 10-feet on-center.

B. Excavation Around Trees:

1. Excavation adjacent to existing trees and shrubs: Where it is necessary to excavate in close proximity to existing trees and shrubs, all possible caution shall be exercised to avoid injury to roots and trunk. Excavation close to trees shall be by hand, tunneling under roots 2 inches and larger in diameter, and shall be only on the approval of the Landscape Architect. Within 24 hours, CONTRACTOR shall

paint cut roots of trees to remain on site. Where this is not possible, CONTRACTOR shall keep the side of excavation adjacent to tree shaded with moist burlap or canvas.

2. Excavate within drip line of trees only where shown.

3. Where trenching for utilities is required within drip line, tunnel under or around roots by hand digging. Do not cut main lateral roots or tap roots. The CONTRACTOR shall notify the ENGINEER prior to cutting roots over 6 inches in diameter. Roots up to and including 3/4-inch shall be cut by hand saws. Do not leave roots exposed to sun or drying for more than 24 hours. Protect all exposed roots with moist organic mulch or burlap and backfill as soon as possible.

4. Where excavating for new construction is required within drip line of tree, excavate by hand to minimize damage to roots and perform as follows:

   a. Use narrow tine spacing forks and comb soil to expose roots.

   b. If main lateral roots are immediately adjacent to location of new construction cut roots 3 inches from new construction.

   c. Do not allow exposed roots to dry out before permanent backfill is placed.

   d. Provide temporary earth cover, or pack with peat moss and wrap with burlap.

   e. Water and maintain in moist condition until covered with backfill.

C. Guarantee:

1. Trees which are protected within fencing that become damaged or die within one year after completion of the WORK shall be replaced with trees of the same species and equal size by the CONTRACTOR at no additional cost to the OWNER.

2. Damaged and destroyed trees which cannot be replaced shall be paid for at the rate of $50.00 per square inch of cross sectional area measured 3 feet above existing grade for trees up to and including 6-inch caliper, and at the rate of $100.00 per square inch of cross sectional areas measured 3 feet above existing grade for trees greater than 6-inch caliper. This amount shall be credited to the OWNER.

3. These damaged and destroyed trees shall be removed from the site, the stumps grubbed and the ground surface repaired with all costs borne by the CONTRACTOR.

- END OF SECTION -

SECTION 02930 - SEEDING AND SODDING

PART 1 -- GENERAL

1.1 THE REQUIREMENT

A. The CONTRACTOR shall apply grass seeding and sodding, complete and in place, in accordance with the Contract Documents.

B. Seeding and sodding materials and installation and maintenance methods shall be compatible with Central California Coastal conditions and specified permit requirements, if any.

1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. Federal Specifications:

FS O-F-241D	Fertilizer, Mixed, Commercial.

B. Commercial Standards:

ANSI/ASTM D 422	Method for Particle-Size Analysis of Soils.

1.3 CONTRACTOR SUBMITTALS

A. Furnish submittals in accordance with Section 01300-Contractor Submittals for approval.

B. **Materials List:** A list of all materials to be used in the turfing and seeding operations together with the source of those materials. The list shall include mulches, soil amendments, seed mixtures, sod species, and erosion control blanketing. Manufacturer's literature showing physical characteristics, applications, and installation instrumentation shall be included.

C. **Schedules:** The following work plans, before work is started.

1. Delivery schedule at least 10 days prior to the intended date of the first delivery.

2. Pesticide Treatment Plan, giving proposed sequence of pesticide treatment work, before work is started. The pesticide trade name, chemical composition, formulation, concentration, application rate of active ingredients and methods of application for all materials furnished, and the name and state license number of the state-certified applicator shall be included.

3. Turfing Operation. A list of seeding and mulching equipment to be used in performance of turfing operation, descriptive data, and calibration tests.

4. Plant Establishment Period. Written calendar time period for the beginning of the plant and turf establishment period. When there is more than one establishment period, the boundaries of the planted and turf areas covered for each period shall be described.

D. Reports

1. 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.

2. Reports for the following materials shall be included.

   a. Topsoil: For pH, chemical analysis, mechanical-analysis and particle size.

   b. Fertilizer: For chemical analysis and composition percent.

   c. Pesticide Material: For EPA registration number and registered uses.

   d. Seed: For mixture, percent pure live seed, minimum percent germination and hard seed, maximum percent weed content, date tested and state certification.

   e. Sod: For species, mixture percentage, percent purity, field location and state certification.

   f. Percolation Test

E. **Certificates:** Certificates of compliance that materials meet the indicated requirements prior to the delivery of materials.

F. Records:

1. Plant Establishment Period

2. Maintenance Report

3. Maintenance Instructions

1.4 CLEANUP

A. Upon completion of all seeding/sodding operations, the portion of the Site used for a work or storage area by the CONTRACTOR shall be cleaned of all debris, superfluous materials, equipment, and garbage.

B. Walks and pavement shall be swept or washed clean upon completion of the WORK of this Section.

1.5 MAINTENANCE OF LANDSCAPING PLANTING PRIOR TO ACCEPTANCE OF PROJECT

A. **General:** The CONTRACTOR shall be responsible for protecting, watering, fertilizing, and maintaining turf and seeded areas until final acceptance of the WORK.

B. At time of acceptance, turf areas shall be totally established with no bare spots, mowed a minimum of 4 times, and the grass shall be at least 1-1/4 to 2 inches in height.

C. Upon completion of seeding/sodding, the entire planted area shall be soaked to saturation by a fine spray. The new planting shall be kept watered by the sprinkling system on the Site during dry weather or whenever necessary for proper establishment of the turf. Care shall be taken to avoid excessive washing or puddling on the surface and any such damage caused thereby shall be repaired by the CONTRACTOR.

D. **Protection:** The CONTRACTOR shall provide adequate protection to all newly seeded/sodded areas including the installation of approved temporary fences to prevent trespassing and damage, as well as erosion control, until the end of the one-year correction period.

E. The CONTRACTOR shall replace any materials or equipment it has damaged or which has been damaged by its employees or subcontractors.

F. Partial utilization of the project shall not relieve the CONTRACTOR of any of the requirements of this Section

G. **Mowing of Turf Areas:** First mowing of turf areas shall begin as soon as the grass has reached a height of 3 inches and subsequent mowing shall be at least once a week, or as often as necessary to maintain turf areas at a uniform height of 1-1/2 to 2 inches.

H. Turf areas shall be fertilized every 3 weeks with 6 lb of 16-16-8 commercial fertilizer per 1000 sq ft for the first 7 weeks and fertilized thereafter once each 5 months prior to acceptance and during maintenance and correction period.

I. Maintenance shall include, in addition to the foregoing, cleaning, edging, the repair of erosion, and other maintenance work. Sidewalks and other paved areas shall be kept clean while planting and maintenance are in progress.

1.6 FINAL INSPECTION AND GUARANTEE

A. Inspection of seeded/sodded areas will be made at final acceptance

B. Written notice requesting inspection shall be submitted to the ENGINEER at least 10 days prior to the anticipated inspection date.

C. Any delay in completing the WORK of this Section beyond a single season will be cause for extending the correction of defects period an equal time.

D. The CONTRACTOR shall, without additional expense to the OWNER, replace seeding and sodding which develops defects or dies during the correction period.

PART 2 -- PRODUCTS

2.1 GENERAL

A. Materials for soil conditioning and weed abatement shall be first-grade, commercial quality and shall have certificates indicating the source of material, analysis, quantity, or weight attached to each sack or container or furnished with each delivery. Delivery certificates shall be given to the ENGINEER as each shipment of material is delivered. A list of the materials used, together with typical certificates of each material, shall be submitted to the ENGINEER prior to final acceptance.

2.2 TOPSOIL

A. Topsoil shall be the existing soil stripped to the depth indicated and stockpiled at a location directed by the ENGINEER in accordance with Section 02200 - Earthwork.

B. Additional topsoil, if needed, shall comply with the following:

1. Topsoil shall be obtained from naturally drained areas and shall be fertile, friable loam suitable for plant growth. Topsoil shall be subject to inspection and approval at the source of supply and upon delivery.

2. Topsoil shall be of uniform quality, free from subsoil, stiff or lumpy clay, hard clods, hardpan, rocks, disintegrated debris, plants, roots, seeds, and any other materials that would be toxic or harmful to plant growth. Topsoil shall contain no noxious weeds or noxious weed seeds.

3. Topsoil shall contain at least 6 percent organic matter as determined by loss of weight after ignition of dried (moisture-free) samples in accordance with current methods of the Association of Official Agricultural Chemists.

4. The acidity range of the topsoil shall be (pH 5.5 to pH 7.5). The salinity level shall be less than 3 millimhos/cm.

5. Clay, as determined by the Bouyoucous hydrometer or by the decantation method, shall not exceed 60 percent of the topsoil material.

6. Mechanical analysis shall be performed and shall conform to ANSI/ASTM D 422.

C. Soil Test

1. Topsoil history: A 3-year history of the herbicide(s) used and crops grown on the topsoil shall be provided by the CONTRACTOR. The history shall also be provided to the laboratory performing the soil test.]

2. Topsoil tests: The topsoil shall be tested for pH, particle size, salt levels, chemical analysis, and mechanical analysis, by an independent testing company or agency which uses [Washington State University/University of Idaho] recommended procedures. The soil samples for the soil tests shall be of a quantity and locations so an accurate soil test representative of the soil(s) can be performed. The independent testing company or agency shall outline the soil testing procedures. The ENGINEER will have the right to be present at the time the samples are taken.

3. Topsoil recommendation: The independent test company performing soil test shall establish the quantities and type of soil amendments and fertilizer (initial and maintenance) that the CONTRACTOR shall add to topsoil. The CONTRACTOR shall obtain approval of topsoil and soil amendments by the ENGINEER prior to the beginning of work.

2.3 FERTILIZER AND ADDITIVES

A. Fertilizer shall be furnished in bags or other standard containers with name, weight, and guaranteed analysis of contents clearly marked thereon.

B. Chemical fertilizers shall be a mixed commercial fertilizer conforming to FS O-F-241D, Type I, with percentages of nitrogen, phosphoric acid, and potash at [5-10-5 or 6-10-4]. The combined N-P-K content shall be the following percentages of total weight: [5] percent nitrogen, [10] percent phosphoric acid and [5] percent potash. Fertilizers shall be uniform in composition, dry, and free flowing.

C. Animal fertilizer shall be well-rotted cattle manure, free from sawdust, shaving or refuse of any kind, and shall contain not more than 25 percent straw or litter by volume.

D. Lime shall be dolomitic limestone containing not less than 85 percent of total carbonates. Limestone shall be ground to such fineness that 100 percent will pass a No. 200 sieve.

E. Agricultural gypsum shall be approved standard brand agricultural calcium sulfate ($CaSO_4$) as applied to soils and shall contain 19 percent combined sulfur.

2.4 MULCH

A. **Wood Cellulose Fiber:** Mulch shall not contain any growth or germination-inhibiting factors and shall be dyed an appropriate color to aid visual monitoring during application. Composition on air-dry weight basis: 9 to 15 percent moisture and pH range from 4.5 to 6.0.

B. Straw mulch or native hay for a soil/seed stabilizer shall be clean hay or straw applied at a rate of 3 tons per acre. Mulch shall be crimped into soil with a mulch crimper. Spacing on the blades of the mulch crimper shall be 6 inches minimum and 9 inches maximum. Blades shall be sufficiently weighted to penetrate the ground 3 inches.

2.5 SEED MIXTURES

A. All seed shall conform with applicable County, State of [Idaho], and Federal regulations. Seed shall be mixed by the seed supplier. The CONTRACTOR shall furnish the seed supplier's guaranteed germination of each variety listed in the seed mixture. Grass seed shall not be delivered to the Site until samples have been approved by the ENGINEER. Approval of samples, however, shall not affect the right of the ENGINEER to reject seed upon or after delivery. Seed which has become wet, moldy, or otherwise damaged prior to use will not be accepted.

B. Seed shall be delivered in strong, clearly marked bags not exceeding 50 pounds each.

C. Grass seed shall be fresh, clean, and new-crop seed composed of the following varieties mixed in the proportions by weight as indicated. Seed shall be tested for compliance with the minimum percentage of purity and germination requirements. All rates specified shall be pure live seed (PLS).

D. The seed mixture shall not contain more than 5 percent weeds or other species that are not required.

E. Any deviation of the indicated seed mixture composition shall be approved by the ENGINEER prior to delivery to the Site.

F. The CONTRACTOR is warned that this seed mixture is composed of native grass and grass-like species, but some lead time may be necessary to locate a distributor and have the seed mix prepared.

SEED MIXTURE			
Common Names	**By Weight (percent)**	**Proportion Purity (percent)**	**Germination (percent)**
Type 1: Application rate of 25 lb/acre			
Baron Kentucky Blue Grass	100	90	90
Type 2: Application rate of 30 lb/acre			
Buffalo Grass	33	90	90
Creeping Red Fescue	25	90	90
Fuccinellia	25	90	90
Penn Fine Rye Grass	17	90	90
Type 3: Application rate of 30 lb/acre			
Western Wheat Grass	33	90	90
Fairway Crested Wheat Grass	33	90	90
Buffalo Grass	34	90	90

2.6 SOD GRASS

A. The sod shall be relatively free of thatch, diseases, nematodes, soil-borne insects, weeds or undesirable plants, stones larger than 1-inch in any dimension, woody plant roots and other material detrimental to a healthy stand of turf. Sod that has become dry, moldy, or yellow from heating, or has irregularly shaped pieces of sod and torn or uneven ends shall be rejected.

B. Sod shall be machine cut to a uniform thickness of 1-1/4 inches within a tolerance of 1/4 inch, excluding top growth and thatch. Measurement for thickness shall exclude top growth and thatch.

C. Sod shall contain at least 85 percent permanent grass suitable to the climate in which it is to be placed; not more than 25 percent nursing grass; not more than 10 percent weed and undesirable grasses, and shall be of good texture, free from obnoxious roots, stones and foreign materials.

D. The sod shall be nursery grown Kentucky Bluegrass or Red Fescue sod. It shall be uniformly cut approximately 3/4-inch or more thick and shall be well rooted, 2-year old growth of permanent and desirable grasses indigenous to this general location. The sod shall be practically free from weeds and undesirable grasses.

2.7 FERTILIZER

A. Fertilizer shall be furnished in bags or other standard containers with name, weight, and guarantee analysis of contents clearly marked thereon. Fertilizer containers shall not exceed 50 pounds each.

B. Chemical fertilizers shall be mixed commercial slow-release fertilizer with percentages of nitrogen, phosphoric acid, and potash at 16-16-16. The combined N-P-K content shall be the following percentages of total weight: 16 percent nitrogen, 16 percent phosphoric acid and 16 percent potash. Fertilizers shall be uniform in composition, dry, and free flowing.

2.8 EROSION CONTROL MATERIAL

A. **Soil Erosion Control Blanket:** Blanket shall be machine-produced mat of wood excelsior formed from a web of interlocking wood fibers, covered on one side with either knitted straw blanket-like mat-construction, covered with biodegradable plastic mesh, or interwoven with biodegradable thread, plastic netting or twisted kraft paper cord netting.

B. **Soil Erosion Control Fabric:** Control fabric shall be knitted construction of polypropylene yarn with uniform mesh openings of 314 per 1-inch square with strips of biodegradable paper. Filler paper strips shall last 6 to 8 months.

C. **Soil Erosion Control Net:** Control net shall be heavy, twisted jute mesh weighing approximately 1.22 pounds per linear yard and 4 feet wide with mesh openings of approximately 1 inch square.

D. **Anchors:** Erosion control anchors shall be as recommended by the manufacturer.

2.9 PESTICIDE

A. Pesticide shall be insecticide, herbicide, fungicide, nematocide, rodenticide, and miticide. Pesticide material shall be labeled for use and applied only as registered by EPA and approved.

B. Herbicide shall contain maximum 54 percent alyphosate as an active ingredient. The herbicide shall not contain a surfactant. The herbicide shall allow seeding/sodding to take place 3 days after application of the herbicide.

PART 3 -- EXECUTION

3.1 GENERAL

A. Delivery of seed and fertilizer may begin only after samples and tests have been approved by the ENGINEER. Seed and fertilizer furnished shall not be different from the approved sample.

B. Seeding shall not be performed at any time when it may be impaired by climatic conditions.

3.2 SOIL PREPARATION

A. The seeding shall not begin until the CONTRACTOR has repaired all areas of settlement, erosion, rutting, etc. and the soils have been placed, compacted, and contoured to finish grade. The ENGINEER shall be notified of areas which prevent the planting work from being executed.

B. After removal of waste materials in the planting areas, such as weeds, roots, rocks 6-inches and larger, construction materials, etc., the seeding subgrade shall be scarified and pulverized to a depth of not less than 6 inches and all surface irregularities removed.

C. Areas requiring grading by the CONTRACTOR including adjacent transition areas shall be uniformly level or sloping between finish elevations to within 0.10-ft above or below required finish elevations.

D. Any unusual subsoil condition that will require special treatment shall be reported to the ENGINEER.

E. **Topsoil:** Topsoil shall be distributed uniformly and spread evenly to a minimum thickness of 4 inches on subgrade for turf areas. Subgrade shall be ripped or disked to a depth of 8-12 inches. Topsoil shall be spread so that planting can proceed with little additional soil preparation or tillage. Topsoil shall not be placed when the subgrade is frozen, excessively wet, extremely dry, excessively compacted or in a condition detrimental to the proposed planting or grading.

F. **Fertilizer:** Fertilizer shall be applied at the rate of [400] pounds per acre. Fertilizer shall be incorporated into the soil to a minimum depth of 4 inches and may be incorporated as part of the tillage or hydroseeding operation.

G. Tillage

1. Preparation. Turf areas shall be filled as needed or have surplus soil removed to attain the finished grade. Drainage patterns shall be maintained as indicated on drawings. Turf areas compacted by construction operations shall be completely pulverized by tillage.

2. Turf Area Debris. Lawn areas shall have debris and stones larger than 1 inch in-any dimension removed from the surface.

3. Protection. Finished graded areas shall be protected from damage by vehicular or pedestrian traffic and erosion.

4. Finish Grading. Finished grade shall be 1 inch below the adjoining grade of any surfaced area. New surfaces shall be blended to existing. Make minor adjustments of finish grades as directed by the ENGINEER.

H. No seeding shall be done when wind velocity exceeds 4 mph, within 4 hours after rain, or if the surface has been compacted without first loosing the ground.

3.3 APPLICATION OF PESTICIDE MATERIAL

A. When pesticide becomes necessary to remove a disease or pest, a state-certified applicator shall apply required pesticide in accordance with State EPA label restrictions and recommendations. Hydraulic equipment for the liquid application of pesticides shall consist of a leak-proof tank, positive agitation methods, controlled application pressure, and metering gauges. A pesticide treatment plan shall be furnished to the ENGINEER as indicated above.

3.4 BROADCAST SEEDING

A. Broadcast seeding shall be performed where indicated or as directed in the field by the ENGINEER.

B. The soil shall be prepared per soil preparation instructions. The ENGINEER will inspect and approve the soil preparation prior to commencing with seeding and fertilizing. The

CONTRACTOR shall prepare only enough ground that can be planted within 24 hours thereafter.

C. Fertilizer shall be evenly applied to the prepared ground at a rate of 350 pounds per acre. Fertilizing shall be completed prior to seeding.

D. Sow seed at the application rates indicated above. Equal quantities of seed shall be sown in two directions at right angles to each other to produce an even distribution of seed over the entire area.

E. The seed shall then be covered with a fine layer of soil to a depth not greater than 1/4-inch.

F. Critical areas within 12 feet of streams or other water bodies shall be mechanically or hand raked to cover seed prior to mulching or installation of erosion control fabric. ENGINEER may designate in the field other areas that require raking.

G. Flat, seeded areas shall be evenly covered with a weed-free straw mulch at the rate of [2,000] pounds per acre. Areas with slopes steeper than 4 horizontal to 1 vertical shall be covered with the indicated erosion control matting.

H. Broadcast seeding method shall be utilized between September 1 and October 30 or between April 1 and June 1.

I. Mechanical application (hydroseeding) is acceptable. The CONTRACTOR shall notify the ENGINEER of proposed method, mulch, and type of equipment to be used and shall receive approval before beginning this operation.

3.5 HYDROSEEDING

A. **General:** Areas labeled turf shall be hydroseeded or drill seeded if flat and larger than 1/2 acre.

B. **Equipment:** Mixing shall be performed in a tank. The tank shall have a built-in continuous agitation and circulation system, of sufficient operating capacity to produce a homogenous slurry of mulch, stabilizer, seed, fertilizer and water in the designated unit proportions for a minimum coverage of one-half acre. The tank shall have a discharge system which will permit attachment of at least 500 feet of hose extensions, a change of elevation of 150 feet in height from tank to discharge nozzle, and still retain enough pressure to apply the slurry to the areas at a continuous and uniform rate.

C. **Proportions:** Proportions per acre shall be as follows:

1. Mulch, 2,500 pounds

2. Seed, proportioned to mixture of seed as specified herein

3. Stabilizer, 120 pounds

4. Fertilizer, 350 pounds

5. Water, 3,000 gallons

D. Application

1. With agitation system operating at part speed, water shall be added to the tank and good recirculation shall be established. Materials shall be added in such a manner that they are uniformly blended into the mixture.

2. When the tank is 1/3 filled with water, add the following materials in the sequence listed:

Sequence	Material
1	Stabilizer, 1/2 acre requirement
2	Three 50-pounds bales mulch
3	Seed, 1/2 acre requirement
4	Fertilizer, 1/2 acre requirement

a. Agitate mixture at full speed when the tank is half filled with water.

b. Add remainder of mulch requirement before tank is 3/4 full.

c. Slurry distribution shall begin immediately. Application of slurry shall be done only when rain is not anticipated for at least three days after slurry application.

d. The entire tank of each batch of slurry shall be emptied and the slurry evenly applied to areas to be hydroseeded within a 2-hour period following the mixing of each slurry batch. Slurry batches not applied during this time will be rejected.

3.6 DRILL SEEDING

A. Flat areas larger than 1/2 acre in size that are designated for seeding in the Contract Documents shall be seeded by drilling.

B. **Seeding:** Seed shall be uniformly drilled to an average depth of 1/4 to 1/2 inch at the rate specified using equipment having drills not more than 6-1/2 inches apart. Row markers shall be used with the drill seeder. Drill seeding shall take place 3 days after application of herbicide.

C. **Rolling:** Immediately after seeding, the entire area shall be firmed with a roller not exceeding 90 pounds for each foot of roller width. Areas seeded with drills equipped with rollers shall not be rolled.

D. **Water:** Watering shall be started within 4 days after completing the seeded area. Water shall be applied at a rate sufficient to ensure moist soil conditions to a minimum depth of 2 inches. Run-off and puddling shall be prevented.

3.7 SOD PLACEMENT

A. **Sodding Period:** Sod shall be placed from March 30 to June 1 for spring planting and from September 15 to November 1 for fall planting.

B. Areas shall be sodded as indicated. Adequate soil moisture shall be ensured prior to sodding by spraying water on the area to be sodded and wetting the soil to a minimum depth of 1 inch.

C. **Placing Sod:** Rows of sod shall be placed parallel to and tightly against each other. joints shall be staggered laterally. The sod strips shall not be stretched or overlapped. All joints shall be butted tight. Voids and air drying of roots shall be prevented. On long slopes, sod shall be laid at right angles to slopes. In ditches, sod shall be laid at right angles to the flow of water. When required, the sod shall be anchored by placing anchors a minimum distance of 2 feet on center with a minimum of 2 anchors per sod section.

D. **Finishing:** All air pockets shall be eliminated and a true and even surface shall be provided by tamping or rolling the sod in place. Displacement of the sod shall be assured by knitting of sod to the soil. Frayed edges shall be trimmed and holes or missing corners shall be patched in the sod.

E. **Water Sod:** Watering shall be started immediately after completing each day of sodding. Water shall be applied at a rate of 1-1/2 inches of water per week and at sufficient intervals to ensure moist soil conditions to a minimum depth of 1 inch. Run-off and puddling shall be prevented

3.8 EROSION CONTROL INSTALLATION

A. Erosion control material is required on slopes greater than 4 to 1. Erosion control material shall be installed in accordance with manufacturer's instructions. Placement of the erosion control material shall be accomplished without damage to installed material or without deviation to finished grade.

- END OF SECTION -

SECTION 03100 - CONCRETE FORMWORK

PART 1 -- GENERAL

1.1 THE REQUIREMENT

A. The CONTRACTOR shall furnish concrete formwork, bracing, shoring, and supports for cast-in-place concrete and shall design and construct falsework in accordance with the Contract Documents.

1.2 CONTRACTOR SUBMITTALS

A. Furnish submittals in accordance with Section 01300 - Contractor Submittals.

B. Manufacturer's information demonstrating compliance with requirements for the following:

1. Form ties and related accessories, including taper tie plugs, if taper ties are used.

2. Form gaskets.

3. Form release agent, including NSF certification if not using mineral oil.

4. List of form materials and locations for use.

C. **Shop Drawings:** Detailed plans for the fabrication and erection of falsework to be used. Such plans shall be in sufficient detail to indicate the general layout, sizes of members, anticipated stresses, grade of materials to be used in the falsework, means of protecting existing construction which supports falsework, and typical soil conditions. Include a list of form materials and locations for use.

D. **Falsework Calculations and Drawings:** The CONTRACTOR's attention is directed to the provisions of Section 1717 of the Division of Industrial Safety, Construction Safety Orders, as revised November 1973, which requires that all falsework or vertical shoring installations where the height of the falsework or vertical shoring, as measured from the top of the sills to the soffit of the superstructure, exceeds 14 feet, or where individual horizontal span lengths exceed 16 feet, or provision for vehicular or railroad traffic through falsework or vertical shoring is made, shall be approved and signed by a civil engineer, registered in the State of California; provided further, that a copy of the falsework plan or shoring layout shall be available on the job site at all times.

1.3 QUALITY ASSURANCE

A. **Tolerances:** The variation from required lines or grade shall not exceed 1/4-inch in 10 feet, non-cumulative, and there shall be no offsets or visible waviness in the finished surface. All other tolerances shall be within the tolerances of ACI 117 - Standard Tolerances for Concrete Construction and Materials

PART 2 -- PRODUCTS

2.1 GENERAL

A. Except as otherwise expressly accepted by the ENGINEER, lumber brought on the Site for use as forms, shoring, or bracing shall be new material. Forms shall be smooth surface forms and shall be of the following materials:

Walls	-	Steel, fiberglass, or plywood panel
Columns	-	Steel, plywood or fiberglass
Roof and floor	-	Plywood
All other work	-	Steel panels, fiberglass, plywood or tongue and groove lumber

B. Form materials which may remain or leave residues on or in the concrete shall be certified as compliant with NSF Standard 61 – Drinking Water System Components.

2.2 FORM AND FALSEWORK MATERIALS

A. Materials for concrete forms, formwork, and falsework shall conform to the following requirements:

1. Lumber shall be Douglas Fir or Southern Yellow Pine, construction grade or better, in conformance with U.S. Product Standard PS 20 - American Softwood Lumber Standard

   Plywood for concrete formwork shall be new, waterproof, synthetic resin bonded, exterior type Douglas Fir or Southern Yellow Pine plywood manufactured especially for concrete formwork, shall conform to the requirements of PS 1 – Construction and Industrial Plywood, for Concrete Forms, Class I, and shall be edge sealed.

2. Form materials shall be metal, wood, plywood, or other material that will not adversely affect the concrete and will facilitate placement of concrete to the shape, form, line, and grade indicated. Metal forms shall accomplish such results. Wood forms for surfaces to be painted shall be Medium Density Overlaid plywood, MDO Ext. Grade.

B. Unless otherwise indicated, exterior corners in concrete members shall be provided with 3/4-inch chamfers or be tooled to 1/2-inch radius. Re-entrant corners in concrete members shall not have fillets unless otherwise indicated.

C. Forms and falsework to support the roof and floor slabs shall be designed for the total dead load, plus a live load of 50 psf minimum. The minimum design load for combined dead and live loads shall be 100 psf.

2.3 FORM TIES

A. Form ties shall be provided with a plastic cone or other suitable means for forming a conical hole to insure that the form tie may be broken off back of the face of the concrete. The maximum diameter of removable cones for rod ties, or of other removable form-tie fasteners having a circular cross-section, shall not exceed 1-1/2 inches; and all such fasteners shall be such as to leave holes of regular shape for reaming. Form ties for water-retaining structures shall have integral waterstops that tightly fit the form tie so that they cannot be moved from mid-point of the tie. Form ties shall be **Wrench Head Snap Tie** by **MeadowBurke; Snap-Ties** by **Dayton/Richmond;** or equal.

B. Removable taper ties may be used when approved by the ENGINEER. A preformed neoprene or polyurethane tapered plug sized to seat at the center of the wall shall be inserted in the hole left by the removal of the taper tie. Use **Taper-Tie** by **MeadowBurke; Taper-Tie** by **Dayton/Richmond;** or equal.

PART 3 -- EXECUTION

3.1 GENERAL

A. Forms to confine the concrete and shape it to the required lines shall be used wherever necessary. The CONTRACTOR shall assume full responsibility for the adequate design of all forms, and any forms which are unsafe or inadequate in any respect shall promptly be removed from the WORK and replaced. Provide worker protection from protruding reinforcement bars in accordance with applicable safety codes. A sufficient number of forms of each kind shall be available to permit the required rate of progress to be maintained. The design and inspection of concrete forms, falsework, and shoring shall comply with applicable local, state, and Federal regulations. Plumb and string lines shall be installed before concrete placement and shall be maintained during placement. Such lines shall be used by CONTRACTOR's personnel and by the ENGINEER and shall be in sufficient number and properly installed. During concrete placement, the CONTRACTOR shall continually monitor plumb and string line form positions and immediately correct deficiencies.

B. Concrete forms shall conform to the shape, lines, and dimensions of members required, and shall be substantial, free from surface defects, and sufficiently tight to prevent leakage. Forms shall be properly braced or tied together to maintain their position and shape under a load of freshly-placed concrete. If adequate foundation for shores cannot be secured, trussed supports shall be provided.

3.2 FORM DESIGN

A. Forms shall be true in every respect to the required shape and size, shall conform to the established alignment and grade, and shall be of sufficient strength and rigidity to maintain their position and shape under the loads and operations incident to placing and vibrating the concrete. Suitable and effective means shall be provided on all forms for holding adjacent edges and ends of panels and sections tightly together and in accurate alignment so as to prevent the formation of ridges, fins, offsets, or similar surface defects in the finished concrete. Plywood, 5/8-inch and greater in thickness, may be fastened directly to studding if the studs are spaced close enough to prevent visible deflection marks in the concrete. The forms shall be tight so as to prevent the loss of water, cement, and fines during placing and vibrating of the concrete. Specifically, the bottom of wall forms that rest on concrete footings or slabs shall be provided with a gasket to prevent loss of fines and paste during placement and vibration of concrete. Such gasket may be a 1- to 1-1/2-inch diameter polyethylene rod held in position to the underside of the wall form. Adequate clean-out holes shall be provided at the bottom of each lift of forms. The size, number, and location of such clean-outs shall be as acceptable to the ENGINEER. Whenever concrete cannot be placed from the top of a wall form in a manner that meets the requirements of the Contract Documents, form windows shall be provided in the size and spacing needed to allow placement of concrete to the requirements of Section 03300 - Cast-in-Place Concrete. The size, number, and location of such form windows shall be as acceptable to the ENGINEER.

3.3 CONSTRUCTION

A. **Vertical Surfaces:** All vertical surfaces of concrete members shall be formed, except where placement of the concrete against the ground is indicated. Not less than 1-inch of concrete shall be added to the indicated thickness of a concrete member where concrete is permitted to be placed against trimmed ground in lieu of forms. Permission to do this on other concrete members will be granted only for members of comparatively limited height and where the character of the ground is such that it can be trimmed to the required lines and will stand securely without caving or sloughing until the concrete has been placed.

B. **Construction Joints:** Concrete construction joints will not be permitted at locations other than those indicated, except as may be acceptable to the ENGINEER. When a second lift is placed on hardened concrete, special precautions shall be taken in the way of the number, location, and tightening of ties at the top of the old lift and bottom of the new to prevent any unsatisfactory effect whatsoever on the concrete. Pipe stubs and anchor bolts shall be set in the forms where required.

C. Form Ties

1. Embedded Ties: Holes left by the removal of form tie cones shall be reamed with suitable toothed reamers so as to leave the surface of the holes clean and rough before being filled with mortar. Wire ties for holding forms will not be permitted. No form-tying device or part thereof, other than metal, shall be left embedded in the concrete. Ties shall not be removed in such manner as to leave a hole extending through the interior of the concrete members. The use of snap-ties which cause spalling of the concrete upon form stripping or tie removal will not be permitted. If steel panel forms are used, rubber grommets shall be provided where the ties pass through the form in order to prevent loss of cement paste. Where metal rods extending through the concrete are used to support or to strengthen forms, the rods shall remain embedded and shall terminate not less than 1-inch back from the formed face or faces of the concrete.

2. Removable Ties: Where taper ties are approved for use, the larger end of the taper tie shall be on the wet side of walls in water retaining structures. After the taper tie is removed, the hole shall be thoroughly cleaned and roughened for bond. A precast neoprene or polyurethane tapered plug shall be located at the wall centerline. The hole shall be completely filled with non-shrink grout for water bearing and below-grade walls. The hole shall be completely filled with non-shrink or regular cement grout for above-grade walls which are dry on both sides. Exposed faces of walls shall have the outer 2 inches of the exposed face filled with a cement grout which shall match the color and texture of the surrounding wall surface.

3.4 REUSE OF FORMS

A. Forms may be reused only if in good condition and only if acceptable to the ENGINEER. Light sanding between uses will be required wherever necessary to obtain uniform surface texture on all exposed concrete surfaces. Exposed concrete surfaces are defined as surfaces which are permanently exposed to view. In the case of forms for the inside wall surfaces of hydraulic/water retaining structures, unused tie rod holes in forms shall be covered with metal caps or shall be filled by other methods acceptable to the ENGINEER.

3.5 REMOVAL OF FORMS

A. Careful procedures for the removal of forms shall be strictly followed, and this WORK shall be done with care so as to avoid injury to the concrete. No heavy loading on green concrete will be permitted. In the case of roof slabs and above-ground floor slabs, forms shall remain in place until test cylinders for the roof concrete attain a minimum compressive strength of 75 percent of the 28-day strength in Section 03300. No forms shall be disturbed or removed under an individual panel or unit before the concrete in the adjacent panel or unit has attained 75 percent of the 28-day strength and has been in place for a minimum of 7 days. The time required to establish said strength shall be as determined by the ENGINEER who will make several test cylinders for this purpose from concrete used in the first group of roof panels placed. If the time so determined is more than the 7-day minimum, then that time shall be used as the minimum length of time. Forms for vertical walls of waterholding structures shall remain in place at least 36 hours after the concrete has been placed. Forms for parts of the WORK not specifically mentioned herein shall remain in place for periods of time as recommended in ACI 347 - Guide to Formwork for Concrete.

3.6 MAINTENANCE OF FORMS

A. Forms shall be maintained at all times in good condition, particularly as to size, shape, strength, rigidity, tightness, and smoothness of surface. Before concrete is placed, the forms shall be thoroughly cleaned. The form surfaces shall be treated with a nonstaining mineral oil or other lubricant acceptable to the ENGINEER. Any excess lubricant shall be satisfactorily removed before placing the concrete. Where field oiling of forms is required, the CONTRACTOR shall perform the oiling at least two weeks in advance of their use. Care shall be exercised to keep oil off the surfaces of steel reinforcement and other metal items to be embedded in concrete.

3.7 FALSEWORK

A. The CONTRACTOR shall be responsible for the design, engineering, construction, maintenance, and safety of all falsework, including staging, walkways, forms, ladders, and similar appurtenances, which shall equal or exceed the applicable requirements of the provisions of the OSHA Safety and Health Standards for Construction, [the requirements of the Construction Safety Orders of the California Division of Industrial Safety,] and the requirements herein.

B. Falsework shall be designed and constructed to provide the necessary rigidity and to support the loads. Falsework for the support of a superstructure shall be designed to support the loads that would be imposed if the entire superstructure were placed at one time.

C. Falsework shall be placed upon a solid footing, safe against undermining, and protected from softening. When the falsework is supported on timber piles, the maximum calculated pile loading shall not exceed 20 tons. When falsework is supported on any portion of the structure which is already constructed, the load imposed by the falsework shall be spread, distributed, and braced in such a way as to avoid any possibility of damage to the structure.

- END OF SECTION -

SECTION 03200 - REINFORCEMENT STEEL

PART 1 -- GENERAL

1.1 THE REQUIREMENT

A. The CONTRACTOR shall provide reinforcement steel and appurtenant work, complete and in place, in accordance with the Contract Documents.

1.2 CONTRACTOR SUBMITTALS

A. Furnish submittals in accordance with Section 01300 - Contractor Submittals.

B. **Shop Drawings**

1. Shop bending diagrams, placing lists, and drawings of all reinforcement steel prior to fabrication. The shop bending diagrams shall show the actual lengths of bars, to the nearest inch measured to the intersection of the extensions (tangents for bars of circular cross section) of the outside surface. Include bar placement diagrams which clearly indicate the dimensions of each bar splice.

2. Details of the concrete reinforcement steel and concrete inserts shall be submitted at the earliest possible date after receipt by the CONTRACTOR of the Notice to Proceed. Said details of reinforcement steel for fabrication and erection shall conform to ACI 315 - Details and Detailing of Concrete Reinforcement, and the requirements herein.

3. Where mechanical couplers are required or permitted to be used to splice reinforcement steel, the CONTRACTOR shall submit manufacturer's literature which contains instructions and recommendations for installation for each type of coupler used; certified test reports which verify the load capacity of each type and size of coupler used; and Shop Drawings which show the location of each coupler with details of how they are to be installed in the formwork.

4. If reinforcement steel is spliced by welding at any location, the CONTRACTOR shall submit mill test reports which shall contain the information necessary for the determination of the carbon equivalent per AWS D1.4 - Structural Steel Welding Code - Reinforcing Steel. The CONTRACTOR shall submit a written welding procedure for each type of weld for each size of bar which is to be spliced by welding; merely a statement that AWS procedures will be followed is not acceptable.

5. If reinforcement steel is spliced by welding at any location, the CONTRACTOR shall submit certifications of procedure qualifications for each welding procedure and certification of welder qualifications, for each welding procedure, and for each welder performing the work.

1.3 QUALITY ASSURANCE

A. If requested by the ENGINEER, the CONTRACTOR shall furnish samples from each heat of reinforcement steel in a quantity adequate for testing. Costs of initial tests will be paid by the OWNER. Costs of additional tests if material fails initial tests shall be the CONTRACTOR's responsibility.

B. Welder qualifications and procedure qualifications shall be as specified in AWS D1.4.

C. If requested by the ENGINEER, the CONTRACTOR shall furnish samples of each type of welded splice in a quantity and of dimensions adequate for testing. At the discretion of the ENGINEER, radiographic testing of direct butt welded splices will be performed. The CONTRACTOR shall provide assistance necessary to facilitate testing. The CONTRACTOR shall repair any weld which fails to meet the requirements of AWS D1.4. The costs of testing will be paid by the OWNER, but the costs of tests which fail to meet requirements shall be the CONTRACTOR's responsibility.

PART 2 -- PRODUCTS

2.1 MATERIAL REQUIREMENTS

A. Materials which may remain or leave residues on or within the concrete shall be certified as compliant with NSF Standard 61- Drinking Water System Components.

2.2 REINFORCEMENT STEEL

A. Reinforcement steel for cast-in-place reinforced concrete construction shall conform to the following requirements:

1. Bar reinforcement shall conform to the requirements of ASTM A 615 - Deformed and Plain Billet - Steel Bars, for Grade 60 reinforcement unless otherwise indicated.

2. Welded wire fabric reinforcement shall conform to the requirements of ASTM A 185 - Welded Steel Wire Fabric, Plain, for Concrete Reinforcement, and the details indicated. Welded wire fabric with longitudinal wire of W4 size wire and smaller shall be in flat sheets or in rolls with a core diameter of not less than 10 inches. Welded wire fabric with longitudinal wires larger than W4 size shall be in flat sheets only.

3. Spiral reinforcement shall be cold-drawn steel wire conforming to the requirements of ASTM A 82 - Steel Wire, Plain, for Concrete Reinforcement.

B. Accessories

1. Accessories shall include all necessary chairs, slab bolsters, concrete blocks, tie wires, dips, supports, spacers, and other devices to position reinforcement during concrete placement. Bar supports shall meet the requirements of the CRSI Manual of Standard Practice including special requirements for supporting epoxy coated reinforcing bars. Wire bar supports shall be CRSI Class 1 for maximum protection with a 1/8-inch minimum thickness of plastic coating which extends at least 1/2-inch from the concrete surface. Plastic shall be gray in color.

2. Concrete blocks (dobies) used to support and position reinforcement steel shall have the same or higher compressive strength as required for the concrete in which they are located. Wire ties shall be embedded in concrete block bar supports.

C. Epoxy coating for reinforcing and accessories, where indicated, shall conform to ASTM A 775 - Epoxy - Coated Reinforcing Steel Bars.

2.3 MECHANICAL COUPLERS

A. Mechanical couplers shall be provided where indicated and where approved by the ENGINEER. The couplers shall develop a tensile strength which exceeds 125 percent of the yield strength of the reinforcement bars being spliced at each splice.

B. Where the type of coupler used is composed of more than one component, all components required for a complete splice shall be provided. This shall apply to all mechanical splices, including those splices intended for future connections.

C. The reinforcement steel and coupler used shall be compatible for obtaining the required strength of the connection. Straight threaded type couplers shall require the use of the next larger size reinforcing bar or shall be used with reinforcing bars with specially forged ends which provide upset threads which do not decrease the basic cross section of the bar.

D. Couplers shall be **Lenton Form Saver** by **Erico Products; Dowel Bar Splicer System** by **Dayton/Richmond**; or equal.

2.4 WELDED SPLICES

A. Welded splices shall be provided where indicated and where approved by the ENGINEER. All welded splices of reinforcement steel shall develop a tensile strength which exceeds 125 percent of the yield strength of the reinforcement bars which are connected.

B. Materials required to conform the welded splices to the requirements of AWS D1.4 shall be provided.

2.5 EPOXY GROUT

A. Epoxy for grouting reinforcing bars shall be specifically formulated for such application, for the moisture condition, application temperature, and orientation of the hole to be filled. Epoxy grout shall meet the requirements in Section 03315 - Grout.

PART 3 -- EXECUTION

3.1 GENERAL

A. Reinforcement steel, welded wire fabric, couplers, and other appurtenances shall be fabricated, and placed in accordance with the requirements of the Building Code and the supplementary requirements herein.

3.2 FABRICATION

A. General

1. Reinforcement steel shall be accurately formed to the dimensions and shapes indicated, and the fabricating details shall be prepared in accordance with ACI 315 and ACI 318 - Building Code Requirements for Reinforced Concrete, except as modified by the Drawings. Bars shall be bent cold. Bars shall be bent per ACI 318.

2. The CONTRACTOR shall fabricate reinforcement bars for structures in accordance with bending diagrams, placing lists, and placing drawings.

B. **Fabricating Tolerances:** Bars used for concrete reinforcement shall satisfy the following fabricating tolerances:

1. Sheared length: plus and minus 1 inch

2. Depth of truss bars: plus 0, minus 1/2 inch

3. Stirrups, ties, and spirals: plus and minus 1/2 inch

4. All other bends: plus and minus 1 inch

3.3 PLACING

A. Reinforcement steel shall be accurately positioned as indicated, and shall be supported and wired together to prevent displacement, using annealed iron wire ties or suitable clips at intersections. Reinforcement steel shall be supported by concrete, plastic or metal supports, spacers or metal hangers which are strong and rigid enough to prevent any displacement of the reinforcement steel. Where concrete is to be placed on the ground, supporting concrete blocks (or dobies) shall be used in sufficient numbers to support the bars without settlement, but in no case shall such support be continuous. Concrete blocks used to support reinforcement steel shall be tied to the steel with wire ties which are embedded in the blocks. For concrete over formwork, the CONTRACTOR shall provide concrete, metal, plastic, or other acceptable bar chairs and spacers.

B. Limitations on the use of bar support materials shall be as follows.

1. Concrete Dobies: permitted at all locations except where architectural finish is required.

2. Wire Bar Supports: permitted only at slabs over dry areas, interior dry wall surfaces, and exterior wall surfaces.

3. Plastic Bar Supports: permitted at all locations except on grade.

C. Tie wires shall be bent away from the forms in order to provide the required concrete coverage.

D. Bars additional to those indicated which may be found necessary or desirable by the CONTRACTOR for the purpose of securing reinforcement in position shall be provided by the CONTRACTOR at its own expense.

E. Unless otherwise indicated, reinforcement placing tolerances shall be within the limits in Section 7.5 of ACI 318 except where in conflict with the requirements of the Building Code.

F. Bars may be moved as necessary to avoid interference with other reinforcement steel, conduits, or embedded items. If bars are moved more than one bar diameter, or enough to exceed the above tolerances, the resulting arrangement of bars shall be as reviewed and accepted by the ENGINEER.

G. Welded wire fabric reinforcement placed over horizontal forms shall be supported on slab bolsters. Slab bolsters shall be spaced not more than 30 inches on centers, shall extend continuously across the entire width of the reinforcement mat, and shall support the reinforcement mat in the plane indicated.

H. Welded wire fabric placed over the ground shall be supported on wired concrete blocks (dobies) spaced not more than 3 feet on centers in any direction. The construction practice of placing welded wire fabric on the ground and hooking into place in the freshly placed concrete shall not be used.

I. Epoxy coated reinforcing bars shall be stored, transported, and placed in such a manner as to avoid chipping of the epoxy coating. Non-abrasive slings made of nylon and similar materials shall be used. Specially coated bar supports shall be used. Chips or cracks in the epoxy coating shall be repaired with a compatible epoxy repair material prior to placing concrete.

J. Accessories supporting reinforcing bars shall be spaced such that there is no deflection of the accessory from the weight of the supported bars. When used to space the reinforcing bars from wall forms, the forms and bars shall be located so that there is no deflection of the accessory when the forms are tightened into position.

3.4 SPACING OF BARS

A. The clear distance between parallel bars (except in columns and between multiple layers of bars in beams) shall be not less than the nominal diameter of the bars nor less than 1-1/3 times the maximum size of the coarse aggregate, nor less than one inch.

B. Where reinforcement in beams or girders is placed in 2 or more layers, the clear distance between layers shall be not less than one inch.

C. In columns, the clear distance between longitudinal bars shall be not less than 1-1/2 times the bar diameter, nor less than 1-1/2 times the maximum size of the coarse aggregate, nor less than 1-1/2 inches.

D. The clear distance between bars shall also apply to the distance between a contact splice and adjacent splices or bars.

3.5 SPLICING

A. General

1. Reinforcement bar splices shall only be used at locations indicated. When it is necessary to splice reinforcement at points other than where indicated, the character of the splice shall be as reviewed and accepted by the ENGINEER.

2. Unless otherwise indicated, dowels shall match the size and spacing of the spliced bar.

B. Splices of Reinforcement

1. The length of lap for reinforcement bars, unless otherwise indicated, shall be in accordance with ACI 318, Section 12.15.1 for a Class B splice.

2. Laps of welded wire fabric shall be in accordance with ACI 318. Adjoining sheets shall be securely tied together with No. 14 tie wire, one tie for each 2 running feet. Wires shall be staggered and tied in such a manner that they cannot slip.

3. Splices in column spiral reinforcement, when necessary, shall be made by welding or by a lap of 1-1/2 turns.

C. **Bending or Straightening:** Reinforcement shall not be straightened or rebent in a manner which will injure the material. Bars shall be bent or straight as indicated. Do not use bends different from the bends indicated. Bars shall be bent cold, unless otherwise permitted by the ENGINEER. No bars partially embedded in concrete shall be field-bent except as indicated or specifically permitted by the ENGINEER.

D. Couplers which are located at a joint face shall be a type which can be set either flush or recessed from the face as indicated. The couplers shall be sealed during concrete placement to completely eliminate concrete or cement paste from entering. Couplers intended for future connections shall be recessed a minimum of 1/2 inch from the concrete surface. After the concrete is placed, the coupler shall be plugged with plastic plugs which have an O-ring seal and the recess filled with sealant to prevent any contact with water or other corrosive materials. Threaded couplers shall be plugged .

E. Unless indicated otherwise, mechanical coupler spacing and capacity shall match the spacing and capacity of the reinforcing indicated for the adjacent section.

3.6 CLEANING AND PROTECTION

A. Reinforcement steel shall at all times be protected from conditions conducive to corrosion until concrete is placed around it.

B. The surfaces of reinforcement steel and other metalwork to be in contact with concrete shall be thoroughly cleaned of all dirt, grease, loose scale and rust, grout, mortar, and other foreign substances immediately before the concrete is placed. Where there is delay in depositing concrete, reinforcement shall be reinspected and, if necessary, recleaned.

3.7 EMBEDMENT OF DRILLED REINFORCING STEEL DOWELS

A. Hole Preparation

1. The hole diameter shall be as recommended by the epoxy manufacturer but shall be no larger than 0.25 inch greater than the diameter of the outer surface of the reinforcing bar deformations.

2. The depth of the hole shall be as recommended by the epoxy manufacturer to fully develop the bar but shall not be less than 12 bar diameters, unless indicated otherwise.

3. The hole shall be drilled by methods which do not interfere with the proper bonding of epoxy.

4. Existing reinforcing steel in the vicinity of proposed holes shall be located prior to drilling. The location of holes shall be adjusted to avoid drilling through or nicking any existing reinforcing bars.

5. The hole shall be blown clean with clean, dry compressed air to remove all dust and loose particles.

B. Embedment

1. Epoxy shall be injected into the hole through a tube placed to the bottom of the hole. The tube shall be withdrawn as epoxy is placed but kept immersed to prevent

formation of air pockets. The hole shall be filled to a depth that insures that excess material will be expelled from the hole during dowel placement.

2. Dowels shall be twisted during insertion into the partially filled hole so as to guarantee full wetting of the bar surface with epoxy. The bar shall be inserted slowly enough to avoid developing air pockets.

- END OF SECTION -

SECTION 03290 - JOINTS IN CONCRETE

PART 1 -- GENERAL

1.1 THE REQUIREMENT

A. The CONTRACTOR shall provide joints in concrete, complete and in place, in accordance with the Contract Documents.

B. Joints in concrete structures shall be the types defined below and will be permitted only where indicated, unless specifically accepted by the ENGINEER.

1.2 TYPES OF JOINTS

A. **Construction Joints:** When fresh concrete is placed against a hardened concrete surface, the joint between the two pours is called a construction joint. Unless otherwise indicated, joints in water bearing members shall be provided with a waterstop and/or sealant groove of the shape indicated. The surface of the first pour may also be required to receive a coating of bond breaker as indicated.

B. **Contraction Joints:** Contraction joints are similar to construction joints except that the fresh concrete shall not bond to the hardened surface of the earlier pour, which shall be coated with a bond breaker. The slab reinforcement shall be stopped 4-1/2 inches from the joint; which is provided with a sleeve-type dowel, to allow shrinkage of the concrete of the later pour. Waterstop and/or sealant groove shall also be provided when indicated.

C. **Expansion Joints:** To allow the concrete to expand freely, a space is provided between the two pours, and the joint shall be formed as indicated. The space is obtained by placing a filler joint material against the earlier pour, to act as a form for the later pour. Unless otherwise indicated, expansion joints in water bearing members shall be provided with a center-bulb type waterstop as indicated.

1. Premolded expansion joint material shall be installed with the edge at the indicated distance below or back from finished concrete surface, and shall have a slightly tapered, dressed, and oiled wood strip secured to or placed at the edge thereof during concrete placement, which shall later be removed to form space for sealing material.

2. The space so formed shall be filled with a joint sealant material as indicated below. In order to keep the two wall or slab elements in line the joint shall also be provided with a sleeve-type dowel as indicated.

D. **Control Joints:** The function of the control joint is to provide a weaker plane in the concrete, where shrinkage cracks will probably occur. A groove, of the shape and dimensions indicated, is formed or saw-cut in the concrete. This groove is afterward filled with a joint sealant material.

1.3 CONTRACTOR SUBMITTALS

A. Furnish submittals in accordance with Section 01300 - Contractor Submittals.

B. Shop Drawings

1. Placement drawings showing the location and type of all joints for each structure.

2. Certified test reports from the sealant manufacturer on the actual batch of material being supplied indicating compliance with requirements shall be furnished before the sealant is used on the job.

3. Copies of Waterstop Welding Certification to be provided by manufacturer or authorized agent of manufacturer. Every person who is to be involved with waterstop installation is required to have individual Certification on file with ENGINEER, which states said individuals are certified and trained to install waterstop per manufacturer's recommendations and specifications.

4. Manufacturer's information demonstrating compliance of the following with indicated requirements:

   a. Bearing Pad

   b. Neoprene Sponge

   c. Preformed Joint Filler

   d. Backing Rod

   e. Bond Breaker

   f. Waterstop

   g. Slip Dowels

   h. PVC Tubing

C. Samples

1. Prior to production of the material required under this Section, qualification samples of waterstops shall be submitted which represent in all respects the material proposed. Such samples shall consist of extruded or molded sections of each size or shape to be used. The balance of the material to be used shall not be produced until after the ENGINEER has reviewed the qualification samples.

D. **Certificates:** Written certification from the manufacturer as an integral part of the shipping form, to show that all of the material shipped to this project meets or exceeds the physical property requirements of the Contract Documents. Supplier certificates are not acceptable.

1.4 QUALITY ASSURANCE

A. **Waterstop Inspection:** It is required that all waterstop field joints shall be subject to rigid inspection, and no such WORK shall be scheduled or started without having made prior arrangements with the ENGINEER for the required inspections. Not less than 24 hours notice shall be given for scheduling such inspections.

B. Field joints in waterstops shall be subject to rigid inspection for misalignment, bubbles, inadequate bond, porosity, cracks, offsets, and other defects which would reduce the potential resistance of the material to water pressure at any point. Defective joints shall

be replaced with material which passes inspection; faulty material shall be removed from the Site and disposed of.

C. The following waterstop defects represent a partial list of defects which shall be grounds for rejection:

1. Offsets at joints greater than 1/16-inch or 15 percent of material thickness, at any point, whichever is less.

2. Exterior crack at joint, due to incomplete bond, which is deeper than 1/16-inch or 15 percent of material thickness, at any point, whichever is less.

3. Any combination of offset or exterior crack which will result in a net reduction in the cross section of the waterstop in excess of 1/16-inch or 15 percent of material thickness at any point, whichever is less.

4. Misalignment of joint which results in misalignment of the waterstop in excess of 1/2-inch in 10 feet.

5. Porosity in the welded joint as evidenced by visual inspection.

6. Bubbles or inadequate bonding which can be detected with a penknife test. (If, while prodding the entire joint with the point of a pen knife, the knife breaks through the outer portion of the weld into a bubble, the joint shall be considered defective.)

7. Visible signs of separation when the cooled splice is bent by hand at any sharp angle.

8. Any evidence of burned material.

D. **PVC Waterstop Samples:** Prior to use of the waterstop material in the field, a sample of a prefabricated (shop made fitting) mitered cross and a tee constructed of each size or shape of material to be used shall be submitted. These samples shall be prefabricated (shop made fitting) so that the material and workmanship represent in all respects the fittings to be provided. Field samples of prefabricated (shop made fitting) fittings (crosses, tees, etc.) will also be selected at random by the ENGINEER for testing by a laboratory at the OWNER's expense. When tested, tensile strength across the joints shall be at least 1120 psi.

E. **Construction Joint Sealant:** The CONTRACTOR shall prepare adhesion and cohesion test specimens as required herein, at intervals of 5 working days while sealants are being installed.

F. The sealant material shall show no signs of adhesive or cohesive failure when tested in accordance with the following procedure in laboratory and field tests:

1. Sealant specimen shall be prepared between 2 concrete blocks (1-inch by 2-inch by 3-inch). Spacing between the blocks shall be 1-inch. Coated spacers (2-inch by 1-1/2-inch by 1/2-inch) shall be used to insure sealant cross-sections of 1/2-inch by 2 inches with a width of 1-inch.

2. Sealant shall be cast and cured according to manufacturer's recommendations except that curing period shall be not less than 24 hours.

3. Following curing period, the gap between blocks shall be widened to 1-1/2-inch. Spacers shall be used to maintain this gap for 24 hours prior to inspection for failure.

1.5 SPECIAL WARRANTY REQUIREMENTS

A. The CONTRACTOR shall furnish a 5-year written warranty of the entire sealant installation against faulty and/or incompatible materials and workmanship, together with a statement that it agrees to repair or replace, to the satisfaction of the OWNER, any such defective areas which become evident within said 5-year guarantee period.

PART 2 -- PRODUCTS

2.1 GENERAL

A. Joint materials shall be listed as compliant with NSF Standard 61.

2.2 WATERSTOPS

A. **PVC Waterstops:** Waterstops shall be extruded from an elastomeric polyvinyl chloride compound containing the plasticizers, resins, stabilizers, and other materials necessary to meet the requirements of this Section. No reclaimed or scrap material shall be used. The CONTRACTOR shall obtain from the waterstop manufacturer and shall furnish to the ENGINEER for review, current test reports and a written certification of the manufacturer that the material to be shipped to the job meets the physical requirements as outlined in the U.S. Army Corps of Engineers Specification CRD-C572-PVC Waterstops, and those listed herein.

1. Flatstrip and Center-Bulb Waterstops: Flatstrip and center-bulb waterstops shall be as manufactured by **Greenstreak Plastic Products Co., Profiles 646, 679,732, and 735; Tamms Horn/Durajoint Types 9,10,11, and 11A** ; or equal; provided, that at no place shall the thickness of flat strip waterstops, including the center bulb type, be less than 3/8-inch. Waterstop shall be provided with factory installed hog rings at 12 inches on centers along the waterstop.

2. Multi-Rib Waterstops: Multi-rib waterstops, where required, shall be as manufactured by **Greenstreak Plastic Products Co., Profiles 789 and 790; Tamms Horn/Durajoint Types 25 and 26;** or equal. Prefabricated (shop made fitting) joint fittings shall be used at all intersections of the ribbed-type waterstops.

3. Retrofit Waterstops: Retrofit waterstops and batten bars shall be as manufactured by **Greenstreak Plastic Products Co., Style #609**, or equal. Waterstop shall be supplied as a complete system including waterstop, SS batten bar, SS anchor bolts, and epoxy gel.

4. **Waterstop Testing Requirements:** When tested in accordance with the test standards, the waterstop material shall meet or exceed the following requirements:

Physical Property, Sheet Material	Value	ASTM Std.
Tensile Strength-min (psi)	2000	D 638, Type IV
Ultimate Elongation-min (percent)	350	D 638, Type IV
Low Temp Brittleness-max (degrees F)	-35	D 746
Stiffness in Flexure-min (psi)	600	D 747

Accelerated Extraction (CRD-C572)

Tensile Strength-min (psi)	1500	D 638, Type IV
Ultimate Elongation-min (percent)	300	D 638, Type IV

Effect of Alkalies (CRD-C572)

Change in Weight (percent)	plus 0.25/minus 0.10	------
Change in Durometer, Shore A	plus and minus 5	D 2240

Finish Waterstop

Tensile Strength-min (psi)	1400	D 638, Type IV
Ultimate Elongation-min (percent)	280	D 638, Type IV

B. **Pre-formed Hydrophilic Waterstop:** Hydrophilic (bentonite-free) waterstops shall be **Hydrotite CJ10202k** as manufactured by **Greenstreak Plastic Products Co., or Adeka Ultraseal MC2010** as manufactured by **Asahi Denka.**

1. Hydrophilic waterstop shall be the type which expands in the presence of water to form a watertight joint seal without damaging the concrete in which it is cast.

2. Waterstop shall be manufactured from chloroprene rubber and modified chloroprene rubber with hydrophilic properties. Waterstop shall have a delay coating to inhibit initial expansion due to moisture present in fresh concrete. The minimum expansion ratio of modified chloroprene shall be not less than 2 to 1 volumetric change in distilled water at 70 degrees F (21 degrees C).

Physical Property, Chloroprene	Value	ASTM Std.
Tensile Strength-min (psi)	1275	D 412
Ultimate Elongation-min (percent)	350	D 412
Hardness, Shore A	55 plus and minus 5	D 2240

Physical Property, Modified Chloroprene	Value	ASTM Std.
Tensile Strength-min (psi)	300	D 412
Ultimate Elongation-min (percent)	600	D 412
Hardness, Shore A	55 plus and minus 5	D 2240

3. Bonding agent for hydrophilic waterstop shall be the manufacturer's recommended adhesive for wet, rough concrete.

C. **Other Types of Waterstops:** When types of waterstops not listed above are indicated, they shall be subjected to the same requirements as those listed herein.

2.3 JOINT SEALANT FOR WATER BEARING JOINTS

A. Joint sealant shall be polyurethane polymer designed for bonding to concrete which is continuously submerged in water. No material will be acceptable which has an unsatisfactory history as to bond or durability when used in the joints of water retaining structures.

B. Joint sealant material shall meet the following requirements (73 degrees F and 5percent R.H.):

Work Life	45 - 180 minutes
Time to Reach 20 Shore "A" Hardness (at 77 degrees F, 200 gr quantity)	24 hours, maximum
Ultimate Hardness (ASTM D 2240)	20 - 45 Shore "A"
Tensile Strength (ASTM D 412)	175 psi, minimum
Ultimate Elongation (ASTM D 412)	400 percent, minimum
Tear Resistance (Die C, ASTM D 624)	75 pounds per inch of thickness, minimum
Color	Light Gray

C. Polyurethane sealants for waterstop joints in concrete shall conform to the following requirements:

1. Sealant shall be 2-part polyurethane with the physical properties of the cured sealant conforming to or exceeding the requirements of ANSI/ASTM C 920 – Elastomeric Joint Sealant, or Federal Specification TT-S-0227 E(3) - Sealing Compound, Elastomeric Type, Multicomponent, for Caulking, Sealing, and Glazing Buildings and Other Structures, for 2-part material, as applicable.

2. For vertical joints and overhead horizontal joints, only "non-sag" compounds shall be used; all such compounds shall conform to the requirements of ANSI/ASTM C 920 Class 25, Grade NS, or Federal Specification TT-S-0227 E(3), Type II, Class A.

3. For plane horizontal joints, the self-leveling compounds which meet the requirements of ANSI/ASTM C 920 Class 25, Grade P, or Federal Specification TT-S-0227 E(3), Type I shall be used. For joints subject to either pedestrian or vehicular traffic, a compound providing non-tracking characteristics, and having a Shore "A" hardness range of 35 to 45, shall be used.

4. Primer materials, if recommended by the sealant manufacturer, shall conform to the printed recommendations of the manufacturer.

D. Sealants, indicated, shall be **PSI-270** as manufactured by **Polymeric Systems Inc., Sikaflex 2C,** as manufactured by **Sika Corporation,** or equal.

E. Sealants for non-waterstop joints in concrete shall conform to Section 07920 - Sealants and Caulking.

2.4 JOINT MATERIALS

A. **Bearing Pad:** Bearing pad shall be neoprene conforming to ASTM D 2000 - Standard Classification System for Rubber Products in Automotive Applications, BC 420, 40 durometer hardness unless otherwise indicated.

B. **Neoprene Sponge:** Sponge shall be neoprene, closed-cell, expanded, conforming to ASTM D 1056 - Flexible Cellular Materials - Sponge or Expanded Rubber, type 2C5-E1.

C. Joint Filler

1. Joint filler for expansion joints in waterholding structures shall be neoprene conforming to ASTM D1056, Type 2C5-E1.

2. Joint filler material in other locations shall be of the preformed non-extruding type joint filler constructed of cellular neoprene sponge rubber or polyurethane of firm texture. Bituminous fiber type will not be permitted. All non-extruding and resilient-type preformed expansion joint fillers shall conform to the requirements and tests set forth in ASTM D 1752 - Preformed Sponge Rubber and Cork Expansion Joint Fillers for Concrete Paving and Structural Construction, for Type I, except as otherwise indicated.

2.5 BACKING ROD

A. Backing rod shall be an extruded closed-cell, polyethylene foam rod. The material shall be compatible with the joint sealant material and shall have a tensile strength of not less than 40 psi and a compression deflection of approximately 25 percent at 8 psi. The rod shall be 1/8-inch larger in diameter than the joint width except that a one-inch diameter rod shall be used for a 3/4-inch wide joint.

2.6 BOND BREAKER

A. Bond breaker shall be **Super Bond Breaker** as manufactured by **Burke Company; Select Cure CRB** as manufactured by **Select Products Co.**; or equal. It shall contain a fugitive dye so that areas of application will be readily distinguishable.

B. Bonding agent for hydrophilic waterstop shall be the manufacturer's recommended adhesive for wet, rough concrete.

2.7 SLIP DOWELS

A. Slip dowels in joints shall be smooth epoxy-coated bars, conforming to ASTM A 775 - Epoxy Coated Reinforcing Steel Bars.

2.8 PVC TUBING

A. PVC tubing in joints shall be Sch. SDR 13.5, conforming to ASTM D 2241 - Poly (Vinyl Chloride) (PVC) Pressure-Rated Pipe (SDR Series).

PART 3 -- EXECUTION

3.1 GENERAL

A. Waterstops shall be embedded in the concrete across joints as indicated. Waterstops shall be fully continuous for the extent of the joint. Splices necessary to provide such continuity shall be accomplished in conformance to printed instructions of manufacturer of the waterstops. The CONTRACTOR shall take suitable precautions and means to support and protect the waterstops during the progress of the work and shall repair or replace at its own expense any waterstops damaged during the progress of the work. Waterstops shall be stored so as to permit free circulation of air around the waterstop material.

B. When any waterstop is installed in the concrete on one side of a joint, while the other half or portion of the waterstop remains exposed to the atmosphere for more than 2 days, suitable precautions shall be taken to shade and protect the exposed waterstop from direct rays of the sun during the entire exposure and until the exposed portion of the waterstop is embedded in concrete.

3.2 SPLICES IN PVC WATERSTOPS

A. Splices in PVC waterstops shall be performed by heat sealing the adjacent waterstop sections in accordance with the manufacturer's printed recommendations. It is essential that:

1. The material not be damaged by heat sealing.

2. The splices have a tensile strength of not less than 80 percent of the unspliced material tensile strength.

3. The continuity of the waterstop ribs and of its tubular center axis be maintained. No edge welding is allowed.

B. Butt joints of the ends of 2 identical waterstop sections may be made while the material is in the forms.

C. All joints with waterstops involving more than 2 ends to be jointed together, and all joints which involve an angle cut, alignment change, or the joining of 2 dissimilar waterstop sections shall be prefabricated (shop made fitting) prior to placement in the forms, allowing not less than 24-inch long strips of waterstop material beyond the joint. Upon being inspected and approved, such prefabricated (shop made fitting) waterstop joint assemblies shall be installed in the forms and the ends of the 24-inch strips shall be butt welded to the straight run portions of waterstop in place in the forms.

D. Where a centerbulb waterstop intersects and is jointed with a non-centerbulb waterstop, care shall be taken to seal the end of the centerbulb, using additional PVC material if needed.

3.3 JOINT CONSTRUCTION

A. **Setting Waterstops:** In order to eliminate faulty installation that may result in joint leakage, particular care shall be taken of the correct positioning of the waterstops during installation. Adequate provisions must be made to support and anchor the waterstops during the progress of the WORK and to insure the proper embedment in the concrete. The symmetrical halves of the waterstops shall be equally divided between the concrete pours at the joints. The center axis of the waterstops shall be coincident with the joint openings. Maximum density and imperviousness of the concrete shall be insured by thoroughly working it in the vicinity of all joints.

B. In placing PVC waterstops in the forms, means shall be provided to prevent them from being folded over by the concrete as it is placed. Waterstops shall be held in place with light wire ties on 12-inch centers which shall be passed through hog rings at the edge of the waterstop and tied to the curtain of reinforcing steel. Horizontal waterstops, with their flat face in a vertical plane, shall be held in place with continuous supports to which the top edge of the waterstop shall be tacked. In placing concrete around horizontal waterstops, with their flat face in a horizontal plane, concrete shall be worked under the waterstops by hand so as to avoid the formation of air and rock pockets.

C. In placing centerbulb waterstops in expansion joints, the centerbulb shall be centered on the joint filler material.

D. Waterstop in vertical wall joints shall stop 6 inches from the top of the wall where such waterstop does not connect with any other waterstop and is not to be connected to a future concrete placement.

E. **Joint Location:** Construction joints and other types of joints shall be provided where indicated. When not indicated, construction joints shall be provided at 25-foot maximum spacing for all concrete construction. Where joints are indicated spaced greater than 40 feet apart, additional joints shall be provided to maintain the 25-foot maximum spacing. The location of all joints, of any type, shall be submitted for acceptance by the ENGINEER.

F. **Joint Preparation:** Special care shall be used in preparing concrete surfaces at joints where bonding between 2 sections of concrete is required. Unless otherwise indicated, such bonding will be required at all horizontal joints in walls. Surfaces shall be prepared in accordance with the requirements of Section 03300 - Cast-in-Place Concrete. Except on horizontal wall construction joints, wall to slab joints, or where otherwise indicated, at all joints where waterstops are required, the joint face of the first pour shall be coated with a bond breaker as indicated herein.

G. **Retrofit Joint Preparation:** Existing surfaces to receive a retrofit waterstop shall be clean and free from any loose or foreign material. Surface shall be given a light sandblast or hydroblast finish to 1/8-inch amplitude prior to application of epoxy and waterstop.

H. **Construction Joint Sealant:** Construction joints in water-bearing floor slabs, and elsewhere as indicated, shall be provided with tapered grooves which shall be filled with a construction joint sealant. The material used for forming the tapered grooves shall be left in the grooves until just before the grooves are cleaned and filled with joint sealant. After removing the forms from the grooves, all laitance and fins shall be removed, and the grooves shall be sand-blasted. The grooves shall be allowed to become thoroughly dry, after which they shall be blown out; immediately thereafter, they shall be primed, bond breaker tape placed in the bottom of the groove, and filled with the construction joint sealant. The primer shall be furnished by the sealant manufacturer. No sealant will be permitted to be used without a primer. Care shall be used to completely fill the sealant grooves. Areas designated to receive a sealant fillet shall be thoroughly cleaned, as outlined for the tapered grooves, prior to application of the sealant.

I. The primer and sealant shall be placed strictly in accordance with the printed recommendations of the manufacturer, taking special care to properly mix the sealant prior to application. The sides of the sealant groove shall not be coated with bond breaker, curing compound, or any other substance which would interfere with proper bonding of the sealant. Sealant shall achieve final cure at least 7 days before the structure is filled with water.

J. Sealant shall be installed by a competent waterproofing specialty contractor who has a successful record of performance in similar installations.

K. Thorough, uniform mixing of 2-part, catalyst-cured materials is essential; special care shall be taken to properly mix the sealer before its application. Before any sealer is placed, the CONTRACTOR shall arrange to have the crew doing the WORK carefully

instructed on the proper method of mixing and application by a representative of the sealant manufacturer.

L. Any joint sealant which fails to fully and properly cure after the manufacturer's recommended curing time for the conditions of the WORK hereunder shall be completely removed; the groove shall be thoroughly sandblasted to remove all traces of the uncured or partially cured sealant and primer, and shall be re-sealed with the indicated joint sealant. Costs of such removal, joint treatment, re-sealing, and appurtenant work shall be the CONTRACTOR's responsibility.

M. Hydrophilic Waterstop

1. Where a hydrophilic waterstop is called for in the Contract Documents, it shall be installed with the manufacturer's instructions and recommendations except as modified herein.

2. When requested by the ENGINEER, the CONTRACTOR shall arrange for the manufacturer to furnish technical assistance in the field.

3. Hydrophilic waterstop shall only be used where complete confinement by concrete is provided. Hydrophilic waterstop shall not be used in expansion or contraction joints nor in the first 6 inches of any non-intersecting joint.

4. The hydrophilic waterstop shall be located as near as possible to the center of the joint and it shall be continuous around the entire joint. The minimum distance from the edge of the waterstop to the face of the member shall be 5 inches.

5. Where the thickness of the concrete member to be placed on the hydrophilic waterstop is less than 12 inches, the waterstop shall be placed in grooves formed or ground into the concrete. The groove shall be at least 3/4-inch deep and 1-1/4 inches wide. When placed in the groove, the minimum distance from the edge of the waterstop to the face of the member shall be 2.5 inches.

6. Where a hydrophilic waterstop is used in combination with PVC waterstop, the hydrophilic waterstop shall overlap the PVC waterstop for a minimum of 6 inches and shall be adhered to PVC waterstop with single component water-swelling sealant as recommended by manufacturer.

7. The hydrophilic waterstop shall not be installed where the air temperature falls outside the manufacturer's recommended range.

8. The concrete surface under the hydrophilic waterstop shall be smooth and uniform. The concrete shall be ground smooth if needed. Alternately, the hydrophilic waterstop shall be bonded to the surface using an epoxy grout which completely fills all voids and irregularities beneath the waterstop material. Prior to installation, the concrete surface shall be wire brushed to remove any laitance or other materials that may interfere with the bonding of epoxy.

9. The hydrophilic waterstop shall be secured in place with concrete nails and washers at 12-inch maximum spacing. This shall be in addition to the adhesive recommended by the manufacturer.

N. **Retrofit Waterstop**: Retrofit waterstops shall be set in a bed of epoxy over a sandblasted surface with stainless steel batten bars and 1/4-inch diameter stainless

steel anchors at 6 inches on center, staggered, and in accordance with the manufacturer's written recommendations.

- END OF SECTION -

SECTION 03300 – CAST-IN-PLACE CONCRETE

PART 1 -- GENERAL

1.1 THE REQUIREMENT

A. The CONTRACTOR shall provide cast-in-place concrete in accordance with the Contract Documents.

B. The following types of concrete are covered in this Section:

1. Structural Concrete: Concrete to be used in all cases except where indicated otherwise in the Contract Documents.

2. Pea Gravel Concrete: Concrete in thin sections and areas with congested reinforcing, at the option of the CONTRACTOR and with written approval of the ENGINEER for the specific location.

3. Sitework Concrete: Concrete to be used for curbs, gutters, catch basins, sidewalks, pavements, fence and guard post embedment, underground pipe encasement, underground duct bank encasement and other concrete appurtenant to electrical facilities unless otherwise indicated.

4. Lean Concrete: Concrete to be used for thrust blocks, pipe trench cut-off blocks and cradles that are indicated on the Drawings as unreinforced. Lean concrete shall be used as protective cover for dowels intended for future connection.

5. The term "hydraulic structure" used in these specifications means environmental engineering concrete structures for the containment, treatment, or transmission of water, wastewater, other fluids, or gases.

1.2 CONTRACTOR SUBMITTALS

A. Furnish submittals in accordance with Section 01300 – Contractor Submittals.

B. **Mix Designs:** Prior to beginning the WORK and within 14 Days of the Notice to Proceed, submit preliminary concrete mix designs which shall show the proportions and gradations of materials proposed for each class and type of concrete. Mix designs shall be checked by an independent testing laboratory acceptable to the ENGINEER. Costs related to such checking shall be CONTRACTOR'S responsibility as part of the WORK. Since laboratory trial batches require 35 calendar days to complete, the CONTRACTOR shall test a minimum of 2 mix designs for each class of concrete.

C. **Delivery Tickets:** Where ready-mix concrete is used, the CONTRACTOR shall furnish delivery tickets at the time of delivery of each load of concrete. Each ticket shall show the state-certified equipment used for measuring and the total quantities, by weight, of cement, sand, each class of aggregate, admixtures, and the amounts of water in the aggregate added at the batching plant, and the amount allowed to be added at the Site for the specific design mix. In addition, each ticket shall state the mix number, total yield in cubic yards, and the time of day, to the nearest minute, corresponding to the times when the batch was dispatched, when it left the plant, when it arrived at the Site, when unloading began, and when unloading was finished.

D. Test data relating to the cement, aggregate, and admixtures shall be less than 6 months old. Furnish the following submittals in accordance with ACI 301 – Structural Concrete for Buildings:

1. Mill tests for cement.

2. Admixture certification. Chloride ion content shall be included.

3. Aggregate gradation test results and certification.

4. Materials and methods for curing.

1.3 CONCRETE CONFERENCE

A. A meeting to review the detailed requirements of the CONTRACTOR's proposed concrete design mixes and to determine the procedures for producing proper concrete construction shall be held no later than 14 Days after the Notice to Proceed.

B. Parties involved in the concrete WORK shall attend the conference, including the following at a minimum:

1. CONTRACTOR's representative

2. Testing laboratory representative

3. Concrete subcontractor

4. Reinforcing steel subcontractor and detailer

5. Concrete supplier

6. Admixture manufacturer's representative

C. The conference shall be held at a mutually agreed upon time and place. The ENGINEER shall be notified no less than 5 Days prior to the date of the conference.

1.4 QUALITY ASSURANCE

A. General

1. Tests on component materials and for compressive strength and shrinkage of concrete shall be performed as indicated. Tests for determining slump shall be in accordance with the requirements of ASTM C 143 – Test Method for Slump of Hydraulic Cement Concrete.

2. Testing for aggregate shall include sand equivalence, reactivity, organic impurities, abrasion resistance, and soundness, according to ASTM C 33 – Concrete Aggregates.

3. The cost of laboratory tests on cement, aggregates, and concrete, will be the OWNER'S responsibility. However, the CONTRACTOR shall pay the cost of any additional tests and investigation on WORK that does not meet the specifications. The laboratory will meet or exceed the requirements of ASTM C 1077 – Practice for Laboratories Testing Concrete and Concrete Aggregates for use in Construction and Criteria for Laboratory Evaluation.

4. Concrete for testing shall be furnished by the CONTRACTOR, and the CONTRACTOR shall assist the ENGINEER in obtaining samples, and disposal and cleanup of excess material.

B. **Inspections:** Continuous inspection by a special inspector approved by the local building department having jurisdiction and by the ENGINEER will be required where necessary to conform with code requirements. Costs of the special inspector shall be paid by the CONTRACTOR. Inspection reports shall be submitted to the ENGINEER. The special inspector shall observe the following work for conformance with the Drawings and Specifications:

   a. During the preparation and taking of required test specimens.

   b. Placing of concrete except Sitework concrete fully supported on earth.

C. Field Compression Tests

   1. Compression test specimens shall be taken during construction from the first placement of each class of concrete and at intervals thereafter as selected by the ENGINEER to insure continued compliance with these specifications. Each set of test specimens shall be a minimum of 5 cylinders.

   2. Compression test specimens for concrete shall be made in accordance with Section 9.2 of ASTM C 31 – Practices for Making and Curing Concrete Test Specimens in the Field. Specimens shall be 6-inch diameter by 12-inch high cylinders.

   3. Compression tests shall be performed in accordance with ASTM C 39 – Test Method for Compressive Strength of Cylindrical Concrete Specimens. One test cylinder will be tested at 7 Days and 2 at 28 Days. The remaining cylinders will be held to verify test results, if needed.

D. Evaluation and Acceptance of Concrete

   1. Evaluation and acceptance of the compressive strength of concrete will be according to the requirements of ACI 318 – Building Code Requirements for Reinforced Concrete, Chapter 5 "Concrete Quality," and as indicated.

   2. A statistical analysis of compression test results will be performed according to the requirements of ACI 214 – Recommended Practice for Evaluation of Strength Test Methods. The standard deviation of the test results shall not exceed 640 psi, when ordered at equivalent water content as estimated by slump.

   3. If any concrete fails to meet these requirements, immediate corrective action shall be taken to increase the compressive strength for subsequent batches of the type of concrete affected.

   4. When the standard deviation of the test results exceeds 640 psi, the average strength for which the mix is designed shall be increased by an amount necessary to satisfy the statistical requirement that the probability of any test being more than 500 psi below or the average of any 3 consecutive tests being below the required compressive strength is 1 in 100. The required average strength shall be calculated by Criterion No. 3 of ACI 214 using the actual standard of deviation.

   5. Concrete that fails to meet the ACI requirements and these Specifications is subject to removal and replacement.

E. Shrinkage Tests

1. Drying shrinkage tests shall be performed for the trial batches indicated in the Article below entitled "Trial Batch and Laboratory Tests," the first placement of each class of structural concrete, and during construction to insure continued compliance with these specifications.

2. Drying shrinkage specimens shall be 4-inch by 4-inch by 11-inch prisms with an effective gauge length of 10-inches; fabricated, cured, dried, and measured in accordance with ASTM C 157 – Test Method for Length Change of Hardened Hydraulic Cement Mortar and Concrete, modified as follows: specimens shall be removed from molds at an age of 23 hours plus or minus 1 hour after trial batching, shall be placed immediately in water at 70 degrees F plus or minus 3 degrees F for at least 30 minutes, and shall be measured within 30 minutes thereafter to determine original length and then submerged in saturated lime water at 73 degrees F plus or minus 3 degrees F. Measurement to determine expansion expressed as a percentage of original length shall be made at age 7 Days. This length at age 7 Days shall be the base length for drying shrinkage calculations ("0" days drying age). Specimens then shall be stored immediately in a humidity control room maintained at 73 degrees F plus or minus 3 degrees F and 50 percent plus or minus 4 percent relative humidity for the remainder of the test. Measurements to determine shrinkage expressed as percentage of base length shall be made and reported separately for 7, 14, 21, and 28 Days of drying after 7 Days of moist curing.

3. The drying shrinkage deformation of each specimen shall be computed as the difference between the base length (at "0" days drying age) and the length after drying at each test age. The average drying shrinkage deformation of the specimens shall be computed to the nearest 0.0001 inch at each test age. If the drying shrinkage of any specimen departs from the average of that test age by more than 0.0004-inch, the results obtained from that specimen shall be disregarded. Results of the shrinkage test shall be reported to the nearest 0.001 percent of shrinkage. Compression test specimens shall be taken in each case from the same concrete used for preparing drying shrinkage specimens. These tests shall be considered a part of the normal compression tests for the project. Allowable shrinkage limitations shall be as indicated in Part 2 below.

F. **Aggregate Testing:** Aggregate testing shall be made for the trial batch in the Article below entitled "Trial Batch and Laboratory Tests," prior to construction and every 12 months during construction to insure continued compliance with these specifications.

G. **Construction Tolerances:** The CONTRACTOR shall set and maintain concrete forms and perform finishing operations to ensure that the completed WORK is within tolerances. Surface defects and irregularities are defined as finishes and are to be distinguished from tolerances. Tolerance is the permissible variation from lines, grades, or dimensions indicated on the Drawings. Where tolerances are not stated in the specifications, permissible deviations will be in accordance with ACI 117 – Standard Tolerance for Concrete Construction and Materials.

1. The following non-cumulative construction tolerances apply to finished walls and slab unless otherwise indicated:

Item	Tolerance
Variation of the constructed linear outline	In 10-feet: 1/4-inch;

from the established position in plan.	In 20-feet or more: 1/2-inch
Variation from the level or from the grades indicated.	In 10-feet: 1/4-inch; In 20-feet or more: 1/2-inch
Variation from plumb	In 10-feet: 1/4-inch; In 20-feet or more: 1/2-inch
Variation in the thickness of slabs and walls.	Minus 1/4-inch; Plus 1/2-inch
Variation in the locations and sizes of slabs and wall openings	Plus or minus 1/4-inch

H. Floor Slab Hardener

1. Job Mockup: In a location designated by the ENGINEER, the CONTRACTOR shall place a 100 square foot floor mockup using the materials and procedures proposed for the WORK. Materials and procedures may be revised as necessary to obtain an acceptable surface, but the same materials and procedures shall be used in the WORK.

2. Field Service: The CONTRACTOR shall obtain onsite proper usage advice from the surface hardener manufacturer while the job mockup is being placed and during initial placement of the WORK. Notify the surface hardener manufacturer at least 3 Days prior to initial use of the product.

3. Installer Qualifications: Installer shall have a minimum of 3 years experience and shall be specialized in application of dry shake surface hardeners.

PART 2 -- PRODUCTS

2.1 CONCRETE MATERIALS

A. General

1. Materials shall be classified as acceptable for potable water use according to NSF Standard 61.

2. Cement for concrete that will contact potable water shall not be obtained from kilns that burn metal rich hazardous waste fuel.

3. Materials shall be delivered, stored, and handled so as to prevent damage by water or breakage. Cement reclaimed from cleaning bags or leaking containers shall not be used. Cement shall be used in the sequence of receipt of shipments.

B. Materials shall comply with the requirements of Sections 201, 203, and 204 of ACI 301, as applicable.

C. Storage of materials shall conform to the requirements of Section 205 of ACI 301.

D. Materials for concrete shall conform to the following requirements:

1. Cement shall be standard brand portland cement conforming to ASTM C 150 – Portland Cement, for Type II or Type V, including Table 2 optional requirements. A minimum of 85 percent of cement by weight shall pass a 325 screen. A single brand of cement shall be used throughout the WORK, and prior to its use, the brand shall be accepted by the ENGINEER. The cement shall be suitably protected from exposure to moisture until used. Cement that has become lumpy shall not be used. Sacked cement shall be stored in such a manner so as to permit access for inspection and sampling. Certified mill test reports, including fineness, for each shipment of cement to be used shall be submitted to the ENGINEER, if requested, regarding compliance with these specifications.

2. Water for mixing and curing shall be potable, clean, and free from objectionable quantities of silty organic matter, alkali, salts, and other impurities. The water shall be considered potable, for the purposes of this Section only, if it meets the requirements of the local governmental agencies. Agricultural water with high total dissolved solids (greater than 1000 mg/l TDS) shall not be used.

3. Aggregates shall be obtained from pits acceptable to the ENGINEER, shall be non-reactive, and shall conform to the requirements of ASTM C 33 – Concrete Aggregates. Maximum size of coarse aggregate shall be as indicated. Lightweight sand for fine aggregate will not be permitted.

    a. Coarse aggregates shall consist of clean, hard, durable gravel, crushed gravel, crushed rock, or a combination thereof. The coarse aggregates shall be prepared and handled in 2 or more size groups for combined aggregates with a maximum size greater than 3/4-inch. When the aggregates are proportioned for each batch of concrete, the 2 size groups shall be combined. See the article below entitled "Trial Batch and Laboratory Tests" for the use of the size groups.

    b. Fine aggregates shall be natural sand or a combination of natural and manufactured sand that is hard and durable. When tested in accordance with ASTM D 2419 – Test Methods for Sand Equivalent Value of Soils and Fine Aggregate, the sand equivalency shall not be less than 75 percent for an average of 3 samples, nor less than 70 percent for an individual test. Gradation of fine aggregate shall conform to ASTM C 33 when tested in accordance with ASTM C 136 for the fineness modulus of the sand used, including the optional grading in Section 6.2. The fineness modulus of sand used shall not be over 3.1.

    c. Combined aggregates shall be well graded from coarse to fine sizes and shall be uniformly graded between screen sizes to produce a concrete that has optimum workability and consolidation characteristics. Where a trial batch is required for a mix design, the final combined aggregate gradations will be established during the trial batch process.

    d. When tested in accordance with ASTM C 33, the ratio of silica released to reduction in alkalinity shall not exceed 1.0.

    e. When tested in accordance with ASTM C 33, the fine aggregate shall produce a color in the supernatant liquid no darker than the reference standard color solution.

f. When tested in accordance with ASTM C 33, the coarse aggregate shall show a loss not exceeding 42 percent after 500 revolutions or 10.5 percent after 100 revolutions.

g. When tested in accordance with ASTM C 33, the loss resulting after 5 cycles of the soundness test shall not exceed 10 percent for fine aggregate and 12 percent for coarse aggregate when using sodium sulfate.

4. Ready-mix concrete shall conform to the requirements of ASTM C 94 – Ready Mixed Concrete.

5. Admixtures: Admixtures shall be compatible and be furnished by a single manufacturer capable of providing qualified field service representation. Admixtures shall be used in accordance with manufacturer's recommendations. If the use of an admixture is producing an inferior end result, the CONTRACTOR shall discontinue use of the admixture. Admixtures shall not contain thiocyanates nor more than 0.05 percent chloride ion, and shall be non-toxic after 30 days.

   a. Air-entraining agent meeting the requirements of ASTM C 260 – Air Entraining Admixtures for Concrete shall be used. Sufficient air-entraining agent shall be used to provide a total air content of 3 to 5 percent. Concrete floors to receive a dry-shake floor hardener shall have an air content not to exceed 3 percent. The OWNER reserves the right, at any time, to sample and test the air-entraining agent. The air-entraining agent shall be added to the batch in a portion of the mixing water. The solution shall be batched by means of a mechanical batcher capable of accurate measurement. Air content shall be tested at the point of placement. Air entraining agent shall be **Micro-Air** by **Master Builders; Daravair** by **W.R. Grace; Sika AEA-15** by **Sika Corporation;** or equal.

   b. Set controlling and water reducing admixtures: Admixtures may be added at the CONTRACTOR's option, subject to the ENGINEER's approval, to control the set, effect water reduction, and increase workability. The cost of adding an admixture shall be the CONTRACTOR's responsibility. Concrete containing an admixture shall be first placed at a location determined by the ENGINEER. Admixtures shall conform to the requirements of ASTM C 494 – Chemical Admixtures for Concrete. The required quantity of cement shall be used in the mix regardless of whether or not an admixture is used.

      1) Concrete shall not contain more than one water reducing admixture.

      2) Set controlling admixture may be either with or without water-reducing properties. Where the air temperature at the time of placement is expected to be consistently greater than 80 degrees F, a set retarding admixture such as **Plastocrete 161MR by Sika Corporation; Pozzolith 300R by Master Builders; Daratard by W.R. Grace;** or equal shall be used. Where the air temperature at the time of placement is expected to be consistently less than 40 degrees F, a non-corrosive set accelerating admixture such as **Plastocrete 161FL by Sika Corporation; Pozzutec 20 by Master Builders; Polarset by W.R. Grace;** or equal shall be used.

      3) Normal range water reducer shall conform to ASTM C 494, Type A. **WRDA 64 or 79 by W.R. Grace; Pozzolith 322-N by Master Builders; Plastocrete 161 by Sika Corporation;** or equal. The quantity of

admixture used and the method of mixing shall be in accordance with the manufacturer's instructions and recommendations.

4) High range water reducer shall conform to ASTM C 494, Type F or G. **Daracem 100 or ADVA 100 by W.R. Grace; Sikament FF or Sikament 86 by Sika Corporation; Rheobuild 1000 by Master Builders**; or equal. High range water reducer shall be added to the concrete after all other ingredients have been mixed and initial slump has been verified. No more than 14 ounces of water reducer per sack of cement shall be used. Water reducer shall be considered as part of the mixing water when calculating the water/cement ratio.

5) If the high range water reducer is added to the concrete at the Site, it may be used in conjunction with the same water reducer added at the batch plant. Concrete shall have a slump of 3-inches plus or minus 1/2-inch prior to adding the high range water reducing admixture at the Site. The high range water reducing admixture shall be accurately measured and pressure injected into the mixer as a single dose by an experienced technician. A standby system shall be provided and tested prior to each day's operation of the primary system.

6) Concrete shall be mixed at mixing speed for a minimum of 70 mixer revolutions or 5 minutes after the addition of the high range water reducer, unless recommended otherwise by the manufacturer.

7) Flyash: Flyash shall not be used.

2.2 CURING MATERIALS

A. Materials for curing concrete shall conform to the following requirements and ASTM C 309 – Liquid Membrane – Forming Components for Curing Concrete.

B. Curing compounds shall be white pigmented, resin based, and compliant with local VOC requirements. Sodium silicate compounds shall not be allowed. Concrete curing compound shall be **Kurez VOX White Pigmented** by **Euclid Chemicals Company; L&M Cure R-2 by L&M Construction Chemicals; 1200-White by W.R. Meadow;** or equal. When curing compound must be removed for finishes or grouting, compounds shall be **Korez DR VOX** by **Euclid Chemical Company; Masterkure-100W** by **ChemRex MBT; L&M Cure R-2 by L & M Construction Chemicals;1100-Clear by W.R. Meadows;** or equal.

1. Polyethylene sheet for use as concrete curing blanket shall be white and shall have a nominal thickness of 6-mils. The loss of moisture when determined in accordance with the requirements of ASTM C 156 – Test Method for Water Retention by Concrete Curing Materials, shall not exceed 0.055 grams per square centimeter of surface.

2. Polyethylene-coated waterproof paper sheeting for use as concrete curing blanket shall consist of white polyethylene sheeting free of visible defects, uniform in appearance, have a nominal thickness of 2-mils, and be permanently bonded to waterproof paper conforming to the requirements of Federal Specification UU-B-790A – Building Paper, Vegetable Fiber (Kraft, Waterproofed, Water Repellant and Fire Resistant). The loss of moisture, when determined in accordance with the requirements of ASTM C 156, shall not exceed 0.055 gram per square centimeter of surface.

3. Polyethylene-coated burlap for use as concrete curing blanket shall be 4-mil thick, white opaque polyethylene film impregnated or extruded into one side of the burlap. Burlap shall weigh not less than 9 ounces per square yard. The loss of moisture, when determined in accordance with the requirements of ASTM C 156, shall not exceed 0.055 grams per square centimeter of surface.

4. Curing mats for use in Curing Method 6 below, shall be heavy shag rugs or carpets or cotton mats quilted at 4-inches on center. Curing mats shall weigh a minimum of 12 ounces per square yard when dry.

5. Evaporation retardant shall be a material such as **Confilm** by **ChemRex MBT; Eucobar** by **Euclid Chemical Company; E-CON** by **L & M Construction Chemicals, Inc.;** or equal.

2.3 NON-WATERSTOP JOINT MATERIALS

A. Materials for non-waterstop joints in concrete shall conform to the following requirements:

1. Preformed joint filler shall be a non-extruding, neoprene sponge or polyurethane type conforming to Section 03290 - Joints in Concrete.

2. Elastomeric joint sealer shall conform to the requirements of Section 07920 - Sealants and Caulking.

3. Mastic joint sealer shall be a material that does not contain evaporating solvents; that will tenaciously adhere to concrete surfaces; that will remain permanently resilient and pliable; that will not be affected by continuous presence of water and will not in any way contaminate potable water; and that will effectively seal the joints against moisture infiltration even when the joints are subject to movement due to expansion and contraction. The sealer shall be composed of special asphalts or similar materials blended with lubricating and plasticizing agents to form a tough, durable mastic substance containing no volatile oils or lubricants and shall be capable of meeting the test requirements set forth below, if testing is required by the ENGINEER.

2.4 FLOOR HARDENER (SURFACE APPLIED)

A. Surface hardener shall be light reflective non-oxidizing metallic aggregate dry shake material that is premeasured, premixed, and packaged at the factory. Surface hardener shall be applied per the manufacturer's recommendations.

B. Curing compound shall meet the moisture retention requirements of ASTM C 309 and the manufacturer recommendations.

C. **Monomolecular Film:** Evaporation retarder shall be used to aid in maintaining concrete moisture during the early placement stages of plastic concrete. Evaporation retarder shall be as recommended by the surface hardener manufacturer.

D. Floor hardener shall be **Lumiplate** by **ChemRex MBT; Emeryplate FF** by **L&M Construction Chemicals;** or equal.

2.5 MISCELLANEOUS MATERIALS

A. Dampproofing agent shall be an asphalt emulsion such as **Hydrocide 600 by ChemRex Sonneborn; Emulsified Asphalt by Euclid Chemical Company; Sealmastic by W. R. Meadows Inc.**, or equal.

B. Bonding agents shall be epoxy adhesives conforming to the following:

1. For bonding freshly-mixed, plastic concrete to hardened concrete, **Sikadur 32 Hi-Mod Epoxy Adhesive** by **Sika Corporation; Concresive Liquid (LPL)**, by **ChemRex MBT; BurkEpoxy MV** by **Burke by Edoco**; or equal.

2. For bonding hardened concrete or masonry to steel, **Sikadur 31 Hi-Mod Gel** by **Sika Corporation; BurkEpoxy NS** by **Burke** by **Edoco; Concresive Paste (LPL)** by **ChemRex MBT;** or equal.

C. **Vapor Retarder:** Vapor retarder shall be 30-mil thick, Class A, 3 ply, nylon or polyester cord reinforced high density polyethylene sheet laminated to a non-woven geotextile fabric, in accordance with ASTM E 1745 - Plastic Water Vapor Retarders Used in Contact with Soil or Granular Fill Under Concrete Slabs. **Reef Industries, Inc., Griffolyn T-65 G** or equal.

D. **Granular Material Above Vapor Retarder:** Crushed stone, gravel, or sand with the following size distribution and meeting the deleterious substance limits of ASTM C 33 for fine aggregates.

Sieve Size	Percentage Passing
3/8-inch	100
4.75 mm	85-100
No. 100	10 – 30

E. Seams in vapor retarder sheet shall be sealed with tape, adhesive, or other material as recommended by sheet manufacturer for the areas to be sealed and sheet material.

F. Colorant for duct bank concrete shall be an integral red oxide coloring pigment used in the proportion of 8 pounds per cubic yard of concrete.

2.6 CONCRETE DESIGN REQUIREMENTS

A. **General:** Concrete shall be composed of cement, admixtures, aggregates, and water of the qualities indicated. The exact proportions in which these materials are to be used for different parts of the WORK will be determined during the trial batch. In general, the mix shall be designed to produce a concrete capable of being deposited so as to obtain maximum density and minimum shrinkage, and, where deposited in forms, to have good consolidation properties and maximum smoothness of surface. The aggregate gradations shall be formulated to provide fresh concrete that will not promote rock pockets around reinforcing steel or embedded items. The proportions shall be changed whenever necessary or desirable to meet the required results. Changes shall be subject to review by the ENGINEER.

B. **Fine Aggregate Composition:** In mix designs for structural concrete, the percentage of fine aggregate in total aggregate by weight, shall be as indicated in the following table.

FINE AGGREGATE	
Fineness Modulus	**Maximum Percent**
2.7 or less	41
2.7 to 2.8	42
2.8 to 2.9	43
2.9 to 3.1	44

1. For other concrete, the maximum percentage of fine aggregate of total aggregate, by weight, shall not exceed 50.

C. Duct bank concrete shall contain an integral red-oxide coloring pigment. Concrete shall be dyed red throughout. Surface treatment to color duct banks will not be acceptable.

D. **Water/Cement Ratio and Compressive Strength:** The water/cement ratio indicated is for saturated-surface dry condition of aggregate. Every Day, throughout the day, the batch water added shall be adjusted for the total free water in the aggregates.

1. Total free moisture of aggregates shall be determined by:

   a. Starting with the total moisture content of all aggregate, calculated by ASTM C 566 -Test Method for Total Moisture Content of Aggregate by Drying

   b. Subtracting the moisture absorbed by the coarse aggregate, calculated by ASTM C 127 – Standard Test Method for Density, Relative Density (Specific Gravity) and Absorption of Coarse Aggregate

   c. Subtracting the moisture absorbed by the fine aggregate, calculated by ASTM C 128 – Standard Test Method for Density, Relative Density (Specific Gravity) and Absorption of Fine Aggregate

2. Concrete shall have the following minimum properties:

Type of Work	Min 28-Day Compressive Strength, psi	Maximum Size Aggregate, in	Cement Content per cubic yd, lbs	Maximum W/C Ratio (by weight)
Structural Concrete				
Roof, floor slabs, columns, walls, and all other concrete items not indicated elsewhere.	4,000	1	564 to 600	0.45

12-inch and thicker walls, slabs on grade, and footings (optional)	4,000	1-1/2	564 to 600	0.45
Pea Gravel Concrete				
Thin sections and areas with congested reinforcing, at the CONTRACTOR'S option and with the written approval of the ENGINEER for the specific location. Maximum fine aggregate 50 percent by weight of aggregate.	4,000	3/8	752 to 788	0.40
Sitework concrete	3,000	1	470 (min)	0.50
Lean concrete	2,000	1	376 (min)	0.60

NOTE: The CONTRACTOR is cautioned that the limiting parameters above are not a mix design. Admixtures may be required to achieve workability required by the CONTRACTOR'S construction methods and aggregates. The CONTRACTOR is responsible for providing concrete with the required workability.

E. **Adjustments to Mix Design:** The CONTRACTOR may elect to decrease the water/cement ratio to achieve the strength and shrinkage requirements and/or add water reducers, as required to achieve workability. The mixes shall be changed whenever such change is necessary or desirable to secure the required strength, density, workability, and surface finish, and the CONTRACTOR shall be entitled to no additional compensation because of such changes. Any changes to the accepted concrete mix design shall be submitted to the ENGINEER for review and shall be tested again in accordance with these Specifications.

2.7 CONSISTENCY

A. The quantity of water in a batch of concrete shall be just sufficient, with a normal mixing period, to produce a concrete that can be worked properly into place without segregation and which can be compacted by vibratory methods to give the desired density, impermeability, and smoothness of surface. The quantity of water shall be changed as necessary, with variations in the nature or moisture content of the aggregates, to maintain uniform production of a desired consistency. The consistency of the concrete in successive batches shall be determined by slump tests in accordance with ASTM C

143 – Test Method for Slump of Hydraulic Cement Concrete. The slumps shall be as follows:

Part of Work	Slump (in)
All concrete, unless indicated otherwise	3-inches plus or minus 1-inch
With high range water reducer added	7-inches plus or minus 2-inches
Pea gravel mix	7-inches plus or minus 2-inches
Ductbank and pipe encasement	5-inches plus or minus 1-inch

2.8 TRIAL BATCH AND LABORATORY TESTS

A. The CONTRACTOR shall only use a mix design for construction that has first met the trial batch testing requirements.

B. Before placing any concrete, a testing laboratory selected by the ENGINEER shall prepare a trial batch of each class of structural concrete, based on the preliminary concrete mixes submitted by the CONTRACTOR. During the trial batch the aggregate proportions may be adjusted by the testing laboratory using the two coarse aggregate size ranges to obtain the required properties. If one size range produces an acceptable mix, a second size range need not be used. Such adjustments will be considered refinements to the mix design and will not be the basis for extra compensation to the CONTRACTOR. Concrete shall conform to the requirements of this Section, whether the aggregate proportions are from the CONTRACTOR's preliminary mix design, or whether the proportions have been adjusted during the trial batch process. The trial batch shall be prepared using the aggregates, cement, and admixture proposed for the project. The trial batch materials shall be of a quantity such that the testing laboratory can obtain 3 drying shrinkage, and 6 compression test specimens from each batch.

C. The determination of compressive strength will be made by testing 6-inch diameter by 12-inch high cylinders; made, cured and tested in accordance with ASTM C 192 - Practice for Making and Curing Concrete Test Specimens in the Laboratory and ASTM C 39. Three compression test cylinders will be tested at 7 Days and 3 at 28 Days. The average compressive strength for the 3 cylinders tested at 28 Days for any given trial batch shall not be less than 125 percent of the indicated compressive strength.

D. A sieve analysis of the combined aggregate for each trial batch shall be performed according to the requirements of ASTM C 136 – Method for Sieve Analysis of Fine and Coarse Aggregates. Values shall be given for percent passing each sieve.

2.9 SHRINKAGE LIMITATION

A. The maximum concrete shrinkage for specimens cast in the laboratory from the trial batch, as measured at 21 Day drying age or at 28 Day drying age shall be 0.036 percent or 0.042 percent, respectively. Standard deviation will not be considered. The CONTRACTOR shall only use a mix design for construction that has first met the trial batch shrinkage requirements. Shrinkage limitations apply only to structural concrete.

B. The maximum concrete shrinkage for specimens cast in the field shall not exceed the trial batch maximum shrinkage requirement by more than 25 percent.

C. If the required shrinkage limitation is not met during construction, the CONTRACTOR shall take any or all of the following actions to reestablish compliance. These actions may include changing the source of aggregates, cement and/or admixtures; reducing water/cement ratio; washing of coarse and/or fine aggregate to reduce fines; increasing the number of construction joints; modifying the curing requirements; or other actions designed to minimize shrinkage or the effects of shrinkage.

2.10 MEASUREMENT OF CEMENT AND AGGREGATE

A. The amount of cement and of each separate size of aggregate entering into each batch of concrete shall be determined by direct weighing equipment furnished by the CONTRACTOR and acceptable to the ENGINEER.

B. Weighing tolerances

Material	Percent of Total Weight
Cement	1
Aggregates	3
Admixtures	3

2.11 MEASUREMENT OF WATER

A. The quantity of water entering the mixer shall be measured by a suitable water meter or other measuring device of a type acceptable to the ENGINEER and capable of measuring the water in variable amounts within a tolerance of one percent. The water feed control mechanism shall be capable of being locked in position so as to deliver constantly any required amount of water to each batch of concrete. A positive quick-acting valve shall be used for a cut-off in the water line to the mixer. The operating mechanism shall prevent leakage when the valves are closed.

2.12 READY-MIXED CONCRETE

A. At the CONTRACTOR'S option, ready-mixed concrete may be used if it meets the requirements as to materials, batching, mixing, transporting, and placing indicated herein and is in accordance with ASTM C 94, including the following supplementary requirements.

B. Ready-mixed concrete shall be delivered to the WORK, and discharge shall be completed within one hour after the addition of the cement to the aggregates or before the drum has been revolved 250 revolutions, whichever is first.

C. Truck mixers shall be equipped with electrically actuated counters by which the number of revolutions of the drum or blades may be readily verified. The counter shall be of the resettable, recording type, and shall be mounted in the driver's cab. The counters shall be actuated at the time of starting mixers at mixing speeds.

D. Each batch of concrete shall be mixed in a truck mixer for not less than 70 revolutions of the drum or blades at the rate of rotation designated by the manufacturer of equipment. Additional mixing, if any, shall be at the speed designated by the manufacturer of the equipment as agitating speed. Materials including mixing water shall be in the mixer

drum before actuating the revolution counter for determining the number of revolution of mixing.

E. Truck mixers and their operation shall be such that the concrete throughout the mixed batch as discharged is within acceptable limits of uniformity with respect to consistency, mix, and grading. If slump tests taken at approximately the 1/4 and 3/4 points of the load during discharge give slumps differing by more than one-inch when the required slump is 3-inches or less, or if they differ by more than 2-inches when the required slump is more than 3-inches, the mixer shall not be used on the WORK unless the causative condition is corrected and satisfactory performance is verified by additional slump tests. Mechanical details of the mixer, such as water measuring and discharge apparatus, condition of the blades, speed of rotation, general mechanical condition of the unit, and clearance of the drum, shall be checked before a further attempt to use the unit will be permitted.

F. Each batch of ready-mixed concrete delivered to the Site shall be accompanied by a delivery ticket furnished to the ENGINEER in accordance with the Paragraph above entitled "Delivery Tickets."

G. The use of non-agitating equipment for transporting ready-mixed concrete will not be permitted. Combination truck and trailer equipment for transporting ready-mixed concrete will not be permitted. The quality and quantity of materials used in ready-mixed concrete and in batch aggregates shall be subject to continuous inspection at the batching plant by the ENGINEER.

PART 3 -- EXECUTION

3.1 PROPORTIONING AND MIXING

A. **Proportioning:** Proportioning of the mix shall conform to the requirements of Chapter 3 "Proportioning" of ACI 301.

B. **Mixing:** Mixing shall conform to the requirements of Chapter 7 of ACI 301.

C. **Slump:** Slumps shall be as indicated herein.

D. **Retempering:** Retempering of concrete or mortar that has partially hardened shall not be permitted.

3.2 PREPARATION OF SURFACES FOR CONCRETING

A. **General:** Earth surfaces shall be thoroughly wetted by sprinkling prior to the placing of any concrete, and these surfaces shall be kept moist by frequent sprinkling up to the time of placing concrete thereon. The surface shall be free from standing water, mud, and debris at the time of placing concrete.

B. Vapor Retarder Sheet

1. Sheet shall be installed under on-grade building floor slabs of occupiable (non-hydraulic) structures and at other locations indicated.

2. Sand base shall be at least 2-inches thick within the foundation line after moistening and compaction by mechanical means. Sand surface shall be flat and level within a tolerance of plus 0-inches to minus 3/4-inch.

3. Place, protect, and repair defects in sheet according to ASTM E 1643 – Standard Practice for Installation of Water Vapor Retarders Used in Contact with Earth or Granular Fill Under Concrete Slabs, and the manufacturer's written instructions. Seams shall be lapped and sealed in accordance with ASTM E 1643.

4. Granular material above the sheet shall be moistened and compacted to 2-inches thickness within the same flatness criteria as the sand base.

C. **Joints in Concrete:** Concrete surfaces upon or against which concrete is to be placed, where the placement of the concrete has been stopped or interrupted so that, as determined by the ENGINEER, the new concrete cannot be incorporated integrally with that previously placed, are defined as construction joints. The surfaces of horizontal joints shall be given a compacted, roughened surface for good bonding. Except where the Drawings call for joint surfaces to be coated, the joint surfaces shall be cleaned of all laitance, loose or defective concrete, foreign material, and be roughened to a minimum 1/4-inch amplitude. Such cleaning and roughening shall be accomplished by hydroblasting or sandblasting (exposing aggregate) followed by thorough washing. Pools of water shall be removed from the surface of construction joints before the new concrete is placed.

D. After the surfaces have been prepared, each approximately horizontal construction joint shall be covered with a 6-inch lift of a pea gravel mix. The mix shall be placed and spread uniformly. Wall concrete shall follow immediately and shall be placed upon the fresh pea gravel mix.

E. **Placing Interruptions:** When placing of concrete is to be interrupted long enough for the concrete to take a set, the working face shall be given a shape by the use of forms or other means that will secure proper union with subsequent WORK; provided that construction joints shall be made only where acceptable to the ENGINEER.

F. **Embedded Items:** No concrete shall be placed until formwork, installation of parts to be embedded, reinforcement steel, and preparation of surfaces involved in the placing have been completed and accepted by the ENGINEER at least 4 hours before placement of concrete. Surfaces of forms and embedded items that have become encrusted with dried grout from previous usage shall be cleaned before the surrounding or adjacent concrete is placed.

G. Inserts or other embedded items shall conform to the requirements herein.

H. Reinforcement, anchor bolts, sleeves, inserts, and similar items shall be set and secured in the forms at locations indicated on the Drawings or shown by Shop Drawings and shall be acceptable to the ENGINEER before any concrete is placed. Accuracy of placement is the responsibility of the CONTRACTOR.

I. **Casting New Concrete Against Old:** Where concrete is to be cast against old concrete (any concrete which is greater than 60 Days of age), the surface of the old concrete shall be thoroughly cleaned and roughened by hydroblasting or sandblasting to expose aggregate. The joint surface shall be coated with an epoxy bonding agent unless indicated otherwise by the ENGINEER.

J. No concrete shall be placed in any structure until all water entering the space to be filled with concrete has been properly cut off or has been diverted by pipes, or other means, and carried out of the forms, clear of the WORK. No concrete shall be deposited underwater nor shall the CONTRACTOR allow still water to rise on any concrete until the concrete has attained its initial set. Water shall not be permitted to flow over the surface

of any concrete in such manner and at such velocity as will injure the surface finish of the concrete. Pumping or other necessary dewatering operations for removing ground water, if required, shall be subject to the review of the ENGINEER.

K. **Corrosion Protection:** Pipe, conduit, dowels, and other ferrous items required to be embedded in concrete construction shall be so positioned and supported prior to placement of concrete that there will be a minimum of 2-inches clearance between said items and any part of the concrete reinforcement. Securing such items in position by wiring or welding them to the reinforcement will not be permitted.

L. Openings for pipes, inserts for pipe hangers and brackets, and anchors shall, where practicable, be provided during the placing of concrete.

M. Anchor bolts shall be accurately set and shall be maintained in position by templates while being embedded in concrete.

N. **Cleaning:** The surfaces of metalwork to be in contact with concrete shall be thoroughly cleaned of dirt, grease, loose scale and rust, grout, mortar, and other foreign substances immediately before the concrete is placed.

3.3 HANDLING, TRANSPORTING, AND PLACING

A. **General:** Placing of concrete shall conform to the applicable requirements of Chapter 8 of ACI 301 and the requirements of this Section. No aluminum materials shall be used in conveying any concrete.

B. **Non-Conforming WORK or Materials:** Concrete which during or before placing is found not to conform to the requirements indicated herein shall be rejected and immediately removed from the WORK. Concrete which is not placed in accordance with these requirements or which is of inferior quality shall be removed and replaced.

C. **Unauthorized Placement:** No concrete shall be placed except in the presence of a duly authorized representative of the ENGINEER. The CONTRACTOR shall notify the ENGINEER in writing at least 24 hours in advance of placement of any concrete.

D. **Placement in Wall and Column Forms:** Concrete shall not be dropped through reinforcement steel or into any deep form, nor shall concrete be placed in any form in such a manner as to leave accumulation of mortar on the form surfaces above the placed concrete. In such cases, means such as hoppers and, if necessary, vertical ducts of canvas, rubber, or metal shall be used for placing concrete in the forms in a manner that it may reach the place of final deposit without separation. In no case shall the free fall of concrete below the ends of ducts, chutes, or buggies exceed 4-feet in walls and 8-feet in columns. Concrete shall be uniformly distributed during the process of depositing and in no case after depositing shall any portion be displaced in the forms more than 6-feet in horizontal direction. Concrete in wall forms shall be deposited in uniform horizontal layers not deeper than 2-feet; and care shall be taken to avoid inclined layers or inclined construction joints except where such are required for sloping members. Each layer shall be placed while the previous layer is still soft. The rate of placing concrete in wall forms shall not exceed 5-feet of vertical rise per hour. Sufficient illumination shall be provided in the interior of forms so that the concrete at the places of deposit is visible from the deck or runway.

E. **Casting New Concrete Against Old:** Epoxy adhesive bonding agent shall be applied to the old surfaces according to the manufacturer's written recommendations. This

provision shall not apply to joints where waterstop is provided. See Section 03290 - Joints in Concrete.

F. **Conveyor Belts and Chutes:** Ends of chutes, hopper gates, and other points of concrete discharge throughout the CONTRACTOR'S conveying, hoisting, and placing system shall be designed and arranged so that concrete passing from them will not fall separated into whatever receptacle immediately receives it. Conveyor belts, if used, shall be of a type acceptable to the ENGINEER. Chutes longer than 50 feet will not be permitted. Minimum slopes of chutes shall be such that concrete of the indicated consistency will readily flow in them. If a conveyor belt is used, it shall be wiped clean by a device operated in such a manner that none of the mortar adhering to the belt will be wasted. Conveyor belts and chutes shall be covered.

G. **Placement in Slabs:** Concrete placed in sloping slabs shall proceed uniformly from the bottom of the slab to the top, for the full width of the placement. As the WORK progresses, the concrete shall be vibrated and carefully worked around the slab reinforcement, and the surface of the slab shall be screeded in an up-slope direction.

H. **Temperature of Concrete:** The temperature of concrete when it is being placed shall be not more than 90 degrees F nor less than 55 degrees F for sections less than 12-inches thick nor less than 50 degrees for other sections. Concrete ingredients shall not be heated to a temperature higher than that necessary to keep the temperature of the mixed concrete, as placed, from falling below the minimum temperature. When the temperature of the concrete is 85 degrees F or above, the time between the introduction of the cement to the aggregates and discharge shall not exceed 45 minutes. If concrete is placed when the weather is such that the temperature of the concrete would exceed 90 degrees F, the CONTRACTOR shall employ effective means, such as precooling of aggregates and mixing water using ice or placing at night, as necessary to maintain the temperature of the concrete below 90 degrees F as it is placed. The CONTRACTOR shall be entitled to no additional compensation on account of the foregoing requirements.

I. Cold Weather Placement

1. Placement of concrete shall conform to ACI 306.1 - Cold Weather Concreting, and the following.

2. Remove snow, ice, and frost from the surfaces, including reinforcement, against which concrete is to be placed. Before beginning concrete placement, thaw the subgrade to a minimum depth of 6-inches. Reinforcement and embedded items shall be warmed to above 32 degrees F prior to concrete placement.

3. Maintain the concrete temperature above 50 degrees F for at least 72 hours after placement.

3.4 PUMPING OF CONCRETE

A. **General:** If the pumped concrete does not produce satisfactory end results, the CONTRACTOR shall discontinue the pumping operation and proceed with the placing of concrete using conventional methods.

B. **Pumping Equipment:** The pumping equipment shall have 2 cylinders and be designed to operate with one cylinder in case the other one is not functioning. In lieu of this requirement, the CONTRACTOR may have a standby pump on the Site during pumping.

C. The minimum diameter of the hose conduits shall be in accordance with ACI 304.2R – Placing Concrete by Pumping Methods.

D. Pumping equipment and hose conduits that are not functioning properly shall be replaced.

E. Aluminum conduits for conveying the concrete shall not be permitted.

F. **Field Control:** Concrete samples for slump, air content, and test cylinders will be taken at the placement end of the hose.

3.5 ORDER OF PLACING CONCRETE

A. The order of placing concrete in all parts of the WORK shall be acceptable to the ENGINEER. In order to minimize the effects of shrinkage, the concrete shall be placed in units as bounded by construction joints at the indicated locations. The placing of units shall be done by placing alternate units in a manner such that each unit placed shall have cured at least 5 Days for hydraulic structures and 2 Days for all other structures before the contiguous unit or units are placed, except that the corner sections of vertical walls shall not be placed until the 2 adjacent wall panels have cured at least 10 Days for hydraulic structures and 4 Days for all other structures.

B. The surface of the concrete shall be level whenever a run of concrete is stopped. To insure a level, straight joint on the exposed surface of walls, a wood strip at least 3/4-inch thick shall be tacked to the forms on these surfaces. The concrete shall be carried about 1/2-inch above the underside of the strip. About one hour after the concrete is placed, the strip shall be removed and any irregularities in the edge formed by the strip shall be leveled with a trowel and laitance shall be removed.

3.6 TAMPING AND VIBRATING

A. As concrete is placed in the forms or in excavations, it shall be thoroughly settled and compacted throughout the entire depth of the layer which is being consolidated, into a dense, homogeneous mass, filling all corners and angles, thoroughly embedding the reinforcement, eliminating rock pockets, and bringing only a slight excess of water to the exposed surface of concrete. Vibrators shall be Group 3 per ACI 309 – Consolidation of Concrete, high speed power vibrators (8000 to 12,000 rpm) of an immersion type in sufficient number and with at least one standby unit as required. Group 2 vibrators may be used only at specific locations when accepted by the ENGINEER.

B. Care shall be used in placing concrete around waterstops. The concrete shall be carefully worked by rodding and vibrating to make sure that all air and rock pockets have been eliminated. Where flat-strip type waterstops are placed horizontally, the concrete shall be worked under the waterstops by hand, making sure that air and rock pockets have been eliminated. Concrete surrounding the waterstops shall be given additional vibration over and above that used for adjacent concrete placement to assure complete embedment of the waterstops in the concrete.

C. Concrete in walls shall be internally vibrated and at the same time rammed, stirred, or worked with suitable appliances, tamping bars, shovels, or forked tools until it completely fills the forms or excavations and closes snugly against each surface. Subsequent layers of concrete shall not be placed until the layers previously placed have been worked thoroughly. Vibrators shall be provided in sufficient numbers, with standby units as required, to accomplish the required results within 15 minutes after concrete of the prescribed consistency is placed in the forms. The vibrating head shall not contact the

surfaces of the forms. Care shall be taken not to vibrate concrete excessively or to work it in any manner that causes segregation of its constituents.

3.7 FINISHING CONCRETE SURFACES

A. **General:** Surfaces shall be free from fins, bulges, ridges, offsets, honeycombing, or roughness of any kind, and shall present a finished, smooth, continuous hard surface. Allowable deviations from plumb or level and from the alignment, profiles, and dimensions indicated are defined as tolerances and are indicated above. These tolerances are to be distinguished from irregularities in finish as described herein. Aluminum finishing tools shall not be used.

B. **Formed Surfaces:** No treatment is required after form removal except for curing, repair of defective concrete, and treatment of surface defects. Where architectural finish is required, it shall be as indicated.

   1. Basins and exposed walls shall be given a smooth finish as indicated below.

C. **Unformed Surfaces:** After proper and adequate vibration and tamping, unformed top surfaces of slabs, floors, walls, and curbs shall be brought to a uniform surface with suitable tools. Immediately after the concrete has been screeded, it shall be treated with a liquid evaporation retardant. The retardant shall be used again after each work operation as necessary to prevent drying shrinkage cracks. The classes of finish for unformed concrete surfaces are designated and defined as follows:

   1. Finish U1 - Sufficient leveling and screeding to produce an even, uniform surface with surface irregularities not to exceed 3/8-inch. No further special finish is required.

   2. Finish U2 - After sufficient stiffening of the screeded concrete, surfaces shall be float finished with wood or metal floats or with a finishing machine using float blades. Excessive floating of surfaces while the concrete is plastic and dusting of dry cement and sand on the concrete surface to absorb excess moisture will not be permitted. Floating shall be the minimum necessary to produce a surface that is free from screed marks and is uniform in texture. Surface irregularities shall not exceed 1/4-inch. Joints and edges shall be tooled where indicated or as determined by the ENGINEER.

   3. Finish U3 - After the Finish U2 surface has hardened sufficiently to prevent excess of fine material from being drawn to the surface, steel troweling shall be performed with firm pressure such as will flatten the sandy texture of the floated surface and produce a dense, uniform surface free from blemishes, ripples, and trowel marks. The finish shall be smooth and free of all irregularities.

   4. Finish U4 - Trowel the Finish U3 surface to remove local depressions or high points. In addition, the surface shall be given a light broom finish with brooming perpendicular to drainage unless otherwise indicated. The resulting surface shall be rough enough to provide a nonskid finish.

   5. Unformed surfaces shall be finished according to the following schedule:

UNFORMED SURFACE FINISH SCHEDULE	
Area	**Finish**
Grade slabs and foundations to be covered with concrete or fill material	U1
Floors to be covered with grouted tile or topping grout	U2
Water bearing slabs with slopes 10 percent and less	U3
Water bearing slabs with slopes greater than 10 percent	U4
Slabs not water bearing	U4
Slabs to be covered with built-up roofing	U2
Interior slabs and floors to receive architectural finish	U3
Top surface of walls	U3

D. Floor Hardener (Surface Applied)

1. The following additional requirements apply to the substrate concrete in areas indicated to be under floor hardener:

   a. Slump shall be no greater than 4-inches when peak ambient temperatures are expected to exceed 65 degrees F and no greater than 3-inches when temperatures will not exceed 65 degrees F.

   b. Air content of the concrete shall not exceed 3 percent.

   c. No calcium chloride or set accelerating admixture containing calcium chloride shall be used.

   d. Do not use admixtures that increase bleeding.

   e. Do not use fly ash.

2. The CONTRACTOR shall finish areas indicated to receive hardener in conformance with the manufacturer's recommendations and the following. After leveling the concrete surface and as soon as the concrete will support an operator and machine without disturbing the level or working up excessive fines, the CONTRACTOR shall float the surface of the slab with a mechanical float fitted with detachable float shoes. Then apply 1/2 to 2/3 of the total amount of dry shake surface hardener uniformly to the surface. A mechanical spreader is recommended. Float the surface once the shake has absorbed sufficient moisture, as indicated by darkening

of the shake. Immediately apply the remainder of the shake and allow it to absorb moisture. Do not apply shake when bleed water is present.

3. Perform a third floating if time and setting characteristics of the concrete will allow, but do not add water to the surface.

4. As the surface stiffens further and loses sheen, trowel with blades set relatively flat, using hand or mechanical methods. Remove marks and pinholes in a final raised trowel operation.

5. Cure the finished surface using the fill-forming curing compound recommended by the manufacturer at a coverage rate which will provide moisture retention in excess of the requirements of ASTM C 309. Maintain ambient temperatures above 50 degrees F during the curing period.

6. Keep floors covered and prohibit traffic and loads for 10 days minimum after completion.

3.8 ARCHITECTURAL FINISH

A. **General:** Architectural finishes shall be provided only where specifically indicated. In other locations, the paragraph entitled Finishing Concrete Surfaces shall apply.

B. Immediately after the forms have been stripped, the concrete surface shall be inspected and any poor joints, voids, rock pockets, or other defective areas shall be repaired and form-tie holes filled as indicated herein.

C. Architectural finishes shall not be applied until the concrete surface has been repaired as required and the concrete has cured at least 28 Days.

D. Architecturally treated concrete surfaces shall conform to the accepted sample in texture, color, and quality. It shall be the CONTRACTOR's responsibility to maintain and protect the completed concrete finishes. All concrete finishes shall be installed and applied according to the manufacturers written directions and instructions.

E. Smooth Concrete Finish

1. The concrete surface shall be wetted, and a grout shall be applied with a brush. The grout shall be made by mixing one part portland cement and one part of fine sand that will pass a No. 16 sieve with sufficient water to give it the consistency of thick paint. The cement used in said grout shall be 1/2 gray and 1/2 white portland cement, or other proportion as determined by the ENGINEER. White portland cement shall be **Atlas white,** or equal. Calcium chloride at 5 percent by volume of the cement shall be used in the brush coat. The freshly applied grout shall be vigorously rubbed into the concrete surface with a wood float filling all small air holes. After all the surface grout has been removed with a steel trowel, the surface shall be allowed to dry and, when dry, shall be vigorously rubbed with burlap to remove completely all surface grout so that there is no visible paint-like film of grout on the concrete. The entire cleaning operation for any area shall be completed the day it is started, and no grout shall be left on the surface overnight.

2. Cleaning operations for any given day shall be terminated at panel joints. It is required that the various operations be carefully timed to secure the desired effect which is a light-colored concrete surface of uniform color and texture without any appearance of a paint or grout film.

3. In the event that improper manipulation results in an inferior finish, the CONTRACTOR shall rub such inferior areas with carborundum bricks.

4. Before beginning any of the final treatment on exposed surfaces, the CONTRACTOR shall treat in a satisfactory manner a trial area of at least 6'-0"x 6'-0" in a location selected by the ENGINEER and ARCHITECT, and shall preserve the approved sample panel undisturbed until final completion. The sample panel shall receive the same types and colors of architectural finishes as the final work, including sealers, joint materials and cleaning solutions. All sandblasting, texturing, finishes and materials shall be represented in finish to the sample panel. The sample panel shall remain in tact until all of the work is completed and shall only be removed upon written approval from the ENGINEER.

F. Sandblasted Concrete Finish

1. Sandblasting shall be done in a safe manner acceptable to local authorities and per OSHA requirements. The sandblasting shall be a light sandblast to remove laitance and to produce a uniform fine aggregate surface texture with approximately 1/32- to 1/16-inch of surface sandblasted off. Corners, patches, form panel joints, and soft spots shall be sandblasted with care.

2. A 4'-0"x 4'-0" sample panel for demonstrating the sandblasted finish shall be provided by the CONTRACTOR for acceptance by the ENGINEER & Architect prior to starting the sandblasting WORK. The sample panel shall include a corner, plugs, and joints and shall be marked after approval. The sample panel shall receive the same types and colors of architectural finishes as the final work, including sealers, joint materials and cleaning solutions. All sandblasting shall be equal in finish to the sample panel. The sample panel shall remain in tact until all of the work is completed and shall only be removed upon written approval from the ENGINEER.

3. Protection against sandblasting shall be provided on adjacent surfaces and materials not requiring sandblasting. After sandblasting, the concrete surfaces shall be washed with clean water and excess sand removed.

3.9 CURING AND DAMPPROOFING

A. **General:** Concrete shall be cured for not less than 7 Days after placing, in accordance with the methods indicated below for the different parts of the WORK.

Surface to be Cured or Dampproofed	Method
Unstripped forms	1
Wall sections with forms removed	6
Construction joints between footings and walls, and between floor slab and columns	2
Encasement and ductbank concrete and thrust blocks	3
All concrete surfaces not specifically indicated in this Paragraph	4

Floor slabs on grade in hydraulic structures	5
Slabs not on grade	6

B. **Method 1:** Wooden forms shall be wetted immediately after concrete has been placed and shall be kept wet with water until removal. If steel forms are used the exposed concrete surfaces shall be kept continuously wet until the forms are removed. If forms are removed within 7 Days of placing the concrete, curing shall be continued in accordance with Method 6 below.

C. **Method 2:** The surface shall be covered with burlap mats which shall be kept wet with water for the duration of the curing period, until the concrete in the walls has been placed. No curing compound shall be applied to surfaces cured under Method 2.

D. **Method 3:** The surface shall be covered with moist earth not less than 4 hours nor more than 24 hours after the concrete is placed. Earthwork operations that may damage the concrete shall not begin until at least 7 Days after placement of concrete.

E. **Method 4:** The surface shall be sprayed with a liquid curing compound.

1. It shall be applied in accordance with the manufacturer's printed instructions at a maximum coverage rate of 200 square feet per gallon and in such a manner as to cover the surface with a uniform film that will seal thoroughly.

2. Where the curing compound method is used, care shall be exercised to avoid damage to the seal during the 7 Day curing period. If the seal is damaged or broken before the expiration of the curing period, the break shall be repaired immediately by the application of additional curing compound over the damaged portion.

3. Wherever curing compound has been applied by mistake to surfaces against which concrete subsequently is to be placed and to which it is to adhere, compound shall be entirely removed by wet sandblasting just prior to the placing of new concrete.

4. Curing compound shall be applied as soon as the concrete has hardened enough to prevent marring on unformed surfaces and within 2 hours after removal of forms. Repairs to formed surfaces shall be made within the 2-hour period; provided, however, that any such repairs which cannot be made within the said 2 hour period shall be delayed until after the curing compound has been applied. When repairs are to be made to an area on which curing compound has been applied, the area involved shall first be wet-sandblasted to remove the curing compound.

5. At locations where concrete is placed adjacent to a panel which has been coated with curing compound, the panel shall have curing compound reapplied to an area within 6-feet of the joint and to any other location where the curing membrane has been disturbed.

6. Prior to final acceptance of the WORK, visible traces of curing compound shall be removed from surfaces in such a manner that does not damage the surface finish.

F. **Method 5**

1. Until the concrete surface is covered with curing compound, the entire surface shall be kept damp by applying water using nozzles that atomize the flow so that the

surface is not marred or washed. The concrete shall be given a coat of curing compound in accordance with Method 4 above. Not less than one hour nor more than 4 hours after the curing compound has been applied, the surface shall be wetted with water delivered through a fog nozzle, and concrete-curing blankets shall be placed on the slabs. The curing blankets shall be polyethylene sheet, polyethylene-coated waterproof paper sheeting, or polyethylene-coated burlap. The blankets shall be laid with the edges butted together and with the joints between strips sealed with 2-inch wide strips of sealing tape or with edges lapped not less than 3-inches and fastened together with a waterproof cement to form a continuous watertight joint.

2. The curing blankets shall be left in place during the 7 Day curing period and shall not be removed until after concrete for adjacent work has been placed. If the curing blankets become torn or otherwise ineffective, the CONTRACTOR shall replace damaged sections. During the first 3 Days of the curing period, no traffic of any nature and no depositing, temporary or otherwise, of any materials shall be permitted on the curing blankets. During the remainder of the curing period, foot traffic and temporary depositing of materials that impose light pressure will be permitted only on top of plywood sheets 5/8-inch minimum thickness, laid over the curing blanket. The CONTRACTOR shall add water under the curing blanket as often as necessary to maintain damp concrete surfaces at all times.

G. **Method 6:** This method applies to both walls and slabs.

1. The concrete shall be kept continuously wet by the application of water for a minimum period of at least 7 Days beginning immediately after the concrete has reached final set or forms have been removed.

2. Until the concrete surface is covered with the curing medium, the entire surface shall be kept damp by applying water using nozzles that atomize the flow so that the surface is not marred or washed.

3. Heavy curing mats shall be used as a curing medium to retain the moisture during the curing period. The curing medium shall be weighted or otherwise held substantially in contact with the concrete surface to prevent being dislodged by wind or any other causes. Edges shall be continuously held in place.

4. The curing blankets and concrete shall be kept continuously wet by the use of sprinklers or other means both during and after normal working hours.

5. Immediately after the application of water has terminated at the end of the curing period, the curing medium shall be removed, the entire concrete surface shall be wetted, and curing compound shall be immediately applied to the entire surface in accordance with Method 4 above.

6. The CONTRACTOR shall dispose of excess water from the curing operation to avoid damage to the WORK.

H. Dampproofing

1. The exterior surfaces of buried roof slabs shall be dampproofed as follows.

2. Immediately after completion of curing the surface shall be sprayed with a dampproofing agent consisting of an asphalt emulsion. Application shall be in 2 coats. The first coat shall be diluted to one-half strength by the addition of water

and shall be sprayed on so as to provide a maximum coverage rate of 100 square feet per gallon of dilute solution. The second coat shall consist of an application of the undiluted material, and shall be sprayed on so as to provide a maximum coverage rate of 100 square feet per gallon. Dampproofing material shall be as indicated above.

3. As soon as the material has taken an initial set, the entire area thus coated shall be coated with whitewash. Any formula for mixing the whitewash may be used if it produces a uniformly coated white surface and remains until placing of the backfill. If the whitewash fails to remain on the surface until the backfill is placed, the CONTRACTOR shall apply additional whitewash.

3.10 PROTECTION

A. The CONTRACTOR shall protect concrete against injury until final acceptance.

B. Fresh concrete shall be protected from damage due to rain, hail, sleet, or snow. The CONTRACTOR shall provide such protection while the concrete is still plastic and whenever precipitation is imminent or occurring.

3.11 CURING IN COLD WEATHER

A. Water curing of concrete may be reduced to 6 Days during periods when the mean daily temperature in the vicinity of the Site is less than 40 degrees F; provided that, during the prescribed period of water curing, when temperatures are such that concrete surfaces may freeze, water curing shall be temporarily discontinued.

B. Concrete cured by an application of curing compound will require no additional protection from freezing if the protection at 50 degrees F for 72 hours is obtained by means of approved insulation in contact with the forms or concrete surfaces; otherwise the concrete shall be protected against freezing temperatures for 72 hours immediately following 72 hours protection at 50 degrees F. Concrete cured by water shall be protected against freezing temperatures for 72 hours immediately following the 72 hours of protection at 50 degrees F.

C. Discontinuance of protection against freezing temperatures shall be such that the drop in temperature of any portion of the concrete will be gradual and will not exceed 40 degrees F in 24 hours. In the spring, when the mean daily temperature rises above 40 degrees F for more than 3 successive Days, the required 72-hour protection at a temperature not lower than 50 degrees F may be discontinued for as long as the mean daily temperature remains above 40 degrees F; provided, that the concrete shall be protected against freezing temperatures for not less than 48 hours after placement.

D. Where artificial heat is employed, special care shall be taken to prevent the concrete from drying. Use of unvented heaters will be permitted only when unformed surfaces of concrete adjacent to the heaters are protected for the first 24 hours from an excessive carbon dioxide atmosphere by application of curing compound; provided, that the use of curing compound for such surfaces is otherwise permitted.

3.12 TREATMENT OF SURFACE DEFECTS

A. As soon as forms are removed, exposed surfaces shall be carefully examined and any irregularities shall be immediately rubbed or ground in a satisfactory manner in order to secure a smooth, uniform, and continuous surface. Plastering or coating of surfaces to be smoothed will not be permitted. No repairs shall be made until after inspection by the

ENGINEER. In no case will extensive patching of honeycombed concrete be permitted. Concrete containing minor voids, holes, honeycombing, or similar depression defects shall be repaired as indicated below. Concrete containing extensive voids, holes, honeycombing, or similar depression defects shall be completely removed and replaced. Repairs and replacements shall be performed promptly.

B. Defective surfaces to be repaired shall be cut back from trueline a minimum depth of 1/2-inch over the entire area. Feathered edges will not be permitted. Where chipping or cutting tools are not required in order to deepen the area properly, the surface shall be prepared for bonding by the removal of all laitance or soft material, plus not less than 1/32-inch depth of the surface film from all hard portions by means of an efficient sandblast. After cutting and sandblasting, the surface shall be wetted sufficiently in advance of shooting with shotcrete or with cement mortar so that while the repair material is being applied, the surfaces underneath will remain moist but not so wet as to overcome the suction upon which a good bond depends. The material used for repair shall consist of a mixture of one sack of cement to 3 cubic feet of sand. For exposed walls, the cement shall contain such a proportion of Atlas white portland cement as is required to make the color of the patch match the color of the surrounding concrete.

C. Holes left by tie-rod cones shall be reamed with suitable toothed reamers so as to leave the surfaces of the holes clean and rough. Holes then shall be repaired in an approved manner with dry-packed cement grout. Holes left by form-tying devices having a rectangular cross-section and other imperfections having a depth greater than their least surface dimension shall not be reamed but shall be repaired in an approved manner with dry-packed cement grout.

D. Repairs shall be built up and shaped in such a manner that the completed WORK will conform to the requirements of this Section, as applicable, using approved methods which will not disturb the bond, cause sagging, or cause horizontal fractures. Surfaces of repairs shall receive the same kind and amount of curing treatment as required for the concrete in the repaired section.

E. Prior to filling any structure with water, cracks shall be "vee'd" as indicated and filled with sealant conforming to the requirements of Section 03290 - Joints in Concrete. This repair method shall be done on the water bearing face of members. Prior to backfilling, faces of members in contact with fill which are not covered with a waterproofing membrane shall also have cracks repaired as indicated herein.

3.13 PATCHING HOLES IN CONCRETE

A. Patching Small Holes

1. Holes that are less than 12-inches in the least dimension and extend completely through concrete members shall be filled.

2. Small holes in members that are water-bearing or in contact with soil or other fill material shall be filled with non-shrink grout. Where a face of the member is exposed to view, the non-shrink grout shall be held back 2-inches from the finished surface. The remaining 2-inches shall then be patched according to the Article above entitled "Treatment of Surface Defects."

3. Small holes through all other concrete members shall be filled with non-shrink grout, with exposed faces treated as above.

B. Patching Large Holes

1. Holes which are larger than 12-inches in the least dimension shall have a keyway chipped into the edge of the opening all around, unless a formed keyway exists. The holes shall then be filled with concrete as indicated herein.

2. Holes which are larger than 24-inches in the least dimension and which do not have reinforcing steel extending from the existing concrete, shall have reinforcing steel set in grout in drilled holes. The reinforcing added shall match the reinforcing in the existing wall unless indicated otherwise.

3. Large holes in members that are water bearing or in contact with soil or other fill shall have a hydrophilic type waterstop material placed around the perimeter of the hole in accordance with Section 03290 - Joints in Concrete, unless there is an existing waterstop in place.

3.14 CARE AND REPAIR OF CONCRETE

A. The CONTRACTOR shall protect concrete against injury or damage from excessive heat, lack of moisture, overstress, or any other cause until final acceptance. Particular care shall be taken to prevent the drying of concrete and to avoid roughening or otherwise damaging the surface. Any concrete found to be damaged, or which may have been originally defective, or which becomes defective at any time prior to the final acceptance of the completed WORK, or which departs from the established line or grade, or which, for any other reason, does not conform to the requirements of the Contract Documents, shall be satisfactorily repaired or removed and replaced with acceptable concrete.

- END OF SECTION -

SECTION 03315 - GROUT

PART 1 -- GENERAL

1.1 THE REQUIREMENT

A. The CONTRACTOR shall provide grout, complete and in place, in accordance with the Contract Documents

B. The following types of grout are covered in this Section:

1. Cement Grout

2. Non-Shrink Grout - Class I (cement based)

3. Non-Shrink Grout - Class II (cement based)

4. Non-Shrink Epoxy Grout

5. Epoxy Anchor Grout for Adhesive Achors

6. Topping Grout and Concrete/Grout Fill

1.2 CONTRACTOR SUBMITTALS

A. Furnish submittals in accordance with Section 01300 - Contractor Submittals.

1. Certified testing lab reports for tests indicated herein.

2. Test results and service report from the field tests and the demonstration and training session verifying the requirements indicated herein.

3. Certification that grouts used on the project contain no chlorides or other chemicals that cause corrosion.

4. Manufacturer's literature containing instructions and recommendations on the mixing, handling, placement, curing and appropriate uses for each type of grout used in the WORK, and location of use. ICBO/ES report shall be submitted for epoxy anchor grout for adhesive anchors.

5. Manufacturer's certification that its non-shrink grout does not contain aluminum, zinc, or magnesium powders as a method of expansion.

6. CONTRACTOR shall submit manufacturer's written warranty as indicated herein.

7. Name and telephone number of grout manufacturer's representative, who will give on-Site service. The representative shall have at least one year of experience with the chosen grouts.

1.3 QUALITY ASSURANCE

A. Field Tests

1. Compression test specimens will be taken during construction from the first placement of each type of grout, and at intervals thereafter as selected by the ENGINEER to ensure continued compliance with these specifications. The specimens will be made by the ENGINEER or its representative.

2. Compression tests and fabrication of specimens for cement grout and cement based non-shrink grout will be performed in accordance with ASTM C 1107 - Packaged Dry, Hydraulic-Cement Grout (Nonshrink), at intervals during construction selected by the ENGINEER. A set of 3 specimens will be made for testing at 7 Days, 28 Days, and each additional time period as appropriate.

3. Compression tests and fabrication of specimens for topping grout, and concrete/grout fill will be performed in accordance with Section 03300 - Cast-in-Place Concrete, at intervals during construction as selected by the ENGINEER.

4. Compression tests and fabrication of specimens for epoxy grouts will be performed in accordance with ASTM C 579 - Test Methods for Compressive Strength of Chemical-Resistant Mortars and Monolithic Surfacings and Polymer Concretes, Method B, at intervals during construction as selected by the ENGINEER. A set of 3 specimens will be made for testing at 7 Days, and each earlier time period as appropriate.

5. The cost of laboratory tests on grout will be paid by the OWNER except where test results show the grout to be defective. In such case, the CONTRACTOR shall pay for the tests, removal and replacement of Defective Work, and re-testing, all as part of the WORK.

6. The CONTRACTOR shall assist the ENGINEER in obtaining specimens for testing and shall furnish materials necessary for fabricating the test specimens.

B. **Construction Tolerances:** Construction tolerances shall be as indicated in Section 03300 unless indicated otherwise.

C. Pre-Installation Demonstration and Training

1. Cement and Epoxy-Based Non-Shrink Grouts

   a. The grout manufacturer shall give a demonstration and training session for the cement based non-shrink and epoxy grouts to be used on the project, before any installation of grout is allowed.

   b. Training session shall use a minimum of 5 bags of cement-based non-shrink class I grout mixed to fluid consistency. Tests shall be conducted for flow cone and bleed tests. Six cubes for testing at 1, 3, and 28 Days shall be made. The remaining grout shall be placed, and curing may be initiated on actual project placements such as baseplates and tie holes to provide on-the-job training for the CONTRACTOR and ENGINEER. The CONTRACTOR employees who will be doing the grouting participate in this training and demonstration session. The training session shall include methods for curing the grout.

   c. The manufacturer shall mix enough cement-based non-shrink class II grout for a minimum of 15 tie holes and shall train the CONTRACTOR'S employees in how to perform the work and cure the grout. The CONTRACTOR shall have the employees assisting in the mixing and sealing of the tie holes.

d. If the project includes patching, throughbolt holes, epoxy anchors, and/or blockouts, the manufacturer shall also train the CONTRACTOR'S employees in the mixing and curing of the epoxy grouts for each of these applications.

e. The CONTRACTOR shall transport the test cubes to an independent test laboratory, obtain the test reports, and report these demonstration and training test cube strengths to the ENGINEER.

2. Epoxy Anchor Grout for Adhesive Anchors

a. Special inspection as recommended by the ICBO/ES report or as required by the building department shall be required for adhesive anchor installations. Cost of special inspection of adhesive anchors will be paid by the OWNER.

b. Before installing adhesive anchors in the WORK, adhesive anchor installers shall be trained and qualified at the Site by the manufacturer's representative. Training and qualification for each installer shall include, but not be limited to:

1) Hole drilling procedure, hole preparation and cleaning techniques, adhesive injection technique and dispenser training/maintenance, rebar dowel preparation and installation, and proof loading/torquing.

2) Anchors installed in both the vertical and horizontal positions in a mock-up concrete panel of adequate size and thickness. Anchors shall be tested in tension and shear loading. A minimum of 3 anchors shall be tested for each installation position.

3) Anchors shall be tested at 2 times the published allowable load in tension and in shear as indicated in the ICBO report.

4) If any of the 3 test bolts in any installation position fail to reach the test loads, the installer shall be re-tested with the same procedure. Re-testing is required only for the failed installation position.

5) An installer who has 3 consecutive successful bolt tests in the first or second trial is considered qualified for adhesive anchor installation for this project. The manufacturer's representative shall issue a certificate to the qualified installer, and a copy of the certificate shall be filed with the CONTRACTOR and be submitted to the ENGINEER.

6) The test anchor size shall be the maximum size adhesive anchor used on the project. The embedment length shall be long enough to develop the allowable steel strength per AISC Manual of Steel Construction.

7) Each installer shall be re-qualified every 6 months for the duration of the project by the same qualifying procedure.

8) The certification of each qualified installer shall be available for verification at the Special Inspector's request.

9) Defective anchors noted by the Special Inspector shall be replaced and re-installed by the CONTRACTOR without any additional compensation.

1.4 SPECIAL CORRECTION OF DEFECTS PROVISIONS

A. Manufacturer's Warranty

1. Furnish one year warranty for WORK provided under this section.

2. Manufacturer's warranty shall not contain a disclaimer limiting responsibility to the purchase price of products or materials furnished.

PART 2 -- PRODUCTS

2.1 APPLICATION

A. Unless indicated otherwise, grouts shall be provided as listed below whether indicated on the Drawings or not.

Application	Type of Grout
Anchor bolts and reinforcing steel required to be set in grout in which the average working or operating temperature will be over 100 degrees F, or in high fire risk areas.	Non-Shrink - Class I
Anchor bolts and reinforcing steel required to be set in grout that is not in high temperature or high fire risk areas.	Epoxy Anchor Grout
Beam and column (1 or 2 story) base plates less than 16-inches in the least dimension.	Non-Shrink - Class I
Column base plates (greater than 2 story or larger than 16-inches in the least dimension)	Non-Shrink - Class II
Storage tanks and other non-motorized equipment and machinery under 30 horsepower	Non-Shrink - Class I
Machinery over 30 horsepower and equipment under 30 horsepower but subject to severe shock loads and high vibration	Non-Shrink Epoxy
Filling blockout spaces for embedded items such as railing posts, gate guide frames, etc.	Non-Shrink - Class I (Class II where placement time exceeds 20 min.)
Under precast concrete elements	Non-Shrink - Class II
Toppings and concrete/grout fill less than 3-inches thick	Topping Grout
Toppings and concrete/grout fill greater than 3-inches thick	Structural Concrete per 03300
Surface repairs	Cement Grout

Repair of holes and defects in concrete members which are not water bearing and not in contact with soil or other fill material	Non-Shrink - Class I
Repair of holes and defects in concrete members which are water bearing or in contact with soil or other fill materials	Non-Shrink - Class II
Any application not listed above, where grout is called for on the Drawings	Non-Shrink Class I, unless noted otherwise

2.2 CEMENT GROUT

A. Cement grout shall be composed of one part cement, 3 parts sand, and the minimum amount of water necessary to obtain the desired consistency. Where needed to match the color of adjacent concrete, white portland cement shall be blended with regular cement as needed. The minimum compressive strength at 28 Days shall be 4000 psi.

B. Cement grout materials shall be as indicated in Section 03300.

2.3 NON-SHRINK GROUTS (cement based)

A. General

1. Cement-based non-shrink grout shall be a prepackaged, inorganic, fluid, non-gas-liberating, non-metallic, cement type grout requiring only the addition of water. Cement from kilns burning metal-rich hazardous waste fuel shall not be used.

2. Manufacturer's instructions shall be printed on each bag or other container in which the materials are packaged. The specific formulation for each class of non-shrink grout indicated herein shall be that recommended by the manufacturer for the particular application.

3. Grout shall not contain chlorides or additives that may contribute to corrosion.

4. Grout shall be formulated to be used at any consistency from fluid to plastic.

5. Cement-based non-shrink grout shall have the following minimum properties when tested at a fluid consistency, at 28 Days:

a. Minimum tensile splitting strength of 500 psi per ASTM C 496 - Standard Test Method for Splitting Tensile Strength of Cylindrical Concrete Specimens.

b. Minimum flexural strength of 1000 psi per ASTM C 580 - Standard Test Method for Flexural Strength and Modulus of Elasticity of Chemical-Resistant Mortars, Grouts, Monolithic Surfacings, and Polymer Concretes.

c. Minimum bond strength (concrete to grout) of 1900 psi per modified ASTM C 882 - Standard Test Method for Bond Strength of Epoxy-Resin Systems Used with Concrete by Slant Shear.

d. Grout shall be certified for use in a marine environment.

B. Class I Non-Shrink Grout

1. Class I non-shrink grout shall have a minimum 28-Day compressive strength of 5000 psi when mixed at a fluid consistency.

2. Class I non-shrink grout shall meet the requirements of ASTM C 1107, Grade B or C, when mixed to fluid, flowable and plastic consistencies.

3. Grout shall have a maximum early age height change of 4.0 percent expansion, and shall have no shrinkage (0.0 percent) in accordance with ASTM C 827 – Test Method for Early Volume Change of Cementitious Mixtures. The grout when tested shall not bleed or segregate at maximum allowed water.

4. Grout shall have no shrinkage (0.0 percent) and a maximum of 0.3 percent expansion in the hardened state when tested in accordance with ASTM C 1090 - Test Method for Measuring Changes in Height of Cylindrical Specimens from Hydraulic-Cement Grout.

5. Furnish certification that the non-shrink property of grout is not based on gas production or gypsum expansion.

6. Class I Non-Shrink Grout shall be **Five Star Grout** by **Five Star Products; Sikagrout 212** by **Sika Corporation; Premier** by **L&M Construction Chemicals; High-Flow Grout** by **Euclid Chemical Company; CG 200 PC** by **Hilti,** or equal.

C. Class II Non-Shrink Grout

1. Class II non-shrink grout shall be a high precision, fluid, extended working time, grout. The minimum 28-Day compressive strength shall be 7500 psi, when mixed at a fluid consistency.

2. Grout shall have a maximum early age height change of 4.0 percent expansion, and shall have no shrinkage (0.0 percent) in accordance with ASTM C 827.

3. Grout shall have no shrinkage (0.0 percent) and a maximum of 0.3 percent expansion in the hardened state when tested in accordance with ASTM C 1090.

4. Class II non-shrink grout shall have an extended working time of 30 minutes minimum when mixed to a fluid consistency as defined in ASTM C 827 at temperature extremes of 45 to 90 degrees F in accordance with ASTM C 1107.

5. Class II non-shrink grout shall meet the requirements of ASTM C 1107, Grade B or C when tested using the amount of water needed to achieve fluid consistency per ASTM C 939.

6. The grout when tested shall not bleed or segregate at maximum allowed water content.

7. Provide certification that its non-shrink property is not based on gas production or gypsum expansion.

8. Class II non-shrink grout shall be **Masterflow 928** by **MBT-Chemrex; Five Star Fluid Grout 100** by **Five Star Products; Crystex** by **L&M Construction Chemicals;** or equal.

2.4 NON-SHRINK EPOXY GROUT

A. Non-shrink epoxy grout shall be a flowable, non-shrink, 100 percent solids system. The epoxy grout system shall have 3 components: resin, hardener, and specially blended aggregate, each premeasured and prepackaged. The resin component shall not contain any non-reactive diluents. Resins containing butyl glycidyl ether (BGE) or other highly volatile and hazardous reactive diluents are not acceptable. Variation of component ratios is not permitted unless specifically recommended by the manufacturer. Manufacturer's instructions shall be printed on each container in which the materials are packaged.

B. Epoxy grout shall have a maximum early age height change of 4.0 percent expansion, and shall have no shrinkage (0.0 percent) in accordance with ASTM C 827, (modified for epoxy grouts by using an indicator ball with a specific gravity between 0.9 and 1.1).

C. Epoxy grout shall have a negligible (less than 0.0006 in/in) length change after hardening, and a coefficient of thermal expansion less than 0.00003 in/in F when tested according to ASTM C 531 - Test Method for Linear Shrinkage and Coefficient of Thermal Expansion of Chemical-Resistant Mortars, Grouts, and Monolithic Surfacing.

D. The epoxy grout shall develop a minimum compressive strength of 9000 psi in 24 hours and 13,000 psi in seven days when tested in accordance with ASTM C 579, method B.

E. The mixed epoxy grout shall have a minimum working life of 90 to 120 minutes at 70 degrees F.

F. The effective bearing area shall be a minimum of 95 percent EBA in accordance with ASTM C 1339 – Standard Test Method for Flowability and Bearing Area of Chemical-Resistant Polymer Machinery Grouts, for bearing area and flow.

G. The chemical formulation of the epoxy grout shall be that recommended by the manufacturer for the particular application. Do not reduce aggregate loading or add solvents to increase flowability.

H. Non-shrink epoxy grout shall have the following minimum properties when tested at 7 Days:

   1. Minimum bond strength to concrete of 3000 psi per ASTM C 882 modified.

   2. Minimum bond strength to steel of 1700 psi per ASTM C 882 modified.

   3. Minimum flexural strength of 2500 psi per ASTM C 580.

   4. Minimum tensile strength of 2000 psi per ASTM C 307 -- Standard Test Method for Tensile Strength of Chemical-Resistant Mortar, Grouts, and Monolithic Surfacings.

I. Non-shrink epoxy grout shall be **Five Star DP Epoxy Grout** by **Five Star Products, Inc.; Masterflow 648 CP Plus** by **MBT-Chemrex; Sikadur 42 Grout-Pak** by **Sika Corporation;** or equal.

2.5 EPOXY ANCHOR GROUT

A. Epoxy anchor grout shall conform to ASTM C 881 - Epoxy-Resin-Base Bonding Systems for Concrete, Type IV, Class B & C, Grade 3 with the exception of gel time.

B. Heat deflection temperature per ASTM D 648 -- Test Method for Deflection Temperature of Plastics Under Flexural Load shall be a minimum 120 degrees F.

C. Manufacturer shall certify that the epoxy anchor grout will maintain 90 percent of its strength up to a temperature of 125 degrees F.

D. Grout shall come in a 2 chambered cartridge with a metering system that provides the proper ratio of hardener and resin. The grout shall also come with a static mixer nozzle to thoroughly mix the hardener and resin together.

E. Epoxy anchor grout shall be capable of being used in submersed applications once cured.

F. Compressive strength per ASTM D 695 - Test Method for Compressive Properties of Rigid Plastics shall be 10,000 psi minimum.

G. If the average working or operating temperature will be over 100 deg F or in a high fire risk area, use cement based non-shrink grout and oversized holes.

H. Overhead anchors and anchors in fire-resistive construction shall be cast-in anchors.

I. Embedment of adhesive anchors/rebar shall be deep enough to develop the anchor/rebar. Embedment shall not exceed 67 percent of the member depth.

J. Epoxy anchor grout shall be **Epcon C6** by **ITW Ramset/Red Head; Power-Fast Epoxy Injection Gel** by **Powers Fasteners; RE 500** by **Hilti, Sikadur AnchorFix-4,** or equal.

2.6 TOPPING GROUT AND CONCRETE/GROUT FILL

A. Where fill is thicker than 3 inches, structural concrete, as indicated in Section 03300 - Cast-in-Place Concrete, may be used when accepted by the ENGINEER.

B. Grout for topping of slabs and concrete/grout fill for built-up surfaces of tank, channel, and basin bottoms shall be composed of cement, fine aggregate, coarse aggregate, water, and admixtures proportioned and be mixed as indicated herein. Materials and procedures indicated for normal concrete in Section 03300 - Cast-in-Place Concrete, shall apply unless indicated otherwise.

C. Topping grout and concrete/grout fill shall contain a minimum of 564 pounds of cement per cubic yard with a maximum water cement ratio of 0.45.

D. Coarse aggregate shall be graded as follows:

U.S. STANDARD SIEVE SIZE	PERCENT BY WEIGHT PASSING
1/2 in	100
3/8 in	90-100
No. 4	20-55
No. 8	5-30

No. 16	0-10
No. 30	0

E. Final mix design shall be as determined by trial mix design as indicated in 03300, except that drying shrinkage tests are not required.

F. **Strength:** Minimum compressive strength of topping grout and concrete/grout fill at 28 Days shall be 4000 psi.

2.7 CURING MATERIALS

A. Curing materials shall be in accordance with Section 03300 and as recommended by the manufacturer of prepackaged grouts.

2.8 CONSISTENCY

A. The consistency of grouts shall be that necessary to completely fill the space to be grouted for the particular application. Dry pack consistency is such that the grout is plastic and moldable but will not flow. Where "dry pack" is called for in the Contract Documents, it shall mean a grout of that consistency; the type of grout to be used shall be as indicated herein for the particular application.

B. The slump for topping grout and concrete/grout fill shall be adjusted to match placement and finishing conditions but shall not exceed 4 inches.

2.9 MEASUREMENT OF INGREDIENTS

A. Measurements for cement grout shall be made accurately by volume using containers. Shovel measurements shall not be allowed.

B. Prepackaged grouts shall have ingredients measured by means recommended by the manufacturer.

PART 3 -- EXECUTION

3.1 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Grout shall be stored in accordance with manufacturer's recommendations.

3.2 GENERAL

A. CONTRACTOR shall arrange for the manufacturer of prepackaged grouts to provide on-Site technical assistance within 72 hours of request, as part of the WORK.

B. Grout shall not be placed until base concrete or masonry has attained its design strength, unless authorized otherwise by the ENGINEER.

C. When cementitious grouts are used on concrete surfaces, the concrete surface shall be saturated with water for 24 hours prior to placement. Upon completion of the saturation period, excess water shall be removed with clean, oil free compressed air prior to grouting. Concrete substrate shall not be wet prior to placement of epoxy grouts.

D. Surface preparation, curing, and protection of cement grout shall be in accordance with Section 03300. The finish of the grout surface shall match that of the adjacent concrete unless otherwise indicated.

E. Surfaces that will be in contact with grout shall be free of dirt, loose rust, oil, wax, grease, curing compounds, laitance, loose concrete, and other deleterious materials.

F. Shade the WORK from sunlight for at least 24 hours before and 48 hours after grouting.

G. Contact the grout manufacturer's representative for assistance on hot and cold weather grouting techniques and precautions if applicable.

3.3 GROUTING PROCEDURES

A. **General:** Mixing, surface preparation, handling, placing, consolidation, curing, and other means of execution for prepackaged grouts shall be done according to the instructions and recommendations of the manufacturer.

B. Structural, equipment, tank, and piping support bases shall be grouted, unless indicated otherwise.

1. The original concrete shall be blocked out or finished off a sufficient distance below the plate to provide for a minimum one-inch thickness of grout, or a thickness as indicated.

2. After the base plate has been set in position at the proper elevation by steel wedges or double nuts on the anchor bolts, the space between the bottom of the plate and the original pour of concrete shall be filled with non-shrink-type grout through a headbox of appropriate size. The mixture shall be of a fluid consistency and poured continuously into the space between the plate and the base concrete. Forms for grout shall be tight against retaining surfaces, and joints shall be sealed as recommended by the grout manufacturer to be liquid-tight. Forms shall be coated as recommended by the grout manufacturer for easy form release. Where this method of placement is not practical or where required by the ENGINEER, alternate grouting methods shall be submitted for acceptance by the ENGINEER.

C. Drilled anchors and Reinforcing Bars

1. General

a. Drilled anchors and reinforcing bars shall be installed in strict accordance with the manufacturer's instructions. Holes shall be roughened with a brush on a power drill, and cleaned. Drilled anchors shall not be installed until the concrete has reached the required 28 Day compressive strength. Anchors shall not be loaded until the grout has reached its indicated strength in accordance with the manufacturer's instructions.

b. The CONTRACTOR shall identify position of reinforcing steel and other embedded items prior to drilling holes. Care shall be exercised in coring and drilling to avoid damaging existing reinforcing or embedded items. Notify the ENGINEER if reinforcing steel or other embedded items are encountered during drilling. Take precautions as necessary to avoid damaging prestressing tendons, electrical and communications conduit, and piping.

2. Epoxy Adhesive Anchors

   a. Grout shall be proportioned and mixed with automatic equipment.

   b. Unless otherwise indicated, embedment shall be sufficient to develop the ultimate tensile strength of the anchor or reinforcing bar per the manufacturer's ICBO report, but shall not be less than 8 diameters for threaded rod, or 12 diameters for reinforcing or smooth bars.

   c. Holes shall be dry.

3. Cement Based Non-Shrink Grout

   a. In places of high temperature or fire hazard, anchor bolts shall be grouted in using cement based non-shrink grout, Class I.

   b. Unless otherwise indicated, embedment shall be sufficient to develop the ultimate tensile strength of the anchor or reinforcing bar per the manufacturer's ICBO report, but shall not be less than 16 diameters for threaded rod or 24 diameters for reinforcing or smooth bars.

   c. When the bolt diameter is one-inch or less, the hole diameter should be a minimum of 2-inches. When the bolt diameter is greater than one-inch, the hole diameter should be at least twice the bolt diameter.

   d. Drilled holes shall be saturated with water for not less than 24 hours before installation of anchor/rod/rebar.

   e. The non-shrink grout should be placed in the holes in a non-sag (trowelable) consistency. The grout should be placed in the holes before the anchor and then the anchor inserted and vibrated to ensure proper coverage.

D. Topping Grout and Concrete/Grout Fill

1. Mechanical, electrical, and finish WORK shall be completed prior to placement of topping or concrete/grout fill. To ensure bonding to the base slab, the base slab shall be given an exposed aggregate finish. Alternatively where accepted by the ENGINEER, the base slab shall be given a roughened textured surface by a close-spaced rake while the surface is green. After curing, high pressure washing shall expose the aggregates and produce not less than a 3/16-inch amplitude roughness. Jackhammers or chipping hammers shall not be used.

2. The minimum thickness of grout topping and concrete/grout fill shall be one-inch. Where the finished surface of concrete/grout fill is to form an intersecting angle of less than 45 degrees with the concrete surface it is to be placed against, a key shall be formed in the concrete surface at the intersection point. The key shall be a minimum of 3-1/2 inches wide by 1-1/2 inches deep.

3. The base slab shall be thoroughly cleaned and wetted to saturated surface dry (SSD) condition per the International Concrete Repair Institute (ICRI) -- Technical Guide for Selecting and Specifying Concrete Surface Preparation for Sealers, Coatings, and Polymer Overlays, prior to placing topping and fill. No topping concrete shall be placed until the slab is completely free from standing pools or ponds of water. A thin coat of neat cement grout shall be broomed into the surface

of the slab just before topping or fill placement. The neat cement grout shall not be allowed to dry before topping placement. If it does dry, it must be immediately removed using wet stiff brooms and reapplied. The topping and fill shall be compacted by rolling or thorough tamping, brought to established grade, and floated. Grouted fill for tank and basin bottoms where scraping mechanisms are to be installed shall be screeded by blades attached to the revolving mechanism of the equipment in accordance with the procedures outlined by the equipment manufacturer after the grout is brought to the established grade. Coat surface with evaporation retardant as needed to prevent plastic shrinkage cracks.

4. Topping grout placed on sloping slabs shall proceed uniformly from the bottom of the slab to the top, for the full width of the placement.

5. The surface shall be tested with a straight edge to detect high and low spots which shall be immediately eliminated. When the topping or fill has hardened sufficiently, it shall be steel troweled to a smooth surface free from pinholes and other imperfections. An approved type of mechanical trowel may be used as an assist in this operation, but the last pass over the surface shall be by hand-troweling. During finishing, no water, dry cement, or mixture of dry cement and sand shall be applied to the surface.

6. As soon as topping or fill finishing is completed, coat surface with curing compound. After the topping is set and sufficiently hard in clarifiers and where required by the ENGINEER, the tank shall be filled with sufficient water to cover the entire floor for 14 days.

3.4 CONSOLIDATION

A. Grout shall be placed in such a manner, for the consistency necessary for each application, to assure that the space to be grouted is completely filled.

3.5 CURING

A. Cement based grouts shall be cured per 03300 and per the manufacturer's recommendations.

- END OF SECTION -

SECTION 03320 – CONCRETE PLACED UNDER WATER

PART 1 -- GENERAL

1.1 THE REQUIREMENT

A. The CONTRACTOR shall provide concrete placed under water as a water-tight plug for the Wet Well Caisson for the Submersible and Pocket PUMP Station, complete and in place, in accordance with the Contract Documents. Placement of concrete can be tremie placement or direct pump placement.

1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. Commercial Standards

ACI 117	Standard Specification for Tolerances for Concrete Construction and Material
ACI 301	Structural Concrete for Buildings
ACI 304R	Guide for Measuring, Mixing, Transporting, and Placing Concrete
ACI 318	Building Code Requirements for Reinforced Concrete C Commercial Standards
ASTM C 33	Standard Test Method for Making and Curing Concrete Test Specimens in the Field
ATM C 39	Standard Test Method for Compressive Strength of Cylindrical Concrete
ASTM C 143	Standard Test Method for Slump of Hydraulic Cement
ASTM C 266	Standard Test Method for Time of Setting of Hydraulic Cement Paste by Gilmore Needles

1.3 CONTRACTOR SUBMITTALS

A. **General:** The CONTRACTOR shall furnish submittals in accordance with Section 01300 – Contractor Submittals.

B. **Shop Drawings:**

1. The CONTRACTOR shall submit detailed plans for concrete placement, which includes pipe spacing and location throughout the duration of placement, and the planned locations to be used of r relocating pipes as the placement progresses.

2. Placement procedures, which includes details of a stable platform for support of tremie and pumping operations.

3. Procedure for preventing water flowing across or through the under water placement site during concreting.

4. Quality control procedures.

5. Inspection Procedures.

C. **Mix Designs:** Prior to beginning the WORK, the CONTRACTOR shall submit preliminary concrete mix designs which show the proportions and gradations of all materials proposed for under water placement. The mix designs shall be checked by an independent testing laboratory acceptable to the ENGINEER.L All costs related to such checking shall be borne by the CONTRACTOR.

D. **Delivery Tickets:** Where ready-mix concrete is used, CONTRACTOR shall furnish certified delivery tickets at the time of delivery of each load of concrete. Each ticket shall show the state certified equipment used for measuring, and the total quantities, by weight, of cement, sand, each class of aggregate, admixtures, and the amounts of water in aggregate, added at the batching plant, and the amount allowed to be added at the site for the specific design mix. In addition, each certificate shall state the mix number, total yield in cubic yards, and the time of day, to the nearest minute, corresponding to the time when the batch was dispatched, when it left the plant, when it arrived at the site, when unloading began, and when unloading was finished.

1.4 QUALITY ASSURANCE

A. Field Tests

1. Compression test specimens will be taken from the first placement of concrete as near to the tremie hopper as possible herein and at intervals thereafter as selected by the ENGINEER to insure continued compliance. Each set of test specimens will be a minimum of 4 cylinders.

2. Compression test specimens for concrete will be made in accordance with Section 9.2 of ASTM C 31. Specimens will be 6-inch diameter by 12-inch high cylinders.

3. Compression tests will be performed in accordance with ASTM C 39. One test cylinder will be tested at 7 days and 2 cylinders at 28 days. The remaining cylinder will be held to verify test results if needed.

4. Slump and air content tests shall be performed when each set of compression test specimens are taken.

B. Evaluation and acceptance of Concrete

1. Evaluation and acceptance of the compressive strength of concrete shall be according to the requirements of ACI 318, Chapter 5 "Concrete Quality", and as indicated herein.

2. If any concrete fails to meet these requirements, immediate corrective action shall be taken to increase the compressive strength for all subsequent batches of concrete affected.

3. All concrete which fails to meet the ACI requirements and these Specifications, is subject to removal and replacement at no additional cost to the OWNER.

C. Construction Tolerances

1. The CONTRACTOR shall ensure that the concrete is within ±3 inches of the elevation as indicated on the Drawings. Surface defects and irregularities are defined as finishes and are to be distinguished from tolerances. Tolerance is the permissible variation from lines, grades, or dimensions indicated. Where tolerances are not stated in the Specifications, permissible deviations will be in accordance with ACI 117.

PART 2 -- PRODUCTS

2.1 CONCRETE MATERIALS

A. Concrete material shall conform to the requirements of Paragraph 2.1 of Section 03300 – Cast-In-Place Concrete, except as modified herein.

1. High Range water reducer as specified in Paragraph 2.1.D.5.b.(4) of Section 03300 – Cast-In-Place Concrete, shall not be used for concrete placed under water.

2.2 CURING MATERIALS

A. Curing material shall conform to the requirements of Paragraph 2.2 of Section 03300 – Cast-In-Place Concrete.

2.3 MISCELLANEOUS MATERIALS

A. Concrete design shall conform to the requirements of Paragraph 2.5 of Section 03300 – Cast-In-Place Concrete.

2.4 CONCRETE DESIGN REQUIREMENTS

A. Concrete design shall conform to the requirements of Paragraph 2.5 of Section 03300 – Cast-In-Place Concrete, except as modified herein:

1. Concrete placed under water shall have a minimum compressive strength of 4,000 psi, and the maximum water to cement ratio equals to 0.45, and the cement content shall not be less than 658 pounds per cubic yard of concrete.

2. Fine aggregate shall be 45 percent, ± 5 percent by volume of total aggregates.

3. Maximum size of coarse aggregate shall be 1-1/2 inches for tremie placement, and 3/4-inch for direct pump placement.

4. Air content shall be 4 percent.

B. The final selection of concrete mixed design shall be based upon test placement under water in a placement box or in a pit which can be dewatered after the placement. Test placements shall be examined for concrete flatness, amount of laitance present, quality of concrete at the extreme flow distances of the test. The ENGINEER shall determine the acceptance or rejection of the mix bases on the results of the test.

2.5 CONSISTENCYH

A. The consistency of the concrete in successive batches shall be determined by slump tests in accordance with ASTM C 143. The slumps shall be7-inch ± 1-inch.

2.6 TRIAL BATCH AND LABORATORY TESTS.

A. Trial batch and laboratory tests shall conform to requirement of Paragraph 2.7 of Section 03300 – Cast-In-Place Concrete, except as modified herein.:

1. Shrinkage test and limitation of shrinkage are not required for concrete placed under water.

2. Initial and final setting time of the concrete mix shall be established in accordance with the requirements of ASTM C 266

2.7 MEASUREMENT OF WATER

A. The quantity of water entering the mixer shall be measured by a suitable water meter or other measuring device of a type acceptable to the ENGINEER and capable of measuring the water in variable amounts within a tolerance of one percent.

B. The quantity of water entering the mixer shall be measured by a suitable water meter or other measuring device of a type acceptable to the ENGINEER and capable of measuring the water in variable amounts within a tolerance of one percent.

2.8 READY-MIXED CONCRETE

A. Ready-mix concrete shall conform to the requirements of Paragraph 2.11 of Section 03300 – Cast-In-Place Concrete.

PART 3 -- EXECUTION

3.1 PROPORTIONING AND MIXING

A. **Proportioning:** Proportioning of the concrete mix shall conform to the requirements of Chapter 3 "Proportioning" of ACI 301.

B. **Mixing:** Mixing of concrete shall conform to the requirements of Chapter 7 ACI 301.

C. **Slump:** Slump shall be as indicated.

D. **Re-Tempering:** Re-tempering of concrete or mortar which has partially hardened will not be permitted.

3.2 PREPARATION OF SURFACES FOR CONCRETING

A. **General:** The existing concrete surface to receive concrete placed under water shall be roughened to 1/4-inch amplitude for bond prior to the placing of any concrete.

B. **Placing Interruptions:** When placing of concrete is to be interrupted longer than the initial setting time is treated as a planned or unplanned horizontal construction joint, the concrete surface shall be "green cut" by a diver after it sets. The concrete surface shall be water jetted immediately prior to resuming concrete placement.

3.3 TREMIE EQUIPMENT AND PLACEMENT PROCEDURE

A. **Tremie Pipes:** Tremie pipes shall be fabricated of heavy gauge steel pipe to withstand all anticipated handling stresses, and shall be sized to prevent aggregate-caused

blocking. Pipes shall be fabricated in sections such that the upper sections can be removed as the placement progressed. The pipe sections shall be jointed with flanges and gasket to prevent water being sucked in the concrete during placement. The tremie pipe shall be marked to facilitate quick determination of the distance from the water surface to the mouth of the tremie

B. **Funnel or Hopper:** Suitably sized funnel or hopper shall be provided for the tremie to allow transfer of adequate volume of concrete from the delivery device to the tremie. A stable platform shall be provided for the tremie support during the placement operation.

3.4 PLACEMENT PROCEDURE

A. General

1. Prior to tremie or direct pumping placing of concrete under water, the CONTRACTOR shall use proper means to prevent flow of water across or through the placement site.

B. Pipe Spacing

1. The CONTRACTOR hall determine the spacing of pipe for concrete placement, but shall maintain a minimum of one pipe for each 300 q ft of concrete placed.

C. Starting Placement

1. Tremie started using the end plate, dry pipe technique shall be filled with concrete before being raised off the bottom. The pipe shall be initially raised sufficiently to establish a mound around the mouth of the tremie pipe.

2. Tremie started using a go-devil shall be lifted a maximum of 6 inches to allow water to escape, then concrete shall be added to the tremie slowly to force the go-devil downward. Once the go-devil reaches the mouth of the tremie, the tremie shall be lifted to allow the escape of the go-devil, and the forming of a mound around the mouth of the pipe.

3. Pipe shall be adequately embedded to the fresh concrete, and slowly raised so as to prevent "loss of seal," Should a "loss of seal" occur in a tremie, placement through that tremie must be terminated immediately, and the tremie removed. The flow must be restarted with the end plate, dry pipe technique, a go-devil shall not be used to restart a tremie after loss of seal.

D. Placing

1. Placement of concrete shall be as continuous as possible through the tremie. Placement interruption less than 30 minutes is allowed to restart without any special procedure. Concrete shall be placed to elevation as indicated on the Drawings.

2. Placement interruptions between 30 minutes and the initial setting time shall be treated by removal, resealing, and restarting the tremie.

3. Placement interruption longer that the initial setting time is treated as a construction joint, or if the interruption is a planned construction joint, the concrete surface shall be "green cut" by a diver after it sets. The concrete surface shall be cleaned by water jetting prior to resuming placement.

4. The rate of concrete rise shall be established based on the concrete production of the local area and the spacing of the pipes. The volume of concrete shall be monitored throughout the placement to detect placement problems, such as underrun, or overrun. Should underrun or overrun occur, corrective actions such as readjusting the rate of concrete rise, and alternating the pipe spacing, shall be taken to ensure proper placement.

5. Tremie blockage shall be cleared with caution to prevent loss of seal.

6. The pipe delivering concrete must be secured and remain fixed horizontally while concrete is flowing, so as not to damage the concrete surface, and create additional laitance, and lead to loss of seal.

7. During the placement, sampling and testing of slump, air content, and temperature shall be taken every hour, or for every 200 cubic yards of concrete placed. Sounding in various location shall also be conducted at the same interval.

E. Post-Placement Evaluation

1. Concrete placed under water shall be evaluated after completion of placing with, but not limited to the methods below.

2. Coring in area of maximum concrete flow, or in area where "loss of seal" occurred during placement.

3. After dewatering, accurately surveying the entire concrete surface to evaluate the adequacy of the concrete placement, such as cracks, voids, and honeycomb. The defects shall be clearly marked for repair. The concrete shall be protected from dryness, or damages until repair is completed.

4. As determined by the ENGINEER, the area of questionable concrete quality shall be cored and tested for compressive strength in accordance with the requirements of Paragraph 1.4.A of this Section.

3.5 CURING

A. Concrete shall be cured for not less than 14 days after placing, by continuous submerging of the top surface with a minimum of 6 inches of water for the full duration of curing period. Curing compound shall not be used for curing. After the completion of the curing period, the concrete surface shall be kept damp by applying water using nozzles, or extending the submerging period until the placement of the reinforced concrete slab on top of the concrete placed under water as shown in the Contract Documents.

B. Wherever curing compound may have been applied by mistake to the concrete surfaces, curing compound shall be entirely removed by wet sandblasting just prior to the placing of new concrete.

3.6 PROTECTION

A. The CONTRACTOR shall protect all concrete against injury until the top slab has been placed. Fresh concrete shall be protected from damage due to rain, hail, sleet, or snow. The CONTRACTOR shall provide such protection while the concrete is still plastic and whenever such precipitation is imminent or occurring. Immediately following the first

frost in the fall, the CONTRACTOR shall be prepared to protect all concrete against freezing. After the first frost, and until the mean daily temperature in the vicinity of the site falls below 40 degrees F for more than one day, the concrete shall be maintained at a temperature not lower than 50 degrees F for at least 72 hours after it is placed.

3.7 CURING IN COLD WEATHER

A. Water curing of concrete may be reduced to 6 days during periods when the mean daily temperature in the vicinity of the site is less than 40 degrees F; provided that, during he prescribed period of water curing, when temperatures are such that concrete surfaces may freeze, water curing shall be temporarily discontinued.

B. Discontinuance of protection against freezing temperatures shall be such that the drop in temperature of any portion of the concrete will be gradual and will not exceed 40 degrees F in 24 hours. In the spring, when the mean daily temperature rises above 40 degrees F for more than 3 successive days, the 72-hour protection at a temperature not lower than 50 degrees F may be discontinued for as long as the mean daily temperature remains above 40 degrees F; provided, that the concrete shall be protected against freezing temperatures for not less than 48 hours after placement.

C. Where artificial heat is employed, special care shall be taken to prevent the concrete from drying.

3.8 TREATMENT OF SURFACE DEFECTS

A. After the post-placement evaluation, and with the defects clearly identified, and inspected by the ENGINEER, repair can proceed prior to or after the curing period. Concrete must be prevented from dryness before the starting of repair, and if repair is to be completed after curing, the repaired area, or the total surface area shall be cured in accordance with the procedure of this Section as directed by the ENGINEER. Plastering or coating of surfaces will not be permitted. Repairs and replacements shall be promptly executed at no increased cost to the CITY.

B. Defective surfaces to be repaired shall be cut back from true line a minimum depth of ½-inch over the entire area. Feathered edges will not be permitted.

C. Cracks 1/16-inch or wider shall be repaired by injection of epoxy grout, injection procedure shall be as recommended by the grout manufacturer.

D. Laitance, or soft materials shall be completely removed, and cut back to a minimum of Y2-inch below the sound concrete surface.

E. Voids and honeycombs shall be cut back to a minimum of Y2-inch below the sound concrete surface.

F. Depression greater than 3 inches, including those formed as a result of cut backs of laitance, voids, and honeycombs, shall be repaired with concrete. Depression less than 3 inches can be filled with concrete when the top slab is poured.

G. When the compressive strength of the cored concrete specimens failed to meet the acceptance criteria of this Section the ENGINEER may require the CONTRACTOR to take additional cores for further testing, repair, remove, or replace part or all of the concrete at no additional cost to the OWNER. All cored holes shall be filled with concrete.

3.9 CARE AND REPAIR OF CONCRETE

A. The CONTRACTOR shall protect all concrete against injury or damage from excessive heat, lack of moisture, overstress, or any other cause until final acceptance by the CITY. Particular care shall be taken to prevent the drying of concrete and to avoid roughening or otherwise damaging the surface. Any concrete found to be damaged, or which may have been originally defective, or which becomes defective at any time prior to the final acceptance of the completed work, or which departs from the established line or grade which for any other reason, does not conform to the requirement of the Contract Documents, shall be satisfactorily repaired or removed and replaced with acceptable concrete at no increased cost to the CITY.

- END OF SECTION -

SECTION 03360 - PNEUMATICALLY-PLACED CONCRETE

PART 1 – GENERAL

1.1 THE REQUIREMENT

A. The CONTRACTOR shall furnish, place, finish, cure, and protect all pneumatically-placed concrete and shall furnish and install all appurtenant work, in accordance with the requirements of the Contract Documents.

B. Pneumatically-placed concrete (shotcrete) as referred to herein shall mean any mixture of portland cement and sand which is dry mixed in a machine, conveyed by air through a hose, hydrated at the discharge nozzle, and deposited by air pressure to its final position in the construction.

1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. Commercial Standards:

ANSI/ACI 506	Practice for Shotcreting
ASTM C 40	Test Method for Organic Impurities in Fine Aggregates for Concrete
ASTM C 87	Test Method for Effect of Organic Impurities in Fine Aggregate on Strength of Mortar
ASTM C 136	Method for Sieve Analysis of Fine and Coarse Aggregates
ASTM C 150	Portland Cement

1.3 CONTRACTOR SUBMITTALS

A. **Shop Drawings:** The CONTRACTOR shall provide Shop Drawings of all steel reinforcing in accordance with the requirements in Section 01300 - Contractor Submittals.

B. **Certificates:** The CONTRACTOR shall provide certificates from manufacturers or suppliers certifying that the materials supplied conform to the requirements of the Contract Documents.

1.4 QUALITY ASSURANCE

A. The compressive strength of the concrete will be determined by the ENGINEER through the medium of 2-inch by 4-inch test cylinders or 4-inch cubes.

B. Cubes may be sawed, or cores may be drilled from slabs prepared especially for testing purposes. All cut surfaces shall be dense and free from sand pockets.

C. To establish a correlation between the cylinders or cubes and 6-inch by 12-inch cylinders, a series of four, 6-inch by 12-inch test cylinders shall be made by coring concrete cylinders from 12-inch by 30-inch by 14-inch concrete specimen blocks. The

specimen blocks shall be shot in one continuous operation to the required height of the block onto a back form of plywood laid on the ground.

D. One concrete test specimen shall be made during each day's operation. Three specimens shall be cut from each concrete block 7 days after its placing. One cylinder will be tested for the 7-day strength, the other 2 will be tested at 28 days. The remainder of the concrete blocks shall be cured and stored until after the 28-day test has been made and until the ENGINEER has informed the CONTRACTOR, in writing, that no additional specimens have to be cut and tested. All concrete specimens shall be properly numbered and dated and a record shall be made by the CONTRACTOR as to the relative location of the work for which these samples were prepared.

E. Special Inspection: It is required that all pneumatically-placed concrete work specified herein shall be subject to inspection by a special inspector [approved] [certified] by the local code enforcement agency having jurisdiction, and no such work shall be scheduled or performed without making prior arrangements to have said special inspector present during all such construction operations hereunder.

1.5 CLEANUP

A. Upon completion of the work specified in this Section, the CONTRACTOR shall remove all forming, shoring, rebound, excess material, and protective materials from the project site.

PART 2 – PRODUCTS

2.1 MATERIALS

A. **Cement:** Cement shall comply with the requirements of ASTM C 150 Type.

B. **Sand:** Sand shall consist of natural sand obtained from a source acceptable to the ENGINEER and shall in all cases be washed. The control of the washing of sand shall be such that the finer particles are retained or removed as required. Washed or saturated sand shall be allowed to drain at least 24 hours to a uniform moisture content before batching. Dry sand shall be moistened before handling when necessary to prevent segregation. The sand shall be screened through a horizontal vibrating screen having square openings, and the grading as determined in accordance with the methods prescribed by ASTM C 136 shall be within the following limits:

	Percent
Passing a 3/8-inch square sieve	100
Passing a No. 4 sieve	90 to 100
Passing a No. 8 sieve	65 to 90
Passing a No. 16 sieve	45 to 75
Passing a No. 30 sieve	30 to 50
Passing a No. 50 sieve	30 to 50

Passing a No. 100 sieve	2 to 8
Passing a No. 200 sieve	0 to 4

C. The difference between the percentages passing the No. 30 and the No. 50 sieves shall not exceed 32.

D. Sand shall be composed of clean, hard, strong, durable, uncoated grains, free from shale, lumps, and soft or flaky particles and from injurious amounts of dust, alkali, organic matter, loam, mica, or other deleterious substances. When tested in accordance with the methods prescribed by ASTM C 40, the color of the supernatant liquid shall not be darker than the standard specified therein and shall not contain more than a total of 3 percent by volume of clay, silt, mica, or other objectionable inorganic materials, as determined by settlement after thoroughly mixing and shaking the sample with 2-1/2 times its volume of a 3 percent (by weight) solution of sodium hydroxide in a graduated column.

E. Sand which in any respect varies from the foregoing requirements shall not be used in the work, and the CONTRACTOR shall do all sorting, crushing, screening, blending, washing, and other operations necessary to make the available material conform to said requirements, and shall receive no extra compensation therefor, nor for the necessity of separating and wasting any part of the natural materials. In case the finer particles from the crushed coarse aggregate are permitted or required to be mixed with the sand from natural deposits, the 2 products shall be uniformly blended before washing or screening to insure a combined product of constant composition.

F. Sand as prepared for use shall be of such quality that 2-inch by 4-inch test cylinders made with a mixture of cement and the sand under test shall develop compressive strengths at 7 and 28 days of not less than 90 percent of those developed by a concrete mix prepared in the same manner with the same cement and graded Ottawa testing sand, all in accordance with the method prescribed in ASTM C 87.

G. Water for pneumatically-applied concrete shall be furnished by the CONTRACTOR. All water shall be clean and free from objectionable quantities of organic matter, alkali, salts, and other impurities which might reduce the strength, durability, or other quality of the pneumatically-applied concrete.

H. **Reinforcement:** Steel reinforcement shall conform to the requirements of Section 03200 - Reinforcement Steel.

2.2 EQUIPMENT

A. **Mixers:** Mixers shall be of a type and size which is sufficient to supply all materials required by the nozzles used while providing a mixing time of not less than 1-1/2 minutes after all the cement and aggregate have been placed in the mixer.

B. **Placing Machines:** Pneumatically-applied concrete shall be placed by the dry-mix process using machines operated at an air pressure of not less than 50 pounds nor more than 75 pounds per square inch when no more than 200 feet of material hose is used. These pressures shall be increased 5 pounds for each additional 50 feet of hose, and not more than 400 feet of hose shall be attached to any machine. The water pressure at the nozzles shall be at least 15 pounds greater than the air pressure in the machine, and the discharge nozzle shall be equipped with a manually operated water-

injection system for directing an even distribution of water through the sand-cement mixture. The water valve shall be capable of ready adjustment to vary the quantity of water, and shall be convenient to the nozzleman. A properly operated air compressor of ample capacity to maintain a supply of clean, dry air adequate for maintaining sufficient nozzle velocity for the application to be performed and at the same time operate a blow pipe for clearing rebound shall be used.

2.3 PROPORTIONING

A. Pneumatically-placed concrete shall ordinarily be mixed in the proportions of one sack of cement (94 pounds) to 4-1/2 cubic feet of sand, but the relative proportions of sand and cement shall be subject to change acceptable to the ENGINEER as the materials used or results obtained indicated to be desirable at any time during the progress of the work.

PART 3 -- EXECUTION

3.1 GENERAL

A. Pneumatically-placed concrete shall be used on the work where shown; and, where not shown, may be used only with written approval of the ENGINEER. Pneumatically-placed concrete shall consist of dry-mixed fine aggregate and portland cement pneumatically-placed by a suitable mechanism, to which mixture the water is added immediately previous to its expulsion from the nozzle.

3.2 RESTRICTIONS ON PLACING PNEUMATICALLY-PLACED CONCRETE

A. **Wind:** Pneumatically-placed concrete shall not be applied under strong wind conditions, as evidenced by the removal of a considerable amount of cement and moisture from the concrete spray; provided, that in areas where strong winds prevail and work must proceed, a richer mix than specified which is acceptable to the ENGINEER, shall be used. The nozzleman shall work against the direction of the wind to avoid concrete being applied on rebound that has been carried with the wind. Shields shall be placed around the nozzleman to prevent the loss of cement carried away by the wind.

B. **Cold Weather:** Pneumatically-placed concrete may be applied in cold weather; provided, that the surfaces are not frozen, the temperature during the day is expected to rise at least to 40 degrees F, and the night temperature of the first night after application is not predicted to drop below 27 degrees F; and provided further, that the CONTRACTOR shall apply concrete under these conditions solely at its own risk. In order to gain quicker setting-up times, Type III high-early-strength portland cement may be used.

C. **Rain:** Whenever rain has damaged newly-placed concrete, the ENGINEER may order such concrete to be removed when it has been determined that a significant amount of cement has been washed out. The CONTRACTOR prior to placing any new layers shall consult with the ENGINEER as to whether or not the concrete damaged by rain is acceptable to the ENGINEER or must be replaced.

D. **Low Humidity:** Under low humidity conditions (below 50 percent) in conjunction with wind, the CONTRACTOR shall immediately cease placing operations until there has been an improvement in the wind and humidity conditions as determined by the ENGINEER. Continuous water-curing shall be started as soon as the concrete has hardened sufficiently to prevent a washout of cement.

3.3 PROTECTION OF ADJACENT WORK

A. The CONTRACTOR shall take every possible precaution to protect adjacent work, concrete surfaces, vehicles, equipment, etc., from being damaged by overshooting concrete and by materials carried by the wind. Overshot concrete and rebound concrete shall be removed before it adheres.

3.4 PROPORTIONING

A. Structural, pneumatically-placed concrete shall be proportioned by volume on the basis of one part of cement to various parts of sand, according to the following table for the stated compressive strengths at 28 days:

Presumptive Compressive Strength in psi at 28 Days	**Cement/Sand Ratio By Volume**
4000	1:4
3000	1:4-1/2
2500	1:5
2000	1:6

The relative proportions of sand and cement shall be subject to adjustment by the ENGINEER as the materials used or results obtained indicate the desirability at any time during the progress of the work.

B. All other pneumatically-placed concrete shall ordinarily be mixed in the proportions of one sack of cement (94 pounds) to 4-1/2 cubic feet of sand, but the relative proportions of sand and cement shall be subject to change acceptable to the ENGINEER as the materials used or results obtained indicate to be desirable at any time during the progress of the work.

C. **Compressive Strength:** Unless otherwise specified, the minimum 28-day compressive strength of the pneumatically-placed concrete shall be 4,000 psi.

3.5 MIXING

A. Mixing and placing of pneumatically-placed concrete shall conform to the requirements specified herein and to the applicable recommendations given in ANSI/ACI 506.

B. The sand and cement shall be thoroughly mixed in a dry state before being deposited in the placing machine or its hopper. Machine mixing will be required unless specific authority to use hand mixing is given by the ENGINEER. The machine and its operation shall be acceptable to the ENGINEER. The mixing operation shall continue for a period of not less than 1-1/2 minutes after all sand and cement has been placed in the mixer. The sand shall contain or be moistened with 6 to 10 percent of water by volume and shall not be mixed with the cement until just before placing in the hopper in order to insure against partial setting of the cement. Dry-mixed materials shall be used promptly after mixing. Any materials that remain in the hopper longer than 45 minutes after mixing shall be discarded. Rebound, recovered clean and free of foreign matter and

otherwise in acceptable condition for reuse, may be reused as sand in a quantity not to exceed 20 percent of the total sand requirements.

3.6 PREPARATION OF FOUNDATION

A. The foundation for areas to receive pneumatically-placed concrete shall be evenly graded before the concrete is applied, and no point on the graded slope shall be above the slope plane shown or as otherwise acceptable to the ENGINEER. The areas shall be thoroughly compacted, with sufficient moisture to provide a firm foundation and to prevent absorption of water from the concrete, but shall not contain free surface water. When indicated in the Contract Documents, joints, side forms, and shooting strips shall be provided for backing or paneling. Ground or gauging wires shall be used where necessary to establish thicknesses, surface planes, and finish lines.

3.7 JOINTS

A. Contraction (dummy) joints shall be provided in the locations shown; where not shown, such joints shall be provided at approximately 15-ft spacing each direction in the case of unreinforced pneumatically-placed concrete, and at approximately 30-ft spacing each direction in the case of reinforced pneumatically-placed concrete. Construction joints shall be provided as shown, or if not shown, as placing stops at locations selected by the CONTRACTOR and acceptable to the ENGINEER.

3.8 REBOUND

A. Rebound recovered which is clean and free of foreign material may be reused as fine aggregate in quantities not to exceed 20 percent of the total fine aggregate requirements.

3.9 PLACING WHERE NO FORMS ARE USED

A. **Preparation of Subgrade:** All cleaning, excavation, fill, backfill, grading of compacted fill, and disposal of excess earth shall be done prior to the application of pneumatically-placed concrete. The surfaces against which pneumatically-placed concrete are to be applied shall be left in a thoroughly compacted condition, and shall be neatly trimmed to line and grade. All surfaces shall be wetted before application, but pneumatically-placed concrete shall not be placed on any surface on which free water exists.

B. **Minimum Thickness:** Minimum thickness shall be 1-1/2 inches unless otherwise indicated in the Contract Documents.

C. **Reinforcement:** Reinforcement shall be as shown; provided, that where welded wire fabric is indicated it shall be spliced as follows: (1) side splices of sheets or roll shall be spliced a minimum of one mesh plus 2 inches; (2) longitudinal splices, or direction of principal stress, shall be spliced a minimum of 2 mesh plus 2 inches. Tie wires shall only be used on cross wires on side splices and on longitudinal wires on end splices.

D. **Ground Wires:** Ground wires shall be installed in channels or ditches in such a manner that they accurately outline the finished surface of the lining as shown. They shall be located at intervals sufficient to insure proper thickness throughout. Wires shall be stretched tight and shall not be removed prior to application of the finish coat.

E. **Headers:** Headers shall be installed along the channel where shown. Headers shall be securely fastened to line and grade.

F. **Placing:** Pneumatically-placed concrete shall be placed in the most expeditious manner as determined by the location of the work. There shall be a nozzleman's helper in attendance at the nozzle whose duty shall be to raise the reinforcement mat sufficiently to permit placing of concrete beneath the mat at frequent intervals to insure proper location of reinforcement. The reinforcing mat shall not be pulled through already placed concrete. Where sides of the channel do not terminate against headers, concrete shall be carried over the side in a berm of not less than the lining thickness, and/or a cut-off wall to prevent moisture seeping under the lining.

G. **Finishing:** After the concrete has been placed as nearly as practicable to the required depth, the surface shall be checked with a straight edge and any low spots or depressions shall be brought up to proper grade by placing additional pneumatically-placed concrete in such a manner that the finished surface is reasonably smooth. Following this, the surface shall receive a steel trowel finish.

H. **Weep Holes:** Where weep holes are shown, they shall be installed so that they are flush with the surface of the lining, and open.

3.10 PLACING AGAINST FORMS

A. **Forms:** Forms shall be of plywood or sheathing and shall be true to line and level. They shall be substantially braced to insure against excessive vibration. Forms shall be built so as to permit the escape of air and rebound and to facilitate the placing of pneumatically-placed concrete. Wall intersections shall be formed in such a manner as to afford a minimum loss of time in pneumatically placing the concrete at the intersection. This may be accomplished by the installation of short removable bulkheads at these points. Columns shall be formed on 2 adjacent sides only where practicable. Forms for beams shall be constructed of a soffit and one side. Where acceptable to the ENGINEER, such forms may be constructed of a soffit form only and a vertical backing of fine wire mesh near the center. Wood beams and shores shall be provided below the soffit in such a manner that no deflection will occur under the load to be superimposed.

B. Sufficient time shall be allowed for installing such of the work which must be attached to forms. Forms shall be thoroughly wetted with water prior to application of the concrete.

C. **Reinforcement:** Reinforcement shall be of the sizes and configuration specified or shown in the Contract Documents. Adequate chairs, ties, or other supports shall be used to maintain the reinforcing in the position required.

D. **Ground Wires:** Adequate ground wires to be used as screeds shall be installed to establish the thickness and surface planes of the work. Both horizontal and vertical ground wires shall be installed at corners and offsets not clearly established by the form work. In general these will occur at exterior corners, one column or beam corner, water tables, sills, belt courses, etc. Ground wires shall be placed so that they are tight and true to line and in such a manner that they may be easily tightened up. Ground wires shall not be removed until application of the finish coat.

E. **Placing:** Whenever possible, except when enclosing reinforcing steel, the nozzle shall be held at right angles to the surface and at a distance of 2-1/2 to 3-1/2 feet. When enclosing steel, the nozzle shall be held so as to direct the material behind the bars. Each side of individual bars shall be shot separately. When enclosing reinforcing steel, a nozzleman's helper equipped with an air blow-out jet shall precede the nozzleman and blow out all rebound, sand, etc., which may have lodged behind the bars. Pneumatically-placed concrete shall emerge from the nozzle in a steady, uninterrupted

flow. When flow becomes intermittent for any cause, the nozzle shall be diverted from the work until the stream again becomes constant. Hydration shall be thorough and uniform without the use of excessive water.

F. In shooting walls or columns, application shall begin at the bottom and the first coat shall completely embed the reinforcement adjacent to the form. The limit of thickness and height shall be determined when the materials begin to sag.

G. In shooting beams, a surface at right angles to the nozzle shall be maintained. Beams, in general, shall not be shot from the top. Where beams are formed of a soffit and a mesh backing at the centerline, they shall be shot from both sides in such a manner that no sags occur.

H. In shooting slabs, the nozzle shall be held at a slight angle to the work so that rebound is blown on to the finished portion where it shall be removed. The air blow-out jet shall be constantly employed to keep the work free of rebound. The limit of material to be placed in one layer shall be reached when it begins to show evidence of too much moisture. All loose material or rebound shall be removed from the surface being concreted before placing succeeding layers. Reinforcement shall be cleaned of any previously deposited concrete which might prevent proper bond to reinforcement. Sufficient time shall be allowed between layers for the material to set. Before set has taken place and before placing any succeeding layer, laitance shall be removed by wire brushing. Any laitance which has set shall be removed by sandblasting. Surfaces shall be damp at all times. Rebound pockets, sags, or other defects shall be carefully cut out and replaced with new pneumatically-placed concrete.

I. **Finishing:** Upon reaching the thickness and planes outlined by forms and ground wires, the surface shall be rodded off to true lines. Low spots shall be built out to proper thickness. Upon completion of rodding, ground wires shall be removed. The finish coat shall be applied starting from the top of walls and working down so that pneumatically-placed concrete is not shot over the finished work. All exposed surfaces shall be finished to straight and true lines, as shown.

J. Finish shall be a steel trowel finish.

3.11 JOINTS

A. **Construction Joints:** Particular care shall be given to formation of construction joints. They shall be sloped to a thin edge and the edge shall be thoroughly wetted before adjacent section of pneumatically-placed concrete is placed. No square joints will be allowed. The location of all construction joints in structural members shall be acceptable to the ENGINEER.

B. **Formed Joints:** All formed joints shall be constructed as detailed, at the locations shown.

3.12 CURING

A. Pneumatically-placed concrete shall be damp cured for at least 5 days after placing or by proper application of an approved sealing compound. Curing shall conform to the applicable requirements of Section 03300 - Cast-in-Place Concrete, except as otherwise specified herein. No concrete shall be placed during freezing weather except when proper protective measures are taken as with ordinary concrete work. Concrete shall not be placed against frosted surfaces.

B. When required by the ENGINEER the CONTRACTOR shall provide longer curing times or supplemental methods for curing concrete in structural members, and no additional payment will be allowed therefor.

- END OF SECTION -

SECTION 03410 - PRECAST CONCRETE

PART 1 -- GENERAL

1.1 THE REQUIREMENT

A. This section covers the design, fabrication, delivery and installation of all precast concrete units, including connections.

B. The CONTRACTOR shall construct all precast items as required in the Contract Documents, including all appurtenances necessary to make a complete installation.

1.2 RELATED WORK SPECIFIED ELSEWHERE

A. Section 03210, Concrete Reinforcement

B. Section 03300, Cast-in-Place Concrete

1.3 REFERENCE SPECIFICATIONS,CODES, AND STANDARDS

A.**Commercial Standards**:

1. AC1 318 – Building Code Requirements for Reinforced Concrete.
2. ASTM A 497 – Welded Deformed Steel Wire Fabric for Concrete Reinforcement.
3. ATSTM A 615 – Plain Billet-Steel Bars for Concrete Reinforcement.
4. ASTM C 108 – Compressive Strength of Hydraulic Cement Mortars.
5. ASTM C 150 – Portland Cement
6. ASTM C 857 – Practice for Minimum Structural Design Loading for Underground Precast Concrete Utility Structures.
7. ASTM C 858 – Specification for Underground Precast Concrete Utility Structures.
8. UBC – Uniform Building Code
9. U.C.B.R – Concrete Manual, 8th Edition.

1.4SUBMITTALS

A. The CONTRACTOR shall submit shop drawings for all precast concrete items. Submitted drawings shall show all dimensions, location and type of lifting inserts, and details of reinforcement and joints in accordance with Section 01300 - Contractor Submittals.

B. For all precast items which are manufactured, the CONTRACTOR shall also submit a list of the design criteria used by the manufacturer.

C. For vaults larger than 2'-00" in any dimension, drawings, and calculations shall be signed by a civil engineer registered in California.

D. The CONTRACTOR shall submit approved ICBO reports for all lifting inserts, showing allowable design loads on the inserts.

E. Verification of compressive strength shall be submitted in accordance with Section 01300 - Contractor Submittals. Such verification may be laboratory trial batch test results with a minimum of three test cylinders or a series of production compression tests with a minimum of 20 sets of test data which fall within the evaluation and acceptance criteria specified herein. Such test must have been made within the previous two years on the identical concrete mix submitted.

1.4 WARRANTY

A. Tests on component materials and for compressive strength of concrete will be performed as specified herein. The cost of all laboratory tests on cement, aggregates, and concrete will be borne by the OWNER. However, the CONTRACTOR shall assist in the preparation of all test samples and shall be charged for the cost of any additional tests and investigation on work performed which does not meet the specifications.

B. Test methods and criteria for evaluation and acceptance of concrete shall be as specified in Section 03300 - Cast-in-Place Concrete.

PART 2 -- PRODUCTS

2.1 MANUFACTURED ITEMS

A. **Miscellaneous Precast Vaults:** (including, but not limited to, Pull Boxes, and Meter Boxes).

1. Size - Vault dimensions shall be as required by drawings.

2. Material - Concrete used for manufactured vaults shall have a minimum 4000 psi compressive strength.

3. Covers - Unless noted otherwise on the Contract Documents, vaults shall have concrete covers with minimum 30-inch diameter galvanized steel lids, which are bolted to galvanized steel frames with stainless steel bolts. The frames and lids shall be provided by the vault manufacturer. Covers shall have lifting handles. When leveling bolts are used to set the vault top sections, the CONTRACTOR shall ensure that the load on the vault will be transferred through the mortar to the vaults, and will not be carried by the leveling bolts.

4. Loading - Where vaults are in areas which may be subjected to vehicular traffic, they shall be designed for H-20 traffic loading. In other areas, they shall be designed for a vertical live load of 300 psf. Lateral loads on all vault walls shall be as follows:

Static: Refer Geotechnical Report By Fugro West Jan28,200..

Wall Loading Condition	Lateral Earth Pr Condition	Equivalent Fluid Wt. (pcf)
Free Standing	Active-Drained	38
Free Standing	Active-Submerged	19+ water pr
Braced	At-Rest-Drained	60

Braced	At-Rest-Submerged	30+ water pr

Surcharge — The lateral earth pressure from uniform surcharge loads shall be estimated as 0.3 times the stress being applied at the ground surface. For traffic surcharges it shall be estimated as an additional 2 feet soil cover, equal to 72 PSF

Seismic: — The estimated resulting force corresponding to the dynamic earth pressure resulting from seismic loads shall be 1/2xEquivalent Weight xH^2, in pounds force per lineal foot of wall (where H is the Height of the wall). The dynamic pressure on the wall shall be estimated as an inverted triangular pressure distribution with resultant force acting 2/3H above the base of the wall

Groundwater: — All vaults shall be designed to resist uplift, with a factor of safety of 1.5, from groundwater at finished grade. Bouyant weight of soil shall be assumed to be 48 pcf.

Seismic acceleration: — UBC Zone 4 requirements with I =1.5, **with a Seismic Zone Factor of 0.4, and Near-Source Factors for the site of Na= 1.3 and Nv=1.6. For additional information see geotechnical report.**

Mechanical Details: — Piping, electrical, and other details shall be as required by the Contract Documents.

2.2 SITE-CAST ITEMS

A. The CONTRACTOR shall design the method of placement for site-cast items and shall add all reinforcing steel, embeds, and other items necessary for such placement. Site-cast items may be cast off-site at the CONTRACTOR's option. All portions of embeds which remain embedded in the concrete shall be made of stainless steel.

2.3 PREFORMED JOINT SEALANT

A. The joint sealing compound shall be **Quik-Seal**, a preformed, cold-applied, ready to use plastic joint sealing compound as supplied by **Quikset Utility Vaults**, Santa Ana, California; **Ram-Neck by K.T. Snyder Company**; or approved equal.

2.4 MORTAR

A. Mortar used between the sections of precast concrete vaults shall be as recommended by the precast manufacturer.

2.5 NON-SHRINK GROUT

A. Non-shrink grout shall be as specified in Section 03315 - Grout.

PART 3 -- EXECUTION

3.1 MANUFACTURED ITEMS

A. **Precast Concrete Manhole Sections:** Precast concrete manhole sections shall be set so as to be vertical, with sections in true alignment. The joint of the previously set section shall be covered with mortar and joint sealant before the next section is placed. Before the mortar is set, joints shall be pointed, and exterior joints shall be thoroughly tooled so as to be slightly concave with a hard polished surface, free of cracks. Interior joints shall be tooled flush in a similar manner.

B. **Pull Boxes, Electrical Manholes, Vaults, and Meter Boxes:** The above mentioned precast items shall be installed in accordance with the manufacturer's recommendations, unless otherwise required by the drawings. All joints shall be sealed by the use of preformed sealant and mortar or non-shrink grout so as to be water tight.

C. **Connections:** Connections to manufactured, precast items shall be made by casting sections of pipe into the items, using non-shrink grout as shown on the drawings, and/or using an approved resilient connector. All such connections shall be water tight.

3.2 SITE-CAST ITEMS

A. All site cast items shall be fabricated in accordance with the Sections 03100 - Concrete Formwork, Section 03200 - Reinforcement Steel, and Section 03300 - Cast-in-Place Concrete. They shall be cast to the dimensions and with the embeds and finishes required on the Contract Drawings.

B. At the CONTRACTOR'S option, site-cast items may be cast off site at a precasting plant and delivered to the site.

- END OF SECTION -

SECTION 04232 - REINFORCED CONCRETE BLOCK MASONRY

PART 1 -- GENERAL

1.1 THE REQUIREMENT

A. The CONTRACTOR shall provide concrete masonry and other appurtenant WORK, complete and in place, in accordance with the Contract Documents.

1.2 CONTRACTOR SUBMITTALS

A. Furnish submittals in accordance with Section 01300 - Contractor Submittals.

B. Samples

1. Samples of concrete masonry unit colors with texture ranges indicated for selection of color. Full size samples of the blocks selected shall be submitted for final approval by the ENGINEER after color selection, if requested. If the required product is a colored and textured unit, the samples shall be colored and textured units.

2. Samples of mortar colors for color selection.

3. A 4-ft minimum square free-standing sample panel shall be prepared for approval before starting masonry work. The panel shall remain at the Site for reference until masonry work is completed.

C. Documentation

1. Reports from testing masonry units.

2. Reports from mortar and grout testing.

3. Reports from prism testing.

D. Grout and mortar mix design

1. Proportions for all components.

2. Mill tests for cement.

3. Admixture certification. Include chloride ion content.

4. Aggregate graduation and certification.

5. Lime certification.

1.3 QUALITY ASSURANCE

A. **Applicable Standards:** Concrete masonry shall conform to the Uniform Building Code (UBC), American Concrete Institute ACI 530 - Building Code Requirements for Masonry Structures and ACI 530.1 - Specification for Masonry Structures, and other applicable codes and standards of the governing authorities.

B. WORK shall conform to the standard of quality established by the approved free-standing sample panel.

C. Concrete block masonry units shall be sampled and tested in accordance with ASTM C 140 - Test Methods of Sampling and Testing Concrete Masonry and Related Units.

D. **Testing of Mortar and Grout:** The CONTRACTOR shall have the mortar and grout tested to assure compliance with the Specifications and the governing codes by a recognized testing laboratory approved by the ENGINEER. Test reports shall be submitted to the ENGINEER.

1. Tests shall be taken at the following times:

   a. At commencement of masonry WORK, at least 2 test samples each of mortar and grout shall be taken on 3 successive Days.

   b. At any change in materials or job conditions, at least 2 samples of each modified material, grout, and mortar shall be tested.

   c. Four random tests each of mortar and grout shall be made. The random test samples shall be taken when requested by the ENGINEER.

   d. Additional samples and tests may be required whenever, in the judgment of the ENGINEER, additional tests beyond the random tests are necessary to determine the quality of the materials.

   e. The costs of tests and test reports, except for any additional tests requested by the ENGINEER, shall be paid by the CONTRACTOR as part of the WORK. The costs of the additional tests and reports, when reports verify compliance with the Contract Documents, will be paid by the OWNER. When tests or reports do not verify compliance, the cost of all additional tests and reports shall be paid by the CONTRACTOR.

2. Samples shall be stored in a moist environment until tested, unless directed otherwise by the ENGINEER or the testing laboratory. Testing for mortar shall be in accordance with ASTM C 270 - Mortar for Unit Masonry. Grout shall be tested per ASTM C 1019 - Standard Test Method for Sampling and Testing Grout.

E. **Test of Masonry Prisms**: The OWNER will test masonry prisms to assure compliance with the Specifications and the governing codes. Testing will be by a recognized testing laboratory.

1. Tests will be made of the following items:

   a. At the time of the construction of the sample panel above, at least 5 masonry prisms shall be made for each type of block herein, except separate prisms are not required for block which only varies by texture.

   b. At any change in materials during construction, at least 5 masonry prisms will be made for each type of block affected.

   c. One set of at least 5 masonry prisms will be made for each masonry structure, besides the structure that the sample is part of, or for each week in which block is laid, for each type of block involved; whichever occurs first.

d. Additional sets of at least 5 masonry prisms may be required whenever, in the judgement of the ENGINEER, additional tests are necessary to determine the quality of the materials.

2. The prisms shall be constructed by the CONTRACTOR in the presence of the ENGINEER. The same personnel who are laying the block in the structure shall construct the masonry prism.

3. The masonry prism shall be constructed and will be tested in accordance with ASTM C 1314 - Test Methods for Compressive Strength of Masonry Prisms, except as modified herein. The prisms shall be composed of one complete cell using full-size blocks that are saw-cut. The minimum ratio of height to smaller width dimension shall be 1.5. The prism shall be at least 15 inches high. A minimum of 2 horizontal bed joints shall be used to form the prism. The prism shall be grouted, after the required 24 hour minimum cure period, using the same grout used in the walls.

4. Compression tests made on sets of specimens made during construction shall include 2 prisms tested at 7 Days after grouting and 3 prisms tested at 28 Days after grouting.

5. The average compressive strength of prisms tested at 28 Days after grouting, multiplied by the appropriate correction factor as given in ASTM C 1314, shall not be less than the indicated masonry compressive strength.

6. If the compressive strength of the prisms fails to meet or exceed that required, adjustments shall be made to the mix designs for the mortar, or grout, or both, as needed to produce the required strength. The masonry units shall also be retested to verify compliance to the requirements of ASTM C 90.

7. If the compressive strength of the prism fails to meet or exceed that required, prisms or cores shall be cut from the walls in sufficient numbers and in sufficient locations to adequately determine the strength of the walls. Those portions of the walls represented by specimens failing to meet the required compressive strength are subject to being removed and replaced.

F. **Inspection:** Whenever required under the provisions of the Building Code, WORK hereunder will be subject to inspection by a special inspector selected by the ENGINEER and approved by the local Building Code representative having jurisdiction. Costs of such inspection will be paid by the OWNER. The Special Inspector will work under the supervision of the ENGINEER. Special inspection will be per specification Section 01540 - Special Inspections.

G. **Extreme Weather Construction:** Cold weather construction shall be per the more stringent of ACI 530.1, UBC Section 2104.3, and local Code requirements. Hot weather construction shall be per the more stringent of ACI 530.1, and local Code requirements.

H. **Product Storage:** Cement, lime, and other cementitious materials shall be delivered and stored in dry, weather-tight sheds or enclosures, in unbroken bags, barrels, or other approved containers, plainly marked and labeled with the manufacturers' names and brands. Mortar and grout shall be stored and handled in a manner that prevents the inclusion of foreign materials and damage by water or dampness. Masonry units shall be handled with care to avoid chipping and breakage, and shall be stored as directed in ACI 530.1. Materials stored on newly constructed floors shall be stacked in such manner that the uniformly-distributed loading does not exceed 30 psf. Masonry

materials shall be protected from contact with the earth and exposure to the weather and shall be kept dry and clean until used.

PART 2 -- PRODUCTS

2.1 CONCRETE MASONRY UNITS

A. Concrete masonry units shall conform to ASTM C 90 - Load-Bearing Concrete Masonry Units. Units shall be medium weight units unless indicated otherwise.

B. Concrete masonry units shall be the size and shape indicated on the Contract Drawings. The Specification is based on the products of **AirVol Block**, 1 Suburban Road, San Luis Obispo, (805) 543-1314 as a standard of quality. Substitutions shall be considered under the provisions of Section 01630.

1. Exposed Faces: Manufacturer's standard color and texture, unless otherwise indicated. All units must be approved by ARCHITECT in writing prior to delivery to job site.

   a. Split Face Wainscot: Color, 403-B, standard split-face texture and finish.

   b. Wainscot Cap: Color 403-C, precision block, shape as indicated on construction drawings.

   c. Honed or Burnished: Color 402-A, with honed face as approved by ARCHITECT.

C. Bond beam, corner, lintel, sill, and other specially shaped blocks shall be provided where required or necessary. Specially shaped non-structural blocks may be constructed by saw cutting. Color and texture shall match that of adjacent units.

D. Concrete masonry units hidden from view entirely may be natural color units the same size as other adjacent masonry units.

E. Concrete masonry units at interior walls shall be medium weight block 8 inch by 8-inch by 16-inch modular size of color matching the integrally colored block.

2.2 MATERIALS

A. Portland cement shall be Type I or II, low alkali, conforming to ASTM C 150 - Portland Cement.

B. Hydrated lime shall be Type S, conforming to ASTM C 207 - Hydrated Lime for Masonry Purposes.

C. Aggregate for mortar shall conform to ASTM C 144 - Aggregate for Masonry Mortar. Aggregate for grout shall conform to ASTM C 404 - Aggregates for Masonry Grout.

D. Water for mixing shall be clear potable water.

E. Reinforcing steel shall be deformed bars conforming to ASTM A 615 - Deformed and Plain Billet-Steel Bars for Concrete Reinforcement, Grade 60.

F. Joint reinforcing shall conform ASTM A 951 - Masonry Joint Reinforcement.

G. Admixture for mortar shall be **Master Builders PS-235** or **Rheomix-235, Sika Co., Sika Red Label,** or equal. The admixture shall not be detrimental to the bonding or help the process of efflorescence.

H. Admixture for grout shall be **Sika Co., Sika Grout Aid,** Type II, **Master Builders Pozzolith,** normal, or equal.

I. Veneer ties shall be per local governing code.

2.3 MORTAR

A. Mortar for concrete block masonry shall conform to ASTM C 270 for Cement-Lime, Type S, with a minimum 28 Day compressive strength of 1800 psi.

2.4 GROUT

A. Grout shall conform to ASTM C 476 - Grout for Masonry, and have a minimum 28-Day compressive strength of 2000 psi. Where the grout space is less than 4 inches, coarse aggregate shall be omitted.

B. Admixtures may only be used when approved by the ENGINEER. When approved for use, admixtures shall be used in accordance with the manufacturer's published recommendations for the grout.

PART 3 – EXECUTION

3.1 GENERAL

A. Measurements for mortar and grout shall be accurately made. Shovel measurements are not acceptable. Mortar proportions shall be accurately controlled and maintained.

B. WORK shall be performed in accordance with the provisions of ACI 530 and 530.1, the UBC, and the local codes for reinforced concrete hollow-unit masonry.

C. The CONTRACTOR shall set or embed anchors, bolts, reglets, sleeves, conduits, and other items as required.

D. Block cutting shall be by machine.

E. Masonry units shall be supported off the ground and shall be covered to protect them from rain. Only clean, dry, uncracked units shall be incorporated.

F. Reinforcing steel shall be cleaned of loose rust and scale, and oil, dirt, paint, laitance, or other substances which may be detrimental to or reduce bonding of the steel and concrete.

G. Immediately before starting WORK, the concrete upon which the masonry will be laid shall be cleaned with water under pressure.

H. Full mortar joint for first course shall be provided.

I. Units shall be shoved tightly against adjacent units to assure good mortar bond.

J. Equipment for mixing and transporting the mortar and grout shall be clean and free from set mortar, dirt, or other foreign matter.

3.2 MIXING

A. Mortar shall be mixed by placing 1/2 of the water and sand in the operating mixer, after which the cement, lime, and remainder of the sand and water shall be added. After ingredients are in the mixer, they shall be mechanically mixed for not less than 5 minutes. Retempering shall be done on the mortar board by adding water within a basin formed within the mortar, and the mortar reworked into the water. Mortar that is not used within one hour shall be discarded.

3.3 ERECTION OF CONCRETE BLOCK MASONRY

A. Masonry WORK shall be erected in-plane, plumb, level, straight, and true to dimensions and executed in accordance with acceptable practices of the trade and the tolerances of ACI 530.1.

B. Unless indicated otherwise, masonry shall be laid up in straight uniform courses with running bond.

C. Masonry shall be erected to preserve the unobstructed vertical continuity of the cells measuring not less than 3 inches by 3 inches in cross-section. Walls and cross webs shall be full bedded in mortar. Head (or end) joints shall be solidly filled with mortar for a distance in from the face of the wall or unit not less than the thickness of the longitudinal face shells.

3.4 JOINTS

A. Vertical and horizontal joints shall be uniform and approximately 3/8-inch wide. Exterior joints and interior exposed block joints shall be concave-tooled to a dense surface. Special care shall be used in tooling joints so as to match existing construction. Interior or exterior non-exposed masonry and masonry behind plaster shall have flush joints.

3.5 CLEANOUTS

A. Cleanout openings shall be provided at the bottoms of cells to be filled at each lift or pour of grout, where such lift or pour is over 4-ft in height. Any overhanging mortar or other obstructions or debris shall be removed from the insides of such cell walls. The cleanouts shall be sealed before grouting and after inspection. Cleanout openings shall match the finished wall in exposed masonry.

3.6 REINFORCEMENT

A. Deep cut bond beam blocks shall be used where horizontal reinforcing steel is embedded. H-block bond beams may be used at locations other than openings.

B. Knock-out openings shall have no steel or joint reinforcing running through the opening. Head, jambs, and sill blocks shall be used to provide an even finish surface to install window when blocks are removed. Joints at head, jambs, and sills shall be stacked and continuous.

C. Vertical reinforcement shall be held in position at top and bottom and at intervals not exceeding 112 diameters of the reinforcement.

3.7 GROUTING

A. All cells and bond beam spaces shall be filled solidly with grout unless indicated otherwise. Grouting shall not be started until the wall has cured for 24 hours. Grout shall not be poured in more than 5-ft lifts.

B. Grout shall be consolidated at time of pouring by puddling or vibrating. Where the grouting operation has been stopped for one hour or longer, horizontal construction joints shall be formed by stopping the grout pour 1-1/2 inches below the top of the uppermost unit.

3.8 PROTECTION

A. Wall surfaces shall be protected from droppings of mortar or grout during construction.

B. FINISHING AND CLEANING

C. Masonry shall not be wet-finished unless exposed to extreme hot weather or hot wind and then only by using a nozzle-regulated fog spray sufficient only to dampen the face but not of such quantity to cause water to flow down over the masonry.

D. Finish masonry shall be cleaned and pointed in a manner satisfactory to the ENGINEER, based upon the standards established by the approved sample panel.

E. Interior and exterior colored masonry work exposed to view shall be cleaned by whip light sandblasting to remove stains and other imperfections.

F. Exposed masonry surfaces of openings and window and door openings such as sills, heads, and jambs shall be finish block surfaces, not formed surfaces, unless indicated otherwise. Closed bottom bond beam blocks shall be used at heads and sills. Pour holes may be used at the sill under window frame and where approved by the ENGINEER.

3.9 VENEER TIES

A. Veneer ties shall be provided per Building Code and trade standards where veneered surfaces are indicated.

- END OF SECTION -

SECTION 05100 - STRUCTURAL STEEL FRAMING

PART 1 -- GENERAL

1.1 THE REQUIREMENT

A. The CONTRACTOR shall provide structural steel framing and appurtenant metal parts required for permanent connection of the structural steel system, complete and in place, in accordance with the Contract Documents.

1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. References herein to "Building Code" or UBC shall mean the Uniform Building Code of the International Conference of Building Officials (ICBO). The edition of the codes adopted as of the date of award of this contract shall apply to the WORK herein.

B. Federal Specifications and Commercial Standards

AISC	Code of Standard Practice for Steel Buildings and Bridges
AISC	Structural Steel Buildings-Allowable Stress Design and Plastic Design
AISC	Allowable Stress Design Specifications for Structural Joints Using ASTM A325 and A490 Bolts approved by the Research Council on Structural Connections of the Engineering Foundation
ASTM A 36	Structural Steel
ASTM A 53	Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded and Seamless
ASTM A 307	Carbon Steel Bolts and Studs
ASTM A 325	Structural Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength
ASTM A 500	Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes
ASTM A 501	Hot-Formed Welded and Seamless Carbon Steel Structural Tubing
ASTM A 992	Steel for Structural Shapes for Use in Building Framing
AWS D1.1	Structural Welding Code – Steel

1.3 CONTRACTOR SUBMITTALS

A. Submit in accordance with Section 01300 - Contractor Submittals.

B. Shop Drawings shall conform to AISC recommendations and specifications and shall show all holes, etc. required for other work. Drawings shall include complete details showing all members and their connections, anchor bolt layouts, schedules for fabrication procedures, and diagrams showing the sequence of erection.

C. Testing laboratory certifications for shop and field welders shall be submitted in triplicate directly to the ENGINEER with copies to the CONTRACTOR and others as required.

PART 2 -- PRODUCTS

2.1 MATERIALS

A. Structural steel

Wide Flange Shapes	ASTM A 992
Other Shapes, Plates, Bars	ASTM A 36
Pipe, Pipe Columns, Bollards	ASTM A 53, Type E or S, Grade B standard weight unless noted otherwise
HSS	ASTM A 500 Grade B

B. Bolts for connections shall be ASTM A 325, unless indicated otherwise. Bolts used to connect dissimilar metals shall be ASTM A 193 and A 194, Type 316 stainless steel.

C. Welded anchor studs shall be headed concrete anchor studs (HAS), or deformed bar anchors (DBA), or threaded studs (TAS), as indicated on the Drawings and as supplied by **Nelson Stud Welding Company**, Lorain, OH; **Omark Industries, KSM Fastening Systems Division**, Seattle, WA, or Portland, OR; or equal.

D. Structural steel shall be cleaned and coated in accordance with Section 09800 - Protective Coating.

E. Steel members in contact with aluminum shall be galvanized per Section 05500 - Miscellaneous Metalwork, unless indicated otherwise.

F. Structural members shall be furnished full length without splices unless otherwise indicated or approved by the ENGINEER.

2.2 INSPECTION AND TESTING

A. Shop inspection may be required by the OWNER at its own expense. The CONTRACTOR shall give ample notice to the ENGINEER prior to the beginning of any fabrication work so that inspection may be provided. The CONTRACTOR shall furnish all facilities for the inspection of materials and workmanship in the shop, and inspectors shall be allowed free access to the necessary parts of the WORK. Inspectors shall have the authority to reject any materials or WORK which does not meet the requirements of these Specifications. Inspection at the shop is intended as a means of facilitating the work and avoiding errors, but it is expressly understood that it will in no way relieve the CONTRACTOR from responsibility for proper materials or workmanship under this Specification.

B. The OWNER may engage inspectors to inspect welded connections and high-strength bolted connections, and to perform tests and prepare test reports.

1. Ten percent of all butt and bevel welds which extend continuously for 24 inches or less shall be completely tested in accordance with AWS D1.1, Part B, Radiographic Testing of Welds, Chapter 6. All butt and bevel welds which extend continuously for more than 24 inches shall be spot tested at intervals not exceeding 36 inches.

2. Welds that are required by the ENGINEER to be corrected shall be corrected or redone and retested as directed, at the CONTRACTOR'S expense and to the satisfaction of the ENGINEER and/or approved independent testing lab.

3. The CONTRACTOR shall test to failure three bolts from each heat lot of bolts furnished to the job to verify compliance with this Specification. The testing laboratory shall be approved by the ENGINEER and all test reports shall be supplied to the ENGINEER in accordance with Section 01300. In addition, high-strength bolts shall be inspected using one of the methods set forth in the AISC Specification "Structural Joints Using ASTM A 325 or A 490 Bolts."

C. The costs for all initial testing will be paid by the OWNER. However, the CONTRACTOR shall pay for all costs for any additional testing and investigation on WORK which does not meet Specifications. The CONTRACTOR shall supply material for testing at no cost to the OWNER and shall assist the ENGINEER in obtaining material for test samples.

PART 3 -- EXECUTION

3.1 MEASUREMENT

A. The CONTRACTOR shall verify all dimensions and shall make any field measurements necessary and shall be fully responsible for accuracy and layout of work. The CONTRACTOR shall review the Drawings, and any discrepancies shall be reported to the ENGINEER for clarification prior to starting fabrication.

3.2 FABRICATION

A. Structural steel shall be fabricated in accordance with the Drawings, AISC Specifications, and as shown on the Shop Drawings.

B. Materials shall be properly marked and match-marked for field assembly.

C. Where finishing is required, assembly shall be completed including bolting and welding of units, before start of finishing operations.

3.3 CONNECTIONS

A. Shop and field connections shall be bolted or welded as indicated. All connections shall develop full strength of members joined and shall conform to AISC standard connections.

B. Unless otherwise indicated, welds shall conform to AISC LRFD Specification for Structural Steel Buildings.

3.4 WELDED CONSTRUCTION

A. The CONTRACTOR shall comply with the current AWS D1.1 Code for procedures, appearance, and quality of welds and welders, and methods used in correcting welding work. All welded architectural metal work where exposed to view shall have welds

ground smooth. Shielded metal arc welding method or gas metal arc welding methods shall be used for welding structural steel.

B. Unless otherwise indicated, all butt and bevel welds shall be complete penetration.

3.5 HOLES FOR OTHER WORK

A. Holes shall be provided as necessary or as indicated for securing other work to structural steel framing, and for the passage of other work through steel framing members. No torch cut holes will be permitted.

3.6 SHOP PAINT PRIMER

A. Shop paint primer shall be applied in accordance with Section 09800. Omit shop applied primer at field weld locations, for the portion of a member to be embedded in concrete, and where galvanizing with no further coating is required.

3.7 PRODUCT DELIVERY, STORAGE, AND HANDLING

A. Structural members shall be loaded in such a manner that they may be transported and unloaded without being excessively stressed, deformed, or otherwise damaged.

B. Structural steel members and packaged materials shall be protected from corrosion and deterioration. Material shall be stored in a dry area and shall not be placed in direct contact with the ground. Materials shall not be placed on the structure in a manner that might cause distortion or damage to the members or the supporting structures. Repair or replace damaged materials or structures as directed.

3.8 ERECTION

A. The CONTRACTOR shall comply with the AISC Specifications and Code of Standard Practice, and with indicated requirements.

B. High-strength bolts shall be installed in accordance with the AISC Specification for Structural Joints using ASTM A 325 Bolts. The connections shall be the friction type, unless indicated otherwise.

C. Anchor bolts and other connectors required for securing structural steel to in-place WORK and templates and other devices for presetting bolts and other anchors to accurate locations shall be furnished by the CONTRACTOR.

D. The CONTRACTOR shall be responsible for designing and installing any temporary bracing required for the safe erection of all structural steel members.

3.9 SETTING BASES AND BEARING PLATES

A. Prior to the placement of non-shrink grout beneath base and bearing plates, the bottom surface of the plates shall be cleaned of all bond-reducing materials, and concrete and masonry bearing surface shall also be cleaned of all bond-reducing materials and roughened to improve bonding.

B. Loose and attached baseplates and bearing plates for structural members shall be set on wedges, leveling nuts, or other adjustable devices.

C. Anchor bolts shall be tightened after the supported members have been positioned and plumbed and the non-shrink grout has attained its indicated strength.

D. Baseplates shall be grouted with non-shrink grout to assure full uniform bearing. Grouting shall be done prior to placing loads on the structure.

3.10 FIELD ASSEMBLY

A. Structural frames shall be set accurately to the lines and elevations indicated. The various members shall be aligned and adjusted to form a part of a complete frame or structure before permanently fastening. Bearing surfaces and other surfaces which will be in permanent contact shall be cleaned before assembly. Necessary adjustments to compensate for discrepancies in elevations and alignments shall be performed.

B. Individual members of the structure shall be leveled and plumbed within AISC tolerances.

C. Required leveling and plumbing measurements shall be established on the mean operating temperature of the structure.

3.11 MISFITS AT BOLTED CONNECTIONS

A. Where misfits in erection bolting are encountered, the ENGINEER shall be immediately notified. The CONTRACTOR shall submit a method to remedy the misfit for review by the ENGINEER. The ENGINEER will determine whether the remedy is acceptable or if the member must be refabricated.

B. Incorrectly sized or misaligned holes in members shall not be enlarged by burning or by the use of drift pins.

C. Correction of misfits is part of the WORK.

3.12 GAS CUTTING

A. Gas cutting torches shall not be used in the field for correcting fabrication errors in the structural framing, except when approved by the ENGINEER. Gas-cut sections shall be finished equal to a sheared appearance.

3.13 TOUCH-UP PAINTING

A. Immediately after erection, field welds, bolted connections, and abraded areas shall be cleaned of the shop paint primer. Touch-up paint primer shall be applied by brush or spray which is the same thickness and material as that used for the shop paint. Galvanized surfaces which have been field welded or damaged shall be repaired in accordance with Section 05500.

B. Finish painting of all structural steel shall be as indicated in Section 09800.

- END OF SECTION -

SECTION 05300 - METAL DECKING

PART 1 -- GENERAL

1.1 THE REQUIREMENT

A. The CONTRACTOR shall provide steel decking and accessory items, complete and in place, in accordance with the Contract Documents.

1.2 REFERENCE SPECIFICATIONS, CODES AND STANDARDS

A. Specifications and Commercial Standards

AISI	Design of Cold - Formed Steel Structural Members.
SDI	Design Manual for Composite Decks, Form Decks, and Roof Decks.
ASTM A 446	Steel Sheet, Zinc-Coated (Galvanized) by the Hot-Dip Process, Structural (Physical) Quality.
ASTM A 653	General Requirements for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy Coated (Galvanealed) by the Hot-Dip Process.
ASTM A 611	Steel, Sheet, Carbon, Cold-Rolled, Structural Quality
AWS D1.3	Structural Welding Code-Sheet Steel

B. ICBO Research Reports for each type of metal decking used in the WORK.

1.3 CONTRACTOR SUBMITTALS

A. **General:** Submittals shall be in accordance with the requirements of Section 01300 - Contractor Submittals.

B. Prior to the commencement of any work, the CONTRACTOR shall submit an affidavit, furnished by the deck manufacturer, certifying to the yield strength. The CONTRACTOR shall submit gage and section properties of the metal deck. The CONTRACTOR shall also furnish the diaphragm shear values for the deck supplied using the welding pattern and/or shear capacity shown on the Drawings. Failure to conform to this requirement shall be ample justification for rejection of the material.

C. The CONTRACTOR shall submit to the ENGINEER an erection layout drawing showing the location of deck sheets, end laps, side laps, types and locations of welds and details of accessories.

D. The CONTRACTOR shall submit an ICBO Research Report for each type of metal decking used in the WORK.

1.4 QUALITY ASSURANCE

A. No insulation, roofing materials or other permanent coverings shall be placed over the decking until the ENGINEER has inspected it for placement, welds and accessories. All stored materials and debris shall be removed to facilitate the inspection. All welds found to be defective by the ENGINEER shall be replaced as a part of the WORK.

1.5 MATERIAL STORAGE

A. Decking stored at the job site before erection shall be stacked on the ground on platforms or pallets and covered with tarpaulins or other weatherproof covering.

PART 2 – PRODUCTS

2.1 STEEL DECK

A. Unless noted on the Drawings, all metal deck shall be manufactured from steel conforming to ASTM A 611, Grades C, D, or E; or A 446, Grades A, B, C, D, E, or F, or equal, having a minimum yield strength of 33,000 psi. The maximum design working stress in the deck shall not exceed the product of 0.6 times the yield strength.

B. The metal deck structural properties shall be as shown on the Drawings. The moment of inertia and section modulus of the metal deck unit shall be computed in accordance with the Steel Deck Institute specifications, and in accordance with the American Iron and Steel Institute, "Specification for the Design of Cold-Formed Steel Structural Members."

C. All steel deck shall be galvanized and shall conform to ASTM A 653 and to the applicable requirements of Section 05500 - Miscellaneous Metalwork. All steel deck shall be free of oil, grease, and dirt before coating.

D. All steel deck shall be finished in accordance with Section 09800 - Protective Coating. Deck shall be free of oil, grease and dirt before finishing application.

E. The metal deck shall have sheet length that covers 3 or more spans.

F. The metal deck sheets shall be formed at the longitudinal sides in such a manner that they will overlap and/or interlock. Where the end of sheets overlap, they shall be die-formed in such a manner that the sheet in the next row telescopes and snugly overlaps the sheet laid previously.

G. All plates needed to connect decking to supports or to maintain deck continuity shall be 14 gauge galvanized sheet.

H. All structural steel shapes, including angles and inserts, shall be as specified in Section 05100 - Structural Steel Framing.

2.2 SUPPLIERS

A. The metal decking shall be manufactured by **Verco Manufacturing Company**, Phoenix, Arizona; **ASC Pacific Inc.**, Tacoma, Washington; **Vulcraft Nucor Corporation Inc.;** or equal.

PART 3 – EXECUTION

3.1 INSTALLATION REQUIREMENTS

A. The CONTRACTOR shall inspect supporting members for correct layout and alignment, and shall not proceed with installation until defects are corrected and supporting members are completely installed and secured.

B. Metal deck sheets and accessories shall be placed in accordance with the manufacturer's recommendations and the Shop Drawings. Roofs having a slope of 1/4-inch per foot or more shall be erected starting at the low side, to ensure that end laps are shingle fashion.

C. Metal deck sheets shall be positioned on supporting steel framework and adjusted to final position with ends bearing a minimum of 2 inches on supporting members. Units shall be placed end to end, with all ribs aligned over the entire length of the run before being permanently fastened.

D. Special care shall be exercised not to damage or overload the deck during installation. The deck shall not be used for storage or as working platforms until permanently secured in position. Construction loads shall not exceed the deck carrying capacity, as recommended by the manufacturer.

E. All openings in the deck shall be cut and fitted neatly and shall be reinforced with structural steel members to distribute the load.

F. Where concrete fill is required on the Drawings, deck shall be installed with closure plates and other accessories as needed to prevent loss of water, cement, and fines during placing and consolidation of the concrete.

G. Edges of any cut openings or any minor surface damage areas shall be repaired in accordance with applicable requirements of the Sections 09800 and 05500.

H. After erection, all surfaces shall be cleaned and left free of all grime and dirt. The CONTRACTOR shall remove unused materials, tools, scaffolding and debris from the premises and leave the area broom clean.

3.2 WELDING

A. Care shall be exercised in the selection of electrodes and an amperage to provide positive welds and to prevent high amperage blowholes. Welds shall be made from the top side of the deck immediately after alignment.

B. The metal deck shall be welded to all supporting members with 1/2-inch effective diameter puddle welds spaced at 12 inches on center at members parallel to the ribs and at every rib valley at members perpendicular to the ribs, unless otherwise shown on the Drawings. Welding washers shall be used when welding steel deck of less than 0.028-inch thickness. Welding washers shall not be used when welding steel deck of 0.028 inches or greater.

C. Side laps shall be welded with 1-1/2 inch long top seam welds, spaced at 12 inches on center unless indicated otherwise.

D. All welds shall be free of sharp points or edges. All welds shall be cleaned immediately by chipping or wire brushing and shall be coated with a zinc dust type primer paint.

E. Welding shall conform to the applicable requirements of AISC "Light Gauge Steel Design." Welders shall be AWS certified.

- END OF SECTION -

SECTION 05500 - MISCELLANEOUS METALWORK

PART 1 -- GENERAL

1.1 THE REQUIREMENT

A. The CONTRACTOR shall provide miscellaneous metalwork and appurtenances, complete and in place, in accordance with the Contract Documents.

1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. Federal Specifications

MIL-G-18015 A (3)	(Ships) Aluminum Planks. (6063-T6)
MIL-A-907E	Antiseize Thread Compound, High Temperature

B. Commercial Standards

AA-M32C22A41	Aluminum Assn.
AASHTO HS-20	Truck Loading
AISC	Manual of Steel Construction
AISI	Design of Light Gauge, Cold-Formed Steel Structural Members
ASTM A 36	Carbon Structural Steel
ASTM A 48	Gray Iron Castings
ASTM A 53	Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
ASTM A 123	Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
ASTM A 153	Zinc Coating (Hot-Dip) on Iron and Steel Hardware
ASTM A 193	Alloy Steel and Stainless Steel Bolting Materials for High Temperature Service
ASTM A 194	Carbon and Alloy Steel Nuts for Bolts for High Pressure and High Temperature Service
ASTM A 307	Carbon Steel Bolts and Studs, 60,000 psi Tensile Strength
ASTM A 325	Structural Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength
ASTM A 500	Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes
ASTM A 992	Steel for Structural Shapes for Use in Building Framing

ANSI/AWS D1.1 Structural Welding Code - Steel

ANSI/AWS D1.2 Structural Welding Code - Aluminum

ANSI/AWS QC1 Qualification and Certification of Welding Inspectors

1.3 CONTRACTOR SUBMITTALS

A. Furnish submittals in accordance with Section 01300 - Contractor Submittals.

B. Shop Drawings

1. Layout drawings for grating, showing the direction of span, type and depth of grating, size and shape of grating panels, seat angle details, and details of grating hold down fasteners. Load and deflection tables shall be submitted for each style and depth of grating used.

2. An ICBO report listing the ultimate load capacity in tension and shear for each size and type of concrete anchor. CONTRACTOR shall submit manufacturer's recommended installation instructions and procedures for adhesive anchors. Upon review, by ENGINEER, these instructions shall be followed specifically.

3. No substitution for the indicated adhesive anchors will be considered unless accompanied with ICBO report verifying strength and material equivalency, including temperature at which load capacity is reduced to 90 percent of that determined at 75 degrees F.

1.4 QUALITY ASSURANCE

A. Weld procedures and welder qualifications shall be available in the CONTRACTOR's field office for review.

B. Welding shall be inspected by a CONTRACTOR-furnished inspector qualified in accordance with AWS requirements and approved by the ENGINEER.

PART 2 -- PRODUCTS

2.1 GENERAL REQUIREMENTS

A. Steel

Wide Flange Shapes	ASTM A 992
Shapes, Plates, Bars	ASTM A 36
Pipe, Pipe Columns, Bollards	ASTM A 53, Type E or S, Grade B standard weight unless noted otherwise
HSS	ASTM A 500 Grade B

B. **Corrosion Protection:** Unless otherwise indicated, fabricated steel metalwork which will be used in a corrosive environment and/or will be submerged in water/wastewater

shall be coated in accordance with Section 09800 -Protective Coating and shall not be galvanized prior to coating. Other miscellaneous steel metalwork shall be hot-dip galvanized after fabrication.

C. **Stainless Steel:** Unless otherwise indicated, stainless steel metalwork and bolts shall be of Type 316 stainless steel. Where anaerobic conditions are noted, Type 304 stainless steel shall be used.

D. **Aluminum:** Unless otherwise indicated, aluminum metalwork shall be of Alloy 6061-T6. Aluminum in contact with concrete, masonry, wood, porous materials, or dissimilar metals shall have contact surfaces coated in accordance with Section 09800.

E. **Cast Iron:** Unless otherwise indicated, iron castings shall conform to the requirements of ASTM A 48, Class 50B or better.

2.2 ALUMINUM RAILINGS

A. **General:** Aluminum handrails and railings shall be component systems complete with anchors, attachments, balusters, brackets, caps, fasteners, gates (swing with self-latching hardware or removable), posts, sleeves, trim, and any other related items required or necessary for a complete installation. Gates and removable rail sections shall be complete with hardware such as self-closing hinges, self-latching latches, hasps, etc. Railings shall conform to the Building Code and OSHA General Industry Occupational Safety and Health Standards (29CFR1910).

B. **Materials:** Materials shall conform to the following:

1. Aluminum: Aluminum shall be U.S. Alloy 6063 T-5 or T-6. Aluminum pipe rail shall not be less than 1-1/2-inch diameter Schedule 40 pipe.

2. Electrolysis Protection: Electrolysis protective material shall be alkali-resistant asphaltum base paint, **Koppers "Bitumastic 50," Texaco "Cement 1401,"** or equal.

3. Sleeves: Sleeves shall be of galvanized steel or PVC.

4. Grout: Grout for handrail posts shall consist of an inorganic, non-shrink, non-metallic premixed grout in accordance with Section 03315 - Grout with a minimum 28-Day compressive strength of 4,000 psi.

5. Fasteners: Fasteners, screws, and bolts shall be concealed and shall be of stainless steel or aluminum.

6. Welding Rods: Aluminum welding rods shall be of a type recommended by the aluminum manufacturer for anodized finished products.

7. Kickplates: Kickplates shall be provided on railings not set in curbs.

C. **Finishes:** Pipe railing system including handrails, railings, tube caps, and other miscellaneous parts of rails shall be provided with a clear anodized finish, AA-M32 C22A41.

D. Manufacturers or Equal

1. **C-V Pipe Rail** by **Crane Veyor Corp.**

2. **Connectorail by Julius Blum and Co.**

2.3 LADDERS

A. Ladders which may be partially or wholly submerged or which are located inside a hydraulic structure, shall be entirely of Type 316 stainless steel. Other ladders shall be carbon steel, hot-dip galvanized after fabrication, or as indicated.

B. Every ladder that does not have an exterior handhold shall be equipped with a pop-up extension. Pop-up extension device shall be manufactured of the same material and finish as the ladder and have telescoping tubular section that locks automatically when fully extended. Upward and downward improvement shall be controlled by stainless steel spring balancing mechanisms. Units shall be completely assembled with fasteners for securing to the ladder rungs in accordance with the manufacturer's instructions.

2.4 METAL GRATING

A. **General:** Metal grating shall be of the design, sizes, and types indicated. Grating shall be completely banded at edges and cutouts using material and cross section equivalent to the bearing bars. Such banding shall be welded to each cut bearing bar. Grating shall be supported around an opening by support members. Where grating is supported on concrete, embedded support angles matching grating material shall be used, unless indicated otherwise. Such angles shall be mitered and welded at corners.

1. Pieces of grating shall be fastened in 2 locations to each support.

2. Where grating forms the landing at the top of a stairway, the edge of the grating that forms the top riser shall have an integral non-slip nosing, width equal to that of the stairway.

3. Where grating depth is not given, grating shall be provided that will be within allowable stress levels and which shall not exceed a deflection of 1/4-inch or the span divided by 180, whichever is less. For standard duty plank and safety grating, the loading to be used for determining stresses and deflections shall be the uniform live load of the adjacent floor or 100 psf, whichever is greater or a concentrated load of 1000 pounds. For heavy duty grating, the loading used for determining stresses and deflections shall be AASHTO HS-20.

B. Material

1. Except where indicated otherwise, bar grating shall be fabricated entirely of aluminum as follows: Bearing and banding bars, alloy 6061-T6; cross bars, alloy 6063-T5.

2. Safety grating shall be fabricated of aluminum alloy 5052-H32

3. Plank grating shall be fabricated of aluminum alloy 6063-T6.

4. Grating that may be partially or wholly submerged shall be fabricated entirely of stainless steel, Type 316.

C. Standard-Duty Grating

1. No single piece of grating shall weigh more than 80 pounds, unless indicated otherwise. Standard duty grating shall be serrated bar grating.

2. Cross bars shall be welded or mechanically locked tightly into position so that there is no movement allowed between bearing and cross bars.

D. Safety Grating

1. Safety grating shall be made of sheet metal punched into an open serrated diamond pattern and be formed into plank sections. The open diamond shapes shall be approximately 1-7/8 inch by 11/16-inch in size. Safety grating shall be **Grip Strut** by **Metal Products Division, United States Gypsum Company; Deck Span** by **IKG Industries**, or equal.

E. Plank Grating

1. Plank grating shall be extruded in 6-inch widths with a minimum of 6 integral 1-bar type bearing bars per plank. The top surface shall be solid with raised ribs, unless indicated otherwise. Where punched grating is required, the top surface shall be provided with a pattern of 3-inch by 19/32-inch rectangular openings spaced at 4 inches on center. The planks shall have continuous tongue and groove type interlock at each side, except that interlocking planks shall be arranged so that any 4-foot wide section may be removed independently from the other grating sections.

2. Plank grating shall be provided with a clear anodized finish, except that punched grating may have standard mill finish.

3. CHECKERED PLATE

F. Checkered plate shall have a pattern of raised lugs on one face and shall be smooth on the opposite face. Lugs shall be a minimum of one-inch in length and raised a minimum of 1/2-inch above the surface. The lugs shall be located in a pattern in which the lugs are oriented at 90 degrees from the adjacent lugs in 2 orthogonal directions. The rows of lugs shall be oriented at 45 degrees from the edges of the plates.

G. Where no plate material is indicated, aluminum shall be provided. Unless indicated otherwise, the minimum plate thickness shall be as required to limit deflection resulting from a live load of 100 psf to 1/4-inch or the span divided by 240, whichever is less.

2.5 FLOOR HATCHES

A. Where access hatches are mounted on a floor slab (including top slabs that are not covered with a roofing membrane) or on a concrete curb, the hatch shall be a flush type as indicated. Hatches mounted on a roof surface that has a membrane or other roofing material covering it shall be the integral raised curb type in accordance with Section 07720 - Roof Accessories.

B. Hatches shall be fabricated from aluminum 5086 H34, 6063 T5 or 6061 T6, unless otherwise indicated. Hatch hardware shall be Type 316 stainless steel. Hatches shall be gutter-type; **Bilco Type "J"** or **"JD," Babcock-Davis Type B-FGA** or equal.

C. The design live load shall be 300 psf, unless indicated otherwise.

D. Hatch opening sizes, number and swing direction of door leaves, and locations, shall be as indicated. Sizes are for the clear opening. Where the number of leaves is not given, openings larger than 42 inches in either direction shall have double-leaf doors. Unless indicated otherwise, hinges shall be located on the longer dimension side. Unless indicated otherwise, ladder hatches shall be a minimum of 30 inches wide by 36 inches

long, with the ladder centered on the shorter dimension, and the door hinge opposite the ladder.

E. Door leaves shall be a minimum of 1/4-inch thick checkered pattern plate. Channel frames shall be a minimum of 1/4-inch material with an anchor flange around the perimeter. Hatches shall be provided with an automatic hold-open arm with release handle. Hatches shall be designed for easy opening from both inside and outside.

F. Hatches shall be designed to be water-tight and shall be equipped with a joint gutter and moat-type edge drain. A minimum 1-1/2 inch diameter drain connection shall be provided, located by the manufacturer.

G. Hatches for submersible pump stations shall include a unistrut channel around the frame perimeter. The face of the unistrut channel shall be flush with the face of the frame and be compatible with the upper guide rail bracket of the submersible wastewater pump manufacturer.

H. Hatches shall include a recessed hasp for a padlock that is covered by a hinged lid flush with the surface.

I. Unless indicated otherwise, hatch nets shall be installed on floor hatches. Hatch nets shall conform to OSHA requirements and shall be **Hatch Net 121**, as manufactured by **Safe Approach, Inc,** Auburn, ME, or equal.

2.6 IRON CASTINGS

A. Iron castings shall be of uniform quality, free from blowholes, porosity, hard spots, shrinkage, distortion, or other defects. They shall be smooth and well cleaned by shotblasting.

B. Covers and grates shall fit together evenly, so that the cover fits flush with the surrounding finished surface and so that the cover does not rock or rattle when loading is applied. Round covers and frames shall have machined bearing surfaces.

C. Covers and grates with matching frames shall be designed to support the following loadings:

1. Where located within a structure, the design loading shall match that required for the adjacent floor area, or, if no floor loading is given, a minimum of 300 pounds per square foot.

2. Exterior covers and grates shall be designed for AASHTO HS-20 loading unless indicated otherwise.

2.7 MANHOLE RUNGS

A. Rungs shall meet ASTM C 478 - Precast Reinforced Concrete Manhole Sections and the following:

1. Rungs shall be spaced not less than 10 inches apart nor more than 14 inches apart as measured between centerlines of the rungs.

2. Rungs shall be parallel, level, and uniformly spaced.

3. The rungs shall be shaped such that feet cannot slide off the end of the rungs.

4. Rungs shall be surfaced so as to prevent injury from punctures or lacerations, and to prevent snagging of clothing.

5. The minimum perpendicular clearance between rungs and any obstruction behind the ladder shall be 6 inches.

6. The minimum width of rungs shall be 14 inches.

B. CONTRACTOR shall submit certified test results in accordance with ASTM C 497 - Standard Test Methods for Concrete Pipe, Manhole Sections, or Tile, Section 10, for the following loads:

1. Horizontal pull out load shall be 400 pounds

2. Vertical load shall be 800 pounds

C. Rungs shall be made of co-polymer polypropylene that encapsulates a minimum 1/2 inch grade 60 steel reinforcing rod. The co-polymer polypropylene shall meet ASTM D 4101, Type PP200B33430.

2.8 CAST-IN-PLACE THRESHOLD

A. The cast-in-place threshold at overhead roll-up doors shall be a steel threshold embedded in the concrete floor slab. The threshold shall be the product of **Eastern Metal Products Co.,** Elizabeth City, NC (telephone: 919-335-5451); or equal.

2.9 FALL PREVENTION SYSTEM

A. The fall protection system at each ladder shall include a carrier rung, ladder ring clamps, sleeves and full body harnesses, dismount section, and components as necessary for a complete system. The carrier rail shall be the same material as the ladder, except for fiberglass ladders, which shall have stainless steel carrier, rails, and shall be the length recommended by the manufacturer for the ladder dimensions, including extensions. The fall protection system shall be **2000 Climb Rite** by **Sellstrom Manufacturing Company, Saf-T-Climb** by **North Safety Products Ltd.,** or equal.

2.10 BOLTS AND ANCHORS

A. **Standard Service (Non-Corrosive Application):** Unless otherwise indicated, bolts, anchor bolts, washers, and nuts shall be steel as indicated. Threads on galvanized bolts and nuts shall be formed with suitable taps and dies such that they retain their normal clearance after hot-dip galvanizing. Except as otherwise indicated, steel for bolt material, anchor bolts, and cap screws shall be in accordance with the following:

1. Structural connections: ASTM A 307, Grade A or B, hot-dip galvanized.

2. Anchor Bolts: ASTM A 307, Grade A or B, or ASTM A 36, hot-dip galvanized.

3. High strength bolts where indicated: ASTM A 325.

4. Pipe and equipment flange bolts: ASTM A 193, Grade B-7.

B. **Corrosive Service:** Bolts, nuts, and washers in the locations listed below shall be stainless steel as indicated.

1. All outdoor locations.

2. All locations subject to continuous or intermittent wetting or spraying other than weather.

3. Buried locations.

4. Submerged locations.

5. Locations subject to seasonal or occasional flooding.

6. Inside hydraulic structures below the top of the structure.

7. Inside buried vaults, manholes, and structures that do not drain through a gravity sewer or to a sump with a pump.

8. Chemical handling areas.

9. Inside trenches, containment walls, and curbed areas.

10. Locations indicated by the Contract Documents or designated by the ENGINEER to be provided with stainless steel bolts.

C. Unless otherwise indicated, stainless steel bolts, anchor bolts, nuts, and washers shall be Type 316 stainless steel, Class 2, conforming to ASTM A 193 for bolts and to ASTM A 194 for nuts. Threads on stainless steel bolts shall be protected with an antiseize lubricant suitable for submerged stainless steel bolts, to meet government specification MIL-A-907E. Buried bolts in poorly drained soil shall be coated the same as the buried pipe.

1. Antiseize lubricant shall be classified as acceptable for potable water use by the NSF.

2. Antiseize lubricant shall be "PURE WHITE" by Anti-Seize Technology, Franklin Park, IL, 60131, AS-470 by Dixon Ticonderoga Company, Lakehurst, NJ, 08733, or equal.

D. Bolt Requirements

1. The bolt and nut material shall be free-cutting steel.

2. The nuts shall be capable of developing the full strength of the bolts. Threads shall be Coarse Thread Series conforming to the requirements of the American Standard for Screw Threads. Bolts and cap screws shall have hexagon heads and nuts shall be Heavy Hexagon Series.

3. Bolts and nuts shall be installed with washers fabricated of material matching the base material of bolts, except that hardened washers for high strength bolts shall conform to the requirements of the AISC Specification. Lock washers fabricated of material matching the bolts shall be installed where indicated.

4. The length of each bolt shall be such that after the joint is made up, the bolt extends through the entire nut, but in no case more than 1/2-inch beyond the nut.

E. **Adhesive Anchors:** Unless otherwise indicated, drilled concrete or masonry anchors shall be adhesive anchors. No substitutions will be considered unless accompanied with ICBO report verifying strength and material equivalency.

1. Epoxy adhesive anchors are required for drilled anchors for indoor installations, in submerged, wet, splash, overhead, and corrosive conditions, and for anchoring handrails and reinforcing bars. Epoxy shall comply with Section 03315 - Grout. Threaded rod shall be galvanized for general purpose applications and stainless steel Type 316 for corrosive applications. Epoxy anchors shall not be permitted in areas where the concrete temperature is in excess of 100 degrees F or higher than the limiting temperature recommended by the manufacturer, whichever is lower. Epoxy anchors shall not be used where anchors are subject to vibration or fire. Embedment depth shall be as the manufacturer recommends for the load to be supported.

2. Unless otherwise indicated, glass capsule, polyester resin adhesive anchors will be permitted in locations not included above and shall be **Hilti HVA** or **Cobra Anchors**. Threaded rod shall be galvanized steel.

F. **Expanding-Type Anchors:** Expanding-type anchors if indicated or permitted, shall be galvanized steel expansion type **ITW Ramset/Redhead "Trubolt" anchors; McCullock Industries "Kwick-Bolt;"** or equal. Lead caulking anchors will not be permitted. Size shall be as indicated. Embedment depth shall be as the manufacturer recommends for the load to be supported. Expansion type anchors that are to be embedded in grout may be steel. Non-embedded buried or submerged anchors shall be stainless steel.

G. **Non-Shrink Grouted Anchors**: Anchors, if indicated or permitted, shall be grouted with a non-shrink cementitious grout in accordance with the manufacturer's recommendation. Embedment depth shall be as the manufacturer recommends for the load to be supported. Non-shrink grout material shall be Class B or C in accordance with Section 03315 - Grout.

2.11 POWDER-DRIVEN PINS

A. **Materials:** Powder-driven pins for installation in concrete or steel shall be heat-treated steel alloy. If the pins are not inherently sufficiently corrosion-resistant for the conditions to which they will be exposed, they shall be protected in an acceptable manner. Pins shall have capped or threaded heads capable of transmitting the loads the shanks are required to support. Pins that are connected to steel shall have longitudinal serrations around the circumference of the shank.

2.12 IMPACT ANCHOR

A. Impact anchors shall be an expansion type anchor in which a nail type pin is driven to produce the expansive force. The pin shall have a zinc sleeve with a mushroom style head and stainless steel nail pin. Anchors shall be **Metal Hit Anchors,** manufactured by **Hilti, Inc., Rawl Zamac Nailin,** manufactured by **the Rawlplug Company;** or equal.

PART 3 – EXECUTION

3.1 FABRICATION AND INSTALLATION REQUIREMENTS

A. **Fabrication and Erection:** Except as otherwise indicated, the fabrication and erection of structural steel shall conform to the requirements of the American Institute of Steel Construction "Manual of Steel Construction."

B. **Aluminum Railings:** Aluminum railing fabrication and installation shall be performed by craftsmen experienced in the fabrication of architectural metalwork. Exposed surfaces shall be free from defects or other surface blemishes. Dimensions and conditions shall be verified in the field. Joints, junctions, miters, and butting sections shall be precision fitted with no gaps occurring between sections, and with surfaces flush and aligned. Electrolysis protection of materials shall be provided.

C. **Floor Hatches:** Unless otherwise indicated, the CONTRACTOR shall provide a 1/2-inch drain line to the nearest floor drain for floor hatches.

D. **Powder-Driven Pins:** Powder-driven pins shall be installed by a craftsperson certified by the manufacturer as being qualified to install the manufacturer's pins. Pins shall be driven in one initial movement by an instantaneous force that has been carefully selected to attain the required penetration. Driven pins shall conform to the following requirements where "D" = pin's shank diameter:

Material Penetrated by Pin	Material Minimum Thickness	Pin Shank Penetration in Supporting Material	Minimum Space From Pin's CL to Edge of Penetrated Material	Minimum Pin Spacing
Concrete	16D	6D minimum	14D	20D
Steel	1/4-inch	Steel thickness	4D	7D

3.2 WELDING

A. **Method:** Welding shall be by the metal-arc method or gas-shielded arc method as described in the American Welding Society's "Welding Handbook" as supplemented by other pertinent standards of the AWS. Qualification of welders shall be in accordance with the AWS Standards governing same.

B. **Quality:** In assembly and during welding, the component parts shall be adequately clamped, supported, and restrained to minimize distortion and for control of dimensions. Weld reinforcement shall be as indicated by the AWS Code. Upon completion of welding, weld splatter, flux, slag, and burrs left by attachments shall be removed. Welds shall be repaired to produce a workmanlike appearance, with uniform weld contours and dimensions. Sharp corners of material that is to be painted or coated shall be ground to a minimum of 1/32-inch on the flat.

3.3 GALVANIZING

A. Structural steel plates shapes, bars, and fabricated assemblies required to be galvanized shall, after the steel has been thoroughly cleaned of rust and scale, be galvanized in accordance with the requirements of ASTM A 123. Any galvanized part that becomes warped during the galvanizing operation shall be straightened. Bolts, anchor bolts, nuts, and similar threaded fasteners, after being properly cleaned, shall be galvanized in accordance with the requirements of ASTM A 153.

B. Field repairs to damaged galvanizing shall be made by preparing the surface and applying a coating.

1. Surface preparation shall consist of removing oil, grease, soil, and soluble material by cleaning with water and detergent (SSPC SP1) followed by brush off blast cleaning (SSPC SP7), over an area extending at least 4 inches into the undamaged area.

2. Coating shall be applied to at least 3-mils dry film thickness. Use **Zinc-Clad XI** by **Sherwin-Williams**, **Galvax** by **Alvin Products**, or **Galvite** by **ZRC Worldwide**.

3.4 DRILLED ANCHORS

A. Drilled anchors and reinforcing bars shall be installed in strict accordance with the manufacturer's instructions. Holes shall be roughened with a brush on a power drill, cleaned and dry. Drilled anchors shall not be installed until the concrete has reached the required 28-day compressive strength. Adhesive anchors shall not be loaded until the adhesive has reached its indicated strength in accordance with the manufacturer's instructions.

3.5 FALL PREVENTION SYSTEM

A. Fall prevention systems shall be provided on ladders used to ascend heights exceeding 20-feet.

- END OF SECTION -

SECTION 06100 - ROUGH CARPENTRY

PART 1 -- GENERAL

1.1 THE REQUIREMENT

A. The CONTRACTOR shall construct rough carpentry and appurtenant WORK, complete and in place, in accordance with the Contract Documents.

B. The WORK shall include, at least the following items:

1. Wood framing, including plates, studding, joists, rafters, purlins, and similar framing elements.

2. Wood blocking, furring, stripping, backing, and nailers, as indicated, or otherwise required for securing other WORK.

3. Plywood sheathing, board sheathing, sidings, and starter boards.

4. Rough hardware appurtenant to the WORK of this Section, as defined below.

1.2 CONTRACTOR SUBMITTALS

A. Furnish the following in accordance with Section 01300 - Contractor Submittals.

1. Manufacturers' catalogs showing rough hardware conforming to or equivalent to hardware indicated.

2. Engineering calculations for design of all wood trusses or joists, signed and stamped by a professional engineer registered in the State of California.

3. Fabrication and erection drawings for glued laminated beams and wood trusses or joists.

4. Certificates of compliance.

5. Certificate of Conformance indicating conformance and grade compliance with AITC A 190.1 - Structural Glued Laminated Timber, Production Requirements for Glulam, by the American Institute of Timber Construction.

PART 2 -- PRODUCTS

2.1 UNTREATED LUMBER

A. **Grading:** Lumber shall be graded in accordance with the rules of one of the following associations: "Grading Rules for Southern Pine Lumber" of the Southern Pine Inspection Bureau; "Standard Grading and Dressing Rules No. 17" of the West Coast Lumber Inspection Bureau (WCLIB); "Grading Rules for Western Lumber" published by Western Wood Products Association; or "Standard Specification for Grades of California Redwood Lumber" of the Redwood Inspection Service (RIS).

B. **Grade Marking:** Each piece of lumber shall bear the official grade mark of one of the above-mentioned grading rules. The association standards selected for grading and grade marking of the lumber shall be as acceptable to the ENGINEER.

C. **Size Dressing:** Lumber, except as otherwise indicated, shall be dressed to size in accordance with the standards of the association under which the lumber is graded. Lumber shall be S4S unless otherwise indicated.

D. **Drying:** Lumber incorporated in the WORK, except where otherwise indicated, shall be air or kiln dried to a moisture content of not more than 19 percent and not less than one percent.

E. **Framing Lumber Grades:** Grades of framing lumber for various uses shall conform to the following:

West Coast Lumber			
Use	**WCLIB Grade**	**Grading Rule**	**Stress F_b**
Joists and Planks – Rafters,	Select Structural	Para. 123-a	1450 psi
Joists, studding 2 by 6 and framing, ledgers, etc.	No.1	Para. 123-b	1000 psi
Structural Light Framing	No. 1	Para. 124-b	1000 psi
Studding and plates, 2 by 4 to 4 by 4	No.1	Para. 124-b	1000 psi
Beams and Stringers	Select Structural	Para. 130-a	1600 psi
Posts and Timbers	Select Structural	Para. 131-a	1500 psi

Southern Lumber			
Use	**SPIB Grade**	**Grading Rule**	**Stress F_b**
Structural Joists and Planks	Select Structural	Para. 311	2550 psi, 5 to 6 inches wide
2- to 4 inches thick – Rafters, Beams			2300 psi, 8 inches wide
Stringers, joists, studding 2 by 6 and larger, miscellaneous framing, ledgers, etc.			2050 psi, 10 inches wide, 1900 psi, 12 inches wide, 1710 psi
	No.1	Para. 312	1650 psi, 5 to 6 inches wide, 1500 psi, 8 inches wide, 1300 psi, 10 inches wide, 1250 psi, 12 inches wide, 1125 psi, 12 inches wide, 1125 psi, 14 inches and wider
Structural Light Framing	Select Structural	Para. 311	2850 psi
Studding and plates 2 by 4 to 4 by 4	No. 1	Para. 312	1850 psi
Posts and Timbers	Select Structural	Para. 401	1500 psi
	No.1	Para. 402	1350 psi

2.2 REDWOOD

A. Redwood shall conform to applicable requirements of the RIS. Redwood lumber used for foundation plates or in contact with concrete shall be Foundation Grade, S4S. Redwood lumber used for stop logs, weirs, and baffles shall be construction grade (Heart).

B. TREATED LUMBER

C. **Marking:** Each piece of treated lumber shall bear the approval mark of an approved testing agency.

D. **Kiln Drying:** Kiln-dried lumber shall be treated with a water-borne preservative and shall have a maximum moisture content of 15 percent after treatment.

E. **Pressure-Treated Lumber:** Pressure-treat in accordance with AWPA C1 - Manual of Recommended Practice, Standard for Preservative Treatment by Pressure Process – All Timber Products. Preservative shall conform to American Wood Preservers Assn. P5 – Standard for Waterborne Preservatives. Creosote shall not be used.

F. **Preservative:** Two thorough coats of preservative, **Zehrung "Zerpel"; Sherwin Williams, "Kemwood Penta,"** or equal, shall be applied at least 2 hours before installation, to surfaces that come in contact with, or are set close to concrete and plaster, except lumber indicated to be pressure-treated. Tank dipping or pressure-treating may be used.

G. **Cuts:** Wherever necessary to cut, notch, dap, drill, or frame treated lumber, newly cut or bored surfaces shall be treated with 2 heavy coats of the same preservative used in the original treatment. The minimum penetration depth shall be 1/4-inch.

H. **Fire-Retardant Treated Lumber:** Where required, fire-retardant treatment for lumber shall conform to the requirements of the governing building code and shall be redried after treatment in accordance with AWPA C1. Allowable values shall be adjusted in accordance with AFPA-NDS.

I. PLYWOOD AND HARDBOARD

J. **Plywood:** Plywood shall conform to the requirements of U.S. Product Standard PS-1 - Construction and Industrial Plywood, and be as indicated herein. Plywood panels shall be marked with grade mark of the American Plywood Association. The mark shall identify the plywood as to species, glue type, and grade in compliance with the applicable commercial standard. Except as otherwise indicated, plywood shall be Douglas Fir, Exterior, C-D, S1S,. Plywood for other specific applications shall be as follows:

1. Plywood for use in concrete forms shall conform to the requirements of Section 03100 - Concrete Formwork.

2. Plywood for back-up boards behind telephone equipment, electrical equipment, or communication equipment shall be Douglas Fir, A-C INT grade for interior locations and A-C-EXT for exterior locations.

3. Plywood tool boards and protective wall paneling shall be Douglas Fir N-D-INT grade.

K. **Hardboard:** Hardboard shall be temper-treated panels manufactured from interfelted ligno-cellulose fibers consolidated under heat and pressure in a hot press to produce a smooth, hard-surfaced material which is resistant to water and stains. Hardboard shall conform to the requirements of AHA A 135.4 – Basic Hardboard, by the American Hardboard Association.

L. **Used Lumber:** For concealed, non-load-bearing applications, used form lumber (except plywood) which is undamaged and complies with requirements herein may be reused if permitted by the ENGINEER. Form plywood shall not be reused.

2.3 ROUGH HARDWARE

A. **General:** The term "rough hardware" shall include nails, screws, lag screws, bolts, nuts, washers, plates, metal fasteners, and framing anchors; anchor bolts which are to be embedded into concrete, concrete masonry, or brick masonry; and similar items employed in erection and construction of the rough carpentry WORK. Rough hardware shall be of standard manufacture, approved by a recognized agency for the intended applications and shall be provided with laboratory test results on capabilities when requested by the ENGINEER. Hardware items shall be steel unless otherwise indicated. Specially fabricated rough hardware shall be provided in accordance with Section 05100 -Structural Steel Framing and Section 05500 - Miscellaneous Metalwork and shall be hot-dip galvanized after fabrication.

B. **Anchors and Fasteners:** Anchors and fasteners for securing wood items, unless otherwise indicated, shall be as follows:

1. Bolts, nuts, and studs shall conform to the requirements of Section 05500 and the following:

   a. ASME B18.5 - Round Head Bolts

   b. FF-N-836E – Nut: Square, Hexagon, Cap, Slotted, Castle. Knurled, Welding, and Single Ball Seat

   c. FF-S-1362 – Stud, Plain, General Purpose

   d. FF-B- 575C – Bolts, Hexagon and Square

2. Nails and staples shall conform to ASTM F1667 – Driven Fasteners - Nails, Spikes and Staples, and shall be the type and size best suited for the intended application. Nails shall be galvanized steel, aluminum, or stainless steel, as appropriate, where exposed to weather. Nails used for fastening plywood to nailers on steel beams shall be of wire gauge noted for common nails, but of 1/2 length. Nails used for exterior (exposed to view) plywood siding, siding, or trim shall be stainless steel.

3. Wood screws shall conform to the requirements of Federal Specification FF-S-111D(1) – Screw, Wood, for the style and material as indicated or be best suited for the purpose. Wood screws shall be galvanized where exposed to view or to weather.

4. Lag screws or lag bolts shall conform to the requirements of ASME B18.2.1 - Square and Hex Bolts and Screws, for the type and grade best suited for the purpose. Lag screws or lag bolts shall be galvanized where exposed to view or weather.

5. Toggle bolts shall conform to the requirements of Federal Specification FF-B-588D – Bolt, Toggle: and Expansion Sleeve, Screw, for the type and grade best suited for the purpose.

6. Expansion shields shall be in accordance with Section 05500.

7. Power-driven pins shall be in accordance with Section 05500.

C. **Metal Framing Devices:** Metal framing devices shall be specially-designed joist hangers, header hangers, framing anchors, post anchors, and structural framing connectors fabricated from steel, hot-dip galvanized after fabrication, and be designed to conform to code requirements. Documentation of load tests by an independent testing laboratory shall be submitted if requested by the ENGINEER. The framing devices shall be as manufactured by **Silver Metal Products, Inc.; Easy Ardes Rib, Simpson Co.; Heckmann Building Products;** or equal. The framing devices shall be equal or superior to those indicated as per design, friction, and loading. The framing device shall be provided complete with the proper sized nails, bolts, lag bolts, or other required fasteners called for in the design calculations for the framing devices.

D. **Plyclips:** Plyclips shall be extruded aluminum clips, manufactured from 6063-T6-aluminum alloy and be designed for intended use. Size shall be as required for plywood or shall be as indicated.

2.4 MISCELLANEOUS PRODUCTS

A. **Building Paper:** Building paper or felt shall be non-perforated, asphalt-saturated organic felt conforming to ASTM D 226 – Asphalt-Saturated Organic Felt Used in Roofing and Waterproofing, 15 lb/100 sq ft.

B. **Termite Shields:** Termite shields shall be not less than 26-gauge, zinc-coated steel or 30-gage, terne steel coated with 40 lb of coating material per 100 square feet.

PART 3 – EXECUTION

3.1 GENERAL

A. **Preliminaries:** Rough carpentry shall be as indicated and as necessary for complete WORK. The CONTRACTOR shall verify drawing dimensions with actual field conditions and shall inspect related WORK and adjacent surfaces, and shall report to the ENGINEER conditions that could prevent proper execution of this WORK.

B. **Work Coordination and Performance:** The CONTRACTOR shall coordinate the subcontractors and trades doing related WORK. WORK of this section shall be carefully planned and laid out. Work shall be performed under the direction of a capable, experienced supervisor.

C. **Rough Hardware:** Rough hardware not otherwise indicated that is necessary for the satisfactory execution of framing, including nails, spikes, dowels, fasteners, and similar incidentals shall be provided by the CONTRACTOR. Rough hardware shall be coordinated, furnished, installed, and embedded as indicated and as required for completeness.

D. **Framing:** Framing members and assemblies shall be closely fitted, accurately set, and rigidly secured to required lines, levels, and arrangements indicated. Framing shall be accurately and neatly cut and shall be securely nailed, spiked, or otherwise fastened in place in a workmanlike manner. Timber connectors and installation thereof shall conform to applicable requirements of AITC 104 – Typical Construction Details and AITC OT-01 – Timber Construction Manual.

3.2 FASTENERS AND FRAMING DEVICES

A. **Nailing:** Where nail spacing is not otherwise regulated by the Building Code, nails shall not be driven closer together than 1/2 their length unless driven in drilled holes, nor driven closer to the edge of a member than 1/4 of their length. Where necessary to prevent splitting, holes shall be drilled slightly smaller than nail diameters. The nails shall penetrate the second or farther member not less than 1/2 the nail length. Common nails shall be used unless otherwise indicated

B. **Bolts and Nuts:** Malleable or cut-steel washers shall be provided under bolt heads and nuts except where bearing on steel plates or other steel attachments or where flat-head countersunk bolts are indicated. Bolt holes shall be drilled 1/32-inch to 1/16-inch larger diameter than the bolts they are to accommodate and shall be bored true-to-line. Members shall be clamped together and bolts shall be driven in place and nuts shall be drawn up tightly. Bolts shall be drawn tight again immediately prior to enclosing with finish or, if left exposed, upon completion of other WORK. Holes at anchor bolts embedded in concrete may be 1/16-inch larger than bolt diameter.

C. **Screws:** Lag and wood screws shall be screwed, not driven, into place. Holes to receive lag screws shall be bored first of the same diameter and depth as shank, then continued to depth equal to length of screw, with diameter equal to the base of the screw thread. Screws shall penetrate into the farther member a distance equal to a least 7 times the diameter of the screw shank. Washers shall be installed under each lag screw head bearing on wood.

D. **Metal Framing Devices:** Metal framing devices shall be provided where indicated. Nails for the framing devices shall be as furnished or recommended by the manufacturer of the anchor device. Nails shall be driven to their full depth at holes in anchors. Bolt and lag fasteners shall be drawn tight.

3.3 FRAMING

A. **Strength Considerations:** Structural wood framing members shall not be spliced between bearing points or supports. Approval shall be obtained from the ENGINEER before cutting of any wood members that may weaken the structure. Due care shall be exercised in placing framing so that structural and other important members do not require cutting for openings, pipes, vents, conduits, or ducts. Bearing surfaces on which wood structural members are to rest shall be finished to give full, true, and even support. Wedges or shims shall not be used to correct faulty WORK. Wood members that have been split or otherwise damaged to such an extent as to impair their strength shall be removed and replaced by the CONTRACTOR as part of the WORK.

B. **Cutting and Notching:** Only skilled workmen shall be used for cutting and framing of wood members required to accommodate structural members, for routing of piping, conduit, ducts, and for the installation of mechanical, electrical, or other apparatus or equipment. Members shall not be cut, notched, or bored more than 1/4 of their depth without adequate and approved reinforcing.

C. **Plate/Sill Material:** Wood nailing blocks, sills, and plates resting on or embedded in concrete or masonry within 18 inches of grade shall be pressure treated.

D. **Plate and Sill Installation:** Bottom plates and sill plates which are secured to concrete shall be located as indicated. The anchor bolts shall be located as indicated or as required by referenced standards if not indicated. The plates and sills shall be leveled

with shims. Washers shall be placed and nuts shall be tightened to level bearing, after which the space (1/2-inch minimum) between the sill and concrete shall be dry-packed with concrete in accordance with Section 03300 - Cast-in-Place Concrete.

E. **Wall Framing:** Studs shall be installed at a spacing of 16 inches on centers unless otherwise indicated. A single plate shall be provided at the bottom and a double plate at the top of wall framing unless otherwise indicated. Joints in upper and lower members of the top plate shall be staggered not less than 4-feet. Stud walls and partitions shall have a continuous row of blocking or firestopping to form a complete and effective separation for the entire width of the wall or partition. Blocking shall be located so that there will be no concealed air spaces greater than 7-feet in horizontal or vertical dimension. Defective materials, including crooked, warped, or bowed materials shall be replaced by the CONTRACTOR as part of the WORK.

F. **Blocking and Backing:** Blocking and backing in walls and ceilings shall be nominal 2-inch thick material of a depth as needed and shall be accurately located around light fixtures, ceiling registers, grilles, and other required mechanical and electrical items. The blocking shall fit snugly and shall be spiked into the supporting framing members. Wood blocking (backing) to receive sheathing, siding, metal lath, and gypsum board shall be provided wherever necessary for securing the facing materials.

G. **Backing for Specialties and Accessories:** Backing shall be accurately located and installed for building specialties, toilet accessories, and finish hardware items as required.

H. **Concrete-Embedded Blocks:** Where required and approved, nominal 2-inch thick nailing blocks (dovetail type) shall be provided in concrete to receive superimposed wood stripping, grounds, and backing. Applied grounds or stripping shall be securely nailed into wood nailing blocks, using nails of approved length.

I. **Furring:** Furring shall be 2-inch by 3-inch wood studs spaced at 16 inches on centers, laid flat to the wall. Light metal framing may be substituted at non-thermal wall conditions in accordance with Section 05400 - Cold Formed (Light) Metal Framing. Other sizes and spacing of furring or stripping shall be as indicated.

J. **Rafters and Joists:** Rafters and joists shall be placed crown up and supported firmly on the framing below. Care shall be used in selection and placing of members. Positive and secure attachment shall be provided. The CONTRACTOR shall provide double joists and double headers to receive trimmers at openings which cut or interrupt normal rafter spacing.

K. **Roofs:** Roofs shall be erected level or shall be sloped as indicated or approved.

L. **Plywood Siding:** Plywood siding shall be applied in accordance with the manufacturer's published recommendations and the APA - Engineered Wood Association standards. Exposed nails used for exterior plywood siding shall be of stainless steel.

M. **Plywood Sheathing:** Plywood sheathing shall be installed with face grain across supports, and end joints shall be over joists and be staggered. Blocking shall be provided at unsupported edges.

N. **Fire Stops:** Fire stops shall be not less than 2-inch nominal thickness and of the same width as the studs. Strips of full-thickness fiberglass or rock wool shall be installed around pipes, ducts, conduits, and other penetrations through fire stops.

O. **Sleepers:** Sleepers for mechanical equipment and curb openings shall be provided and coordinated with appropriate trades for locations and sizes. Sleepers shall be ripped to conform to roof slope if necessary.

P. **Sand Blasting:** Members required to be sandblasted shall be lightly sandblasted. Field sandblasting shall conform to requirements of governing authorities.

- END OF SECTION -

SECTION 06105 - MISCELLANEOUS CARPENTRY

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following:

1. Rough carpentry work not specified elsewhere and generally intended for support of other work.
2. Wood furring.
3. Miscellaneous blocking, grounds, nailers, and panels.
4. All rough hardware, nails, screws, and all fasteners for connecting wood to concrete and masonry, not specified elsewhere.
5. The work incidental to the laying out and the general progress of the structure, including temporary barricades for protection of the work, workmen, and the public.
6. The Contractor shall consult and cooperate with trades whose work proceeds and follows the work of this section to insure an orderly procedure in the execution of all rough carpentry work.

B. Related Sections: The following Sections contain requirements that relate to this Section:

1. Division 3 Section "Cast-In-Place Concrete" for wood formwork.

1.3 SUBMITTALS

A. General: Submit the following according to Conditions of Contract and Division 1 Specification Sections.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Delivery and Storage: Keep materials under cover and dry. Protect against exposure to weather and contact with damp or wet surfaces. Stack material above ground level on uniformly spaced supports to prevent deformation.

1. For material pressure treated with waterborne chemicals, place spacers between each bundle for air circulation.

PART 2 - PRODUCTS

2.1 LUMBER, GENERAL

A. Standards: Furnish lumber manufactured to comply with PS 20 "American Softwood Lumber Standard" and with applicable grading rules of inspection agencies certified by American Lumber Standards Committee's (ALSC) Board of Review.

B. Grade Stamps: Furnish lumber with each piece factory-marked with grade stamp of inspection agency that indicates grading agency, grade, species, moisture content at time of surfacing, and mill.

1. For exposed lumber, furnish pieces marked on ends or back of each piece.

C. Sizes: Provide nominal (actual) sizes indicated, complying with PS 20 except where actual sizes are specifically noted as being required.

D. Surfacing: Dressed lumber, S4S, unless otherwise indicated.

2.2 DIMENSION LUMBER FOR CONCEALED CONDITIONS

A. Species: Douglas F112.

B. Moisture Content: S-DRY, KD 19 or MC 19 (19 percent maximum moisture content).

C. Grade: No. 2 or standard grade.

2.3 BOARDS FOR EXPOSED CONDITIONS

A. Species: Any wood species listed by PS 20.

1. Douglas fir.
2. Hem-fir.

B. Moisture Content: Kiln-dry, KD 15 or MC 15 (15 percent maximum moisture content).

C. Grade: No. 2, 2 Common, Construction Common, or Construction Boards.

2.4 CONSTRUCTION PANELS

A. Standards: Comply with requirements of PS 1 Voluntary Product Standard "Construction and Industrial Plywood" for veneer plywood and APA PRP-108 "Performance Standards and Policies for Structural-Use Panels" for performance-rated panels.

1. Trademark: Furnish construction panels that are each factory-marked with APA trademark for grade specified.

B. Miscellaneous Exposed Plywood: A-D Interior, thickness as indicated but not less than 1/2 inch (12.7 mm) nominal.

C. Electrical/Telephone Backing Panels: C-D Plugged, Exposure 1 plywood panels, fire-retardant treated, thickness as indicated but not less than 1/2 inch (12.7 mm) nominal.

2.5 FASTENERS

A. General: Where miscellaneous carpentry is exposed to weather, in ground contact, or in area of high relative humidity, provide fasteners with a hot-dip zinc coating per ASTM A 153 or of AISI Type 304 stainless steel.

B. Nails, Wire, Brads and Staples: FS FF-N-105.

C. Bolts: ASTM A 307, Grade A (ASTM F 568, Property Class 4.6); with ASTM A 563 (ASTM A 563M) hex nuts and flat washers.

2.6 PRESERVATIVE WOOD TREATMENT BY PRESSURE PROCESS

A. General: Obtain preservative-treated lumber complying with AWPA Standard C2. Mark each treated item with AWPB Quality Mark Requirements. Coat surfaces cut after treatment to comply with AWPA M4.

B. Above-Ground Wood Treatment: Pressure treat with waterborne preservatives to a minimum retention of 0.25 lb/cu ft (4.0 kg/cu m).

1. Kiln-dry interior dimension lumber after treatment to 15 percent maximum moisture content.
2. Kiln-dry interior construction panels after treatment to 15 percent maximum moisture content.
3. Treat wood items indicated and in the following circumstances:

   a. In contact with roofing, flashing, or waterproofing.
   b. In contact with masonry or concrete.
   c. Within 18 inches (450 mm) of grade.

C. Ground-Contact Wood Treatment: Pressure treat with waterborne preservatives to a minimum retention of 0.40 lb/cu ft (6.4 kg/cu m).

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

A. Discard units of material with defects that impair quality of miscellaneous carpentry and in sizes that would require an excessive number or poor arrangement of joints.

B. Cut and fit miscellaneous carpentry accurately. Install members plumb and true to line and level.

C. Coat cut edges of preservative-treated wood to comply with AWPA M4.

D. Securely fasten miscellaneous carpentry as indicated and according to applicable codes and recognized standards.

E. Countersink nail heads on exposed carpentry work and fill holes.

F. Use fasteners of appropriate type and length. Predrill members when necessary to avoid splitting wood.

3.2 WOOD FURRING

A. General: Install at spacing indicated, with closure strips at edges and openings. Shim with wood as required for tolerance of finished work.

B. Furring to Receive Plywood Paneling: Install 1 by 3 inch nominal size (19 by 64 mm actual size) furring at 24 inches (600 mm) o.c., horizontally and vertically. Select furring strips for freedom from knots that could cause bent-over nails and damage to paneling.

3.3 CONSTRUCTION PANELS

A. Comply with applicable installation recommendations in APA Form E30 "Design/Construction Guide--Residential & Commercial."

- END OF SECTION -

SECTION 06172 - WOOD TRUSSES

PART 1 -- GENERAL

1.1 THE REQUIREMENT

A. The CONTRACTOR shall provide wood trusses, 3X joists, bridging, bracing, and appurtenances, complete and in place, in accordance with the Contract Documents.

B. **Single-Source Engineering Responsibility**: Provide trusses engineered by the truss fabricator to support superimposed dead and live loads indicated. Design shall be approved and certified by a qualified professional engineer.

C. **Single-Source Responsibility for Connector Plates**: Provide metal connector plates from one manufacturer.

1.2 CONTRACTOR SUBMITTALS

A. **General:** Submittals shall be in accordance with Section 01300 - Contractor Submittals.

B. Calculations and drawings shall be stamped by a Professional Engineer licensed in the State of California.

C. Submit

1. Truss Shop Drawings shall show the following for each type of truss:

a. Location, configuration, and dimensions of joists

b. Slope or depth, span, camber, and spacing

c. Required bearing widths

d. Design loads as applicable

e. Top chord live load (including snow loads) and dead load

f. Bottom chord live and dead loads

g. Concentrated loads and their points of application

h. Controlling wind and seismic loads

i. Adjustments to lumber and metal connector plate design values for conditions of use

j. Each reaction force and direction

k. Metal connector plate type, size, thickness or gauge, and the dimensioned location of each metal connector plate.

l. Lumber size, species, and grade for each member

m. Connection requirements

n. Calculated deflection ratio and/or maximum deflection for live and total load

o. Maximum axial compression forces in the truss members

p. Required permanent truss member bracing locations

q. Handling and erection recommendations

2. Approved ICBO reports for truss connector plates to be used, showing allowable design loads on the plates.

3. Product certificates signed by officer of truss fabricating firm, certifying that metal-plate-connected wood trusses comply with indicated requirements and Shop Drawings.

4. Qualification data for firms and persons to demonstrate their capabilities and experience. Include lists of completed projects with project names and addresses, names and addresses of architects and owners, and other information indicated.

5. Material test reports from a qualified independent testing agency listing and interpreting test results for compliance of fire-retardant-treated wood products with indicated requirements.

6. Material certificates for dimension lumber required to comply with minimum allowable unit stresses. Indicate species and grade selected for each use and design values approved by the American Lumber Standards Committee (ALSC) Board of Review

1.3 QUALITY ASSURANCE

A. **Materials:** Materials and assembly shall be inspected to determine compliance with the Building Code. Every material shall be graded, marked, or labeled.

B. **Certificate:** At completion of fabrication of the trusses, the approved fabricator shall submit a certificate of compliance to the ENGINEER stating that the WORK was performed in accordance with the Contract Documents.

C. Qualifications

1. General: The items in this Section shall be furnished by firms having at least 5 years experience with similar products and having a record of successful installations

2. Metal-Plate Connector Manufacturer: A manufacturer that is a member of Truss Plate Institute (TPI) and that complies with TPI quality control procedures for manufacture of connector plates published in TPI 1- National Design Standard for Metal-Plate-Connected Wood Truss Construction.

3. Fabricator: Engage a firm that:

a. Complies with the following requirements for quality control and is experienced in fabricating metal-plate-connected wood trusses similar to those indicated and with a record of successful in-service performance:

b. Trusses shall be manufactured on the premises of a fabricator that is registered and approved to perform such WORK without special inspection. Registration and approval shall be based upon review of the fabricator's written procedural and quality control manuals and periodic auditing of fabrication practices by an approved inspection agency. Approved inspection agency shall be SPIB; Timber Products Inspection, Inc; TPI, or other independent inspecting and testing agency acceptable to the ENGINEER and local authorities having jurisdiction. Proof of registration and approval shall be submitted to the ENGINEER.

c. The truss manufacturer shall retain an approved agency having no financial interest in the plant being inspected to make nonscheduled inspections of truss fabrication and delivery operations. The inspections shall cover the entire truss operation, including lumber storage, handling, cutting fixtures, presses or rollers, fabrication, bundling and banding, handling and delivery.

4. Professional Engineer Qualifications: A professional engineer who is legally authorized to practice where the Site is located and who is experienced in providing engineering services of the kind indicated that have resulted in installing metal-plate-connected wood trusses similar to those indicated and with a record of successful in-service performance.

5. Installer: An experienced Installer who has completed wood truss installation similar in material, design, and scope to that indicated and with a record of successful in-service performance.

PART 2 -- PRODUCTS

2.1 GENERAL

A. **Design and Fabrication:** The design and fabrication of metal plate connected wood trusses shall be in accordance with TPI 1, applicable portions of TPI DSB - Recommended Design Specification for Temporary Bracing of Metal Plate Connected Wood Trusses, and the AFPA NDS - National Design Specification for Wood Construction and Supplements.

B. The roof shall be designed to withstand the following vertical uniform loads:

1. Dead Load

a. Top chord 26 psf + chord wt.

b. Bottom chord 28 psf + chord wt.

c. Actual truss weight

d. Air conditioning units as indicated

2. Live Load: 20 psf basic

3. Wind loading criteria shall be as indicated on the Drawings.

4. Seismic loading criteria shall be as indicated on the Drawings.

C. Design trusses to withstand design loads without deflections greater than the following:

1. Vertical deflection of 1/360 of the span due to the live load.

2. Vertical deflection of 1/240 the span due to the total load.

D. Individual roof elements shall be designed to resist additional lateral loads as indicated. These additional loads are due to wind and/or seismic loading conditions, and building code load duration factors may be used in calculating stresses.

E. As a minimum, the following load conditions with appropriate building code prescribed load duration factors shall be considered in the roof design:

1. Dead Load + Live Load

2. Dead Load + Seismic

3. Dead Load + Wind Load (Up or Down)

F. The maximum spacing of the trusses shall be 24 inches unless otherwise indicated on the Drawings.

G. Joist hangers, anchors, and other connectors to connect the wood trusses to the walls or other structural systems shall be designed by the manufacturer.

H. The truss manufacturer shall coordinate the design with the HVAC Drawings and Shop Drawings to provide space and support for HVAC equipment to be supported on or from the bottom or top truss chords.

2.2 TRUSSES

A. Lumber shall conform to the species and be fully recognized nominal sizes according to the manufacturer's design. Members shall be cut from lumber bearing the proper grade mark stamps of a recognized grading association or licensed lumber inspection agency. No lumber shall be used that does not appear to conform to the proper dimensions and/or grades.

B. **Grading:** Lumber shall be graded in accordance with the rules of one of the following associations: "Grading Rules for Southern Pine Lumber" of the SPIB; "Standard No.17" of the WCLIB; or "Grading Rules for Western Lumber" published by WWPA.

C. **Grade Marking:** Each piece of lumber shall bear the official grade mark of one of the above-mentioned grading rules.

D. **Size Dressing:** Lumber, except as otherwise indicated, shall be dressed to size in accordance with the standards of the association under which the lumber is graded. Lumber shall be S4S unless otherwise indicated.

E. **Marking:** Each truss shall be legibly branded, marked, or otherwise have permanently affixed thereto the following information located within 2-feet of the center of the span on the face of the bottom chord:

1. Identity of the company manufacturing the trusses and the address

2. The design load

3. The spacing of the trusses

F. **Moisture Content:** At the time of fabrication, the moisture content of lumber shall be within the proper limits as stated in the referenced specifications and the appropriate load duration factors shall account for any variations in this moisture content.

G. Connector Plates

1. Connector plates shall be designed by the manufacturer.

2. Connector plates shall be structural-quality steel sheet, zinc coated by hot-dip process complying with ASTM A 653 - Steel Sheet, Zinc Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot Dip Process, G60 coating designation; Grade 33, and shall not be less than 0.0359-inch thick.

3. Connector plates shall be clearly marked with the manufacturer's name.

4. Connector plates shall be provided on both sides of the truss (2 plates per joint), and connector plated truss joints shall be designed in accordance with the methods in the TPI Standards.

H. **Bracing:** Permanent lateral bracing shall be 3 by 6 lumber minimum and be as shown on the truss manufacturer's drawings.

I. **Painting and Tagging:** Prior to shipment, similar ends of trusses shall be painted to show erection orientation. Florescent red and green Truss Joist Institute safety and specialty tags cautioning against cutting trusses or altering trusses and indicating bearing locations, orientation, permanent lateral bracing, and field splices shall be affixed to trusses.

2.3 FASTENERS

A. **General**: Provide fasteners of size and type indicated that comply with the manufacturer's requirements

B. **Nails, Wire, Brads, and Staples**: ASTM F 1667 - Driven Fasteners: Nails, Spikes, and Staples.

C. **Power-Driven Fasteners**: CABO NER-272 - Power Driven Staples and Nails for Use in All Types of Building Construction.

D. **Wood Screws**: ASME B18.6.1 - Wood Screws (Inch Series).

E. **Lag Bolts and Screws**: ASME B18.2.1. - Square and Hex Bolts and Screws (Inch Series).

F. **Bolts**: Steel bolts complying with ASTM A 307 - Wood Screws (Inch Series), Grade A with ASTM A 563 - Carbon and Alloy Steel Nuts, hex nuts and, where indicated, flat washers.

2.4 METAL FRAMING ANCHORS

A. **General:** Provide metal framing anchors of structural capacity, type, size, metal, and finish that comply with requirements, including the following:

1. Research or Evaluation Reports: Provide products for which model code research or evaluation reports exist that are acceptable to authorities having jurisdiction and that demonstrate compliance with Building Code.

2. Allowable Design Loads: Provide products with published allowable design loads that meet or exceed those indicated. Manufacturer's published values shall be determined from empirical data or by rational engineering analysis, and be demonstrated by comprehensive testing performed by a qualified independent testing agency.

B. **Galvanized Steel Sheet**: Hot-dip, zinc-coated steel sheet complying with ASTM A 653, G60 coating designation; structural, commercial, or lock-forming quality, as standard with manufacturer for type of anchor indicated.

2.5 OTHER FRAMING MEMBERS

A. Simple framing members shall be designed in accordance with Section 06100 - Rough Carpentry.

B. Joist hangers, anchors, and other connection hardware shall be of standard manufacture, approved by a recognized agency for the intended applications. Specially fabricated hardware shall be provided in accordance with Section 05500-Miscellaneous Metalwork, hot-dip galvanized after fabrication.

PART 3 -- EXECUTION

3.1 TRUSS FABRICATION

A. The top and bottom chords shall have a minimum size of 3 by 6 with a top chord extension as indicated.

B. Trusses and other roof structural components shall be fabricated in a properly equipped manufacturing facility of a permanent nature. They shall be manufactured by experienced workmen, using precision cutting and truss fabricating equipment and meeting the requirements of TPI 1, under the direct supervision of a qualified foreman. Trusses shall be fabricated under strict rules of inspection and quality control as required by the Building Code and shall be open to the ENGINEER or its representative at all times.

C. Truss members shall be accurately cut to length and angle and shall be true to line to assure tight joints for the finished truss. Tolerances shall be per TPI 1.

D. Truss members and connector plates shall be properly placed in special jigs, and the members tightly clamped in place, remaining in that position until the connector plates have been installed.

E. Camber shall be built into the trusses as noted on manufacturer's designs.

3.2 HANDLING, ERECTION, AND BRACING

A. Handle and store trusses with care and comply with manufacturer's written instructions and TPI recommendations to avoid damage and lateral bending.

B. Inspect trusses showing discoloration, corrosion, or other evidence of deterioration. Discard and replace trusses that are damaged or defective.

C. The CONTRACTOR shall be responsible for field erection of the trusses and other roof framing components, including items such as proper handling, safety precautions, temporary bracing to prevent toppling like dominoes of the trusses during erection, and any other safeguards or procedures which are consistent with good workmanship and building erection practices.

D. The CONTRACTOR shall comply with applicable requirements and recommendations of TPI HIB - Commentary and Recommendations for Handling Installing & Bracing Metal Plate Connected Wood Trusses.

E. The CONTRACTOR shall comply with engineered drawings, truss layout plans, and TPI HIB when erecting the truss. Fabricated trusses and sub-components shall be handled and stored so that they are not subject to damage. If the trusses are to be stockpiled prior to erection, sufficient bearing points and/or bracing shall be provided to prevent excessive lateral bending or tipping over or other damage.

F. Framing anchors and/or truss hangers shall be provided by the CONTRACTOR in accordance with the manufacturer's recommendations and the Contract Documents.

G. During the construction period, the CONTRACTOR shall provide means for adequate distribution of any concentrated loads, so the carrying capacity of any one truss and/or other component is not exceeded.

H. The CONTRACTOR shall install proper erection bracing to hold the trusses true and plumb and in safe condition until the permanent truss bracing and bridging is solidly nailed in place, forming a structurally sound roof framing system. Erection and permanent bracing shall be installed and components shall be firmly fastened before any loads are applied to the roof.

   1. The CONTRACTOR shall install erection bracing in accordance with TPI HIB. Brace trusses as they are erected by forming 2 by 4 triangles within each of the three planes in a truss system. Attach bracing with two 16D double-headed nails at each crossing truss minimum. Short cleats or spacer pieces of lumber between adjacent trusses shall not be used.

I. The plywood sheathing shall be installed in accordance with the Drawings. Full bundles of plywood sheathing shall not be stacked on trusses.

J. The CONTRACTOR shall not attempt to field repair, cut, or otherwise alter trusses without consulting the truss manufacturer.

- END OF SECTION -

SECTION 06200 - FINISH CARPENTRY

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following:

1. Interior standing and running trim.

2. Installation of all miscellaneous finish carpentry.

B. Related Sections: The following Sections contain requirements that relate to this Section:

1. Division 6 Section "Miscellaneous Carpentry" for furring, blocking, and other carpentry work.

2. Division 7 Section "Joint Sealants" for sealants.

3. Division 9 Section "Painting" for back priming and finishing of finish carpentry.

1.3 SUBMITTALS

A. **General**: Submit the following in accordance with Conditions of Contract and Division 1 Specification Sections.

B. Product data for each type of factory-fabricated product and process specified, including details of construction relative to materials, dimensions of individual components, profiles, textures, and colors.

C. Samples for verification purposes of the following:

1. Lumber and panel products for non-factory-applied finish, 50 square inches (300 sq cm) for lumber and 8-1/2 x 11 inches (215 x 280 mm) for panels for each species and cut, finished on one side and one edge, with one-half of exposed surface finished.

1.4 QUALITY ASSURANCE

A. **Installer Qualifications:** Arrange for installation of finish carpentry by a firm that can demonstrate successful experience in installing finish carpentry items similar in type and quality to those required for this Project.

1.5 DELIVERY, STORAGE, AND HANDLING

A. **Delivery and Storage**: Keep materials under cover and dry. Protect against exposure to weather and contact with damp or wet surfaces. Stack lumber as well as plywood and other panels. Provide for air circulation within and around stacks and under temporary

coverings including polyethylene and similar materials.

B. Do not deliver interior finish carpentry until environmental conditions meet requirements specified for installation areas. If finish carpentry must be stored in other than installation areas, store only in areas where environmental conditions meet requirements specified for installation areas.

1.6 PROJECT CONDITIONS

A. **Environmental Conditions**: Obtain and comply with finish carpentry manufacturer's and installer's coordinated advice for optimum temperature and humidity conditions for finish carpentry during its storage and installation.

PART 2 - PRODUCTS

2.1 MATERIALS, GENERAL

A. **Lumber Standards:** Comply with PS 20 "American Softwood Lumber Standard" for lumber and with applicable grading rules of inspection agencies certified by American Lumber Standards Committee Board of Review.

B. **Plywood Standards:** Comply with PS 1 "U.S. Product Standard for Construction and Industrial Plywood" for plywood and, for products not manufactured under PS 1, with APA PRP-108.

C. **Inspection Agencies:** Inspection agencies and the abbreviations used to reference them with lumber grades and species include the following:

1. WWPA - Western Wood Products Association.

D. **Grade Stamps:** Provide lumber with each piece factory-marked with grade stamp of inspection agency evidencing compliance with grading rule requirements and identifying grading agency, grade, species, moisture content at time of surfacing, and mill.

E. **Formaldehyde Emission Levels:** Comply with formaldehyde emission requirements of each voluntary standard referenced below:

1. Hardwood Plywood: HPMA FE.

2.2 INTERIOR STANDING AND RUNNING TRIM

A. **Trim:** For trim in form of boards and worked products, provide lumber complying with the following requirements.

1. Species and Appearance: Clear dry poplar free from defects and selected for compatible grain and color.

2. Texture: Surfaced (smooth).

2.3 MISCELLANEOUS MATERIALS

A. Fasteners for Interior Finish Carpentry: Nails, screws, and other anchoring devices of

type, size, material, and finish required for application indicated to provide secure attachment, concealed where possible.

1 Countersink nails, fill surface flush, and sand where face nailing is unavoidable.

2 Where finish carpentry materials are exposed in areas of high humidity, provide fasteners and anchorages with hot-dip galvanized coating complying with ASTM A 153.

B. **Adhesives:** Comply with manufacturer's recommendations for adhesives.

C **Flashing:** Comply with requirements of Division 7 Section "Flashing and Sheet Metal" for flashing materials installed in finish carpentry.

D **Sealants:** Comply with requirements of Division 7 Section "Joint Sealants" for materials required for sealing siding work.

2.4 FABRICATION

A. Wood Moisture Content: Comply with requirements of specified inspection agencies and manufacturer's recommendations for moisture content of finish carpentry in relation to relative humidity conditions existing during time of fabrication and in installation areas. Provide finish carpentry with moisture content that is compatible with Project requirements.

B. Fabricate finish carpentry to dimensions, profiles and details indicated. Ease edges to radius indicated for the following:

1. Lumber less than 1 inch (25 mm) in nominal thickness: 1/16 inch (1.5 mm).

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates for compliance with requirements for installation tolerances and other conditions affecting installation and performance of finish carpentry. Do not proceed with installation until unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Clean substrates of projections and substances detrimental to application.

B. Condition finish carpentry to average prevailing humidity conditions in installation areas before installation for a minimum of 24 hours unless longer conditioning recommended by manufacturer.

C. Backprime lumber for painted finish exposed on the exterior. Comply with requirements for surface preparation and application in Section "Painting."

3.3 INSTALLATION, GENERAL

A. Do not use finish carpentry materials that are unsound, warped, bowed, twisted,

improperly treated or finished, not adequately seasoned, or too small to fabricate with proper jointing arrangements.

B. Install finish carpentry plumb, level, true, and aligned with adjacent materials. Use concealed shims where required for alignment.

1. Scribe and cut finish carpentry to fit adjoining work. Refinish and seal cuts as recommended by manufacturer.

2. Install to tolerance of 1/8 inch (3 mm) in 96 inches (2400 mm) for plumb and level. Install adjoining finish carpentry with 1/16 inch (1.5 mm) maximum offset for flush installation and 1/8 inch (3 mm) maximum offset for reveal installation.

3. Coordinate finish carpentry with materials and systems that may be in or adjacent to standing and running trim and rails. Provide cutouts for mechanical and electrical items that penetrate exposed surfaces of trim and rails.

C. Finish in accordance with specified requirements.

D. Refer to Division 9 Sections for final finishing of finish carpentry.

3.4 STANDING AND RUNNING TRIM

A. Install with minimum number of joints practical, using full-length pieces from maximum lengths of lumber available. Stagger joints in adjacent and related standing and running trim and rails. Cope at returns and miter at corners to produce tight-fitting joints with full-surface contact throughout length of joint. Use scarf joints for end-to-end joints. Plane back of casings to provide uniform thickness across joints if required.

1. Match color and grain pattern across joints.

2. Install trim after drywall joint finishing operations are completed.

3. Drill pilot holes in hardwood prior to nailing or fastening to prevent splitting. Fasten to prevent movement or warping. Countersink nail heads on exposed carpentry work and fill holes.

3.5 ADJUSTING

A. Repair damaged or defective finish carpentry where possible to eliminate functional or visual defects. Where not possible to repair, replace finish carpentry. Adjust joinery for uniform appearance.

3.6 CLEANING

A. Clean finish carpentry on exposed and semiexposed surfaces. Touch up factory-applied finishes to restore damaged or soiled areas.

3.7 PROTECTION

A. Provide final protection and maintain conditions that ensure finish carpentry is without damage or deterioration at time of Substantial Completion.

-END OF SECTION-

SECTION 07160 - BITUMINOUS DAMPPROOFING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following:

1. Cold-applied, asphalt emulsion dampproofing.

1.3 SUBMITTALS

A. **General:** Submit each item in this Article according to the Conditions of the Contract and Division 1 Specification Sections.

B. Product data for each type of product specified, including data substantiating that materials comply with requirements for each dampproofing material specified. Include recommended method of application, recommended primer, number of coats, coverage or thickness, and recommended protection course.

1. Certification by dampproofing manufacturer that products supplied comply with local regulations controlling use of volatile organic compounds (VOCs).

1.4 QUALITY ASSURANCE

A. **Installer Qualifications:** Engage an experienced Installer who has completed bituminous dampproofing similar in material, design, and extent to that indicated for this Project and with a record of successful in-service performance.

B. **Single-Source Responsibility**: Obtain primary dampproofing materials and primers from one source and by a single manufacturer. Provide secondary materials only as recommended by manufacturer of primary materials.

1.5 PROJECT CONDITIONS

A. Substrate: Proceed with dampproofing only after substrate construction and penetrating work have been completed.

B. Weather Limitations: Proceed with dampproofing only when existing and forecasted weather conditions will permit work to be performed according to manufacturer's recommendations and warranty requirements.

C. Ventilation: Provide adequate ventilation during application of dampproofing in enclosed spaces. Maintain ventilation until dampproofing has thoroughly cured.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. **Manufacturers:** Subject to compliance with requirements, provide products by one of the following:

1. Cold-Applied, Asphalt Emulsion Dampproofing:

a. ChemRex, Inc.; Sonneborn Building Products Div.
b. Euclid Chemical Co.
c. Karnak Chemical Corporation.
d. Koppers Industries, Inc.
e. Meadows: W.R. Meadows, Inc.

2.2 BITUMINOUS DAMPPROOFING

A. **General:** Provide products recommended by manufacturer for designated application.

1. Odor Elimination: For interior and concealed-in-wall uses, provide type of bituminous dampproofing material warranted by manufacturer to be substantially odor free after drying for 24 hours under normal conditions.

B. **Cold-Applied, Asphalt Emulsion Dampproofing:** Asphalt-based emulsions recommended by the manufacturer for dampproofing use when applied according to the manufacturer's instructions.

1. Trowel Grade: Emulsified asphalt mastic, prepared with mineral- colloid emulsifying agents suitable for application in a relatively thick film, complying with ASTM D 1187, Type I.

2. Semimastic Grade: Emulsified asphalt semimastic, prepared with mineral-colloid emulsifying agents and containing fibers other than asbestos, complying with ASTM D 1227, Type III or IV.

3. Spray Grade: Emulsified asphalt, prepared with mineral-colloid emulsifying agents without fibrous reinforcement, complying with ASTM D 1227, Type III.

2.3 MISCELLANEOUS MATERIALS

A. **Primer:** Asphalt primer complying with ASTM D 41, for asphalt-based dampproofing.

B. **Protection Course, Board Type:** Premolded, 1/8-inch- (3-mm-) thick, multi-ply, semirigid board, consisting of a mineral-stabilized asphalt core sandwiched between layers of asphalt-saturated felt, and faced on one side with polyethylene film.

1. **Products:** Subject to compliance with requirements, provide one of the following:

a. Protection Course II; ChemRex, Inc.; Sonneborn Building Products Div.
b. Bituthene Asphaltic Hardboard; Grace: W.R. Grace & Co.
c. PC-2 Protection Course; Meadows: W.R. Meadows, Inc.

C.

Protection Course, Roll Roofing Type: Smooth-surfaced roll roofing, complying with ASTM D 224, Type II.

PART 3 - EXECUTION

3.1 PREPARATION

A. Clean substrate of projections and substances detrimental to work; comply with recommendations of prime materials manufacturer.

B. Install cant strips and similar accessories as shown and as recommended by prime materials manufacturer even though not shown.

C. Fill voids, seal joints, and apply bond breakers, if any, as recommended by prime materials manufacturer, with particular attention at construction joints.

D. Install separate flashings and corner protection stripping, as recommended by prime materials manufacturer, where indicated to precede application of dampproofing. Comply with details shown and with manufacturer's recommendations. Pay particular attention to requirements at building expansion joints, if any.

E. Prime substrate as recommended by prime materials manufacturer.

F. Protection of Other Work: Do not allow liquid and mastic compounds to enter and clog drains and conductors. Prevent spillage and migration onto other surfaces of work by masking or otherwise protecting adjoining work.

3.2 INSTALLATION, GENERAL

A. Comply with manufacturer's recommendations except where more stringent requirements are indicated and where Project conditions require extra precautions to ensure satisfactory performance of work.

B. **Application:** Apply dampproofing to the following surfaces.

1. Exterior, below-grade surfaces of exterior concrete or masonry walls in contact with earth or other backfill and where space is enclosed on opposite side.

2. Back side of concrete or masonry retaining walls to prevent percolating of water through the wall or facing.

3. Where indicated on the Drawings.

C. **Hot-Applied Asphalt Dampproofing:** Apply on exterior surfaces only.

D. **Cold-Applied Asphalt Dampproofing:** For exterior surfaces, provide either emulsified or cut-back, asphalt dampproofing materials, at Contractor's option. For interior surfaces, provide only emulsified asphalt materials.

E. **Reinforcement:** At changes in plane or where otherwise shown as "reinforced," install lapped course of glass fabric in first coat of dampproofing compound before it thickens.

F. **Bituminous Cant Strips**: Install 2-by-2-inch (50-by-50-mm) cant strip of bituminous grout at base of vertical dampproofing where it meets horizontal surface.

G. Apply vertical dampproofing down walls from finished-grade line to top of footing, extend over top of footing, and down a minimum of 6 inches (150 mm) over outside face of footing. Extend 12 inches (300 mm) onto intersecting walls and footings, but do not extend onto surfaces exposed to view when the Project is completed.

3.3 COLD-APPLIED, ASPHALT EMULSION DAMPPROOFING

A. **Spray Grade:** Brush or spray apply a coat of asphalt emulsion dampproofing at a rate of 1.5 to 2.5 gal./100 sq. ft. (0.6 to 1 L/sq. m), depending on substrate texture, to produce a uniform, dry-film thickness of not less than 15 mils (0.4 mm). Apply in 2 coats, if necessary, to obtain required thickness, allowing time for complete drying between coats.

B. **Semimastic Grade:** Brush or spray apply a coat of asphalt emulsion dampproofing at a rate of 5 gal./100 sq. ft. (2 L/sq. m), to produce a uniform, dry-film thickness of not less than 30 mils (0.8 mm).

C. **Trowel Grade:** Trowel apply a coat of mastic asphalt emulsion dampproofing onto substrate at a minimum rate of 7 gal./100 sq. ft. (2.8 L/sq. m), to produce an average, dry-film thickness of 60 mils (1.5 mm) but not less than 30 mils (0.8 mm) at any point.

3.4 PROTECTION AND CLEANING

A. Protect exterior, below-grade dampproofing membrane from damage until backfill is completed. Remove overspray and spilled materials from surfaces not intended to receive dampproofing.

3.5 INSTALLATION OF PROTECTION COURSE

A. General: Install protection course of type indicated over completed-and-cured dampproofing treatment. Comply with dampproofing materials manufacturer's recommendations for method of support or attaching of protection materials. Support with spot application of trowel-grade mastic where not otherwise indicated.

- END OF SECTION -

SECTION 07210 - BUILDING INSULATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following:

1. Insulation under slabs-on-grade where shown on the plans.

2. Building insulation in batt form.

3. Sound attenuation batt.

1.3 DEFINITIONS

A. Thermal Resistivity: Where the thermal resistivity of insulation products are designated by "r-values," ("rSI-values,") they represent the reciprocal of thermal conductivity (k-values). Thermal conductivity is the rate of heat flow through a homogenous material exactly 1 inch (25.4 mm) thick. Thermal resistivities are expressed by the temperature difference in degrees F (Kelvins) between the two exposed faces required to cause one BTU (one Watt) to flow through one square foot (one sq. m) per hour at mean temperatures indicated.

1.4 SUBMITTALS

A. **General:** Submit the following in accordance with Conditions of Contract and Division 1 Specification Sections.

B. Product data for each type of insulation product specified.

C. Product test reports from and based on tests performed by qualified independent testing laboratory evidencing compliance of insulation products with requirements including r-values (aged values for plastic foam insulations), fire performance characteristics, perm ratings, water absorption ratings, and other properties, based on comprehensive testing of current products.

1.5 QUALITY ASSURANCE

A. **Fire Performance Characteristics:** Provide insulation materials identical to those whose indicated fire performance characteristics have been determined per the ASTM test method indicated below, by UL or other testing and inspecting organizations acceptable to authorities having jurisdiction. Identify products with appropriate markings of applicable testing and inspecting organization.

1. Surface Burning Characteristic: ASTM E 84.

2. Fire Resistance Ratings: ASTM E 119.

3. Combustion Characteristics: ASTM E 136.

B. **Single-Source Responsibility for Insulation Products:** Obtain each type of building insulation from a single source with resources to provide products of consistent quality in appearance and physical properties without delaying progress of the Work.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Protect insulation materials from physical damage and from deterioration by moisture, soiling, and other sources. Store inside and in a dry location. Comply with manufacturer's recommendations for handling, storage, and protection during installation.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. **Manufacturers:** Subject to compliance with requirements, provide insulation products of one of the following:

1. Manufacturers of Glass or Slag Fiber Insulation:

a. CertainTeed Corp.

b. Manville: Building Insulations Div., Manville Sales Corp.

c. Owens/Corning Fiberglas Corp.

2. Manufacturers of Semi-Refractory Fiber Insulation:

a. USG: Thermafiber Div., USG Interiors, Inc.

2.2 INSULATING MATERIALS

A. **General:** Provide insulating materials that comply with requirements and with referenced standards.

1. Preformed Units: Sizes to fit applications indicated, selected from manufacturer's standard thicknesses, widths, and lengths.

B. **Un-Faced Mineral Fiber Blanket/Batt Insulation:** Thermal insulation produced by combining mineral fibers of type described below with thermosetting resins to comply with ASTM C 665 for Type III, Class A.

1. Mineral Fiber Type: Fibers manufactured from glass or slag.

2. Surface Burning Characteristics: Maximum flame spread and smoke developed values of 25 and 50, respectively.

2.3 SAFING INSULATION

A. U.S.G. Thermafier (4" thick), ASTM E 119. Or approved equal.

2.4 AUXILIARY INSULATING MATERIALS

A. **Adhesive for Bonding Insulation:** Product with demonstrated capability to bond insulation or mechanical anchors securely to substrates indicated without damaging or corroding either insulation, anchors, or substrates.

B. **Waffle Board:** Premolded, semi-rigid composition, supplied in widths and lengths to provide adequate air flow and ventilation between the roof sheathing and the insulation.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions with Installer present, for compliance with requirements of the Sections in which substrates and related work are specified and to determine if other conditions affecting performance of insulation are satisfactory. Do not proceed with installation of insulation until unsatisfactory conditions have been corrected.

3.2 INSTALLATION, GENERAL

A. Comply with insulation manufacturer's instructions applicable to products and application indicated. If printed instructions are not available or do not apply to project conditions, consult manufacturer's technical representative for specific recommendations before proceeding with installation of insulation.

B. Extend insulation full thickness as indicated to envelop entire area to be insulated. Cut and fit tightly around obstructions, and fill voids with insulation. Remove projections that interfere with placement.

C. Apply a single layer of insulation of required thickness, unless otherwise shown or required to make up total thickness.

3.3 INSTALLATION OF PERIMETER AND UNDER-SLAB INSULATION

A. On vertical surfaces, set units in adhesive applied in accordance with manufacturer's instructions. Use type of adhesive recommended by manufacturer of insulation.

3.4 INSTALLATION OF GENERAL BUILDING INSULATION

A. Apply insulation units to substrate by method indicated, complying with manufacturer's recommendations. If no specific method is indicated, bond units to substrate with adhesive or use mechanical anchorage to provide permanent placement and support of units.

B. Seal joints between closed-cell (nonbreathing) insulation units by applying adhesive, mastic, or sealant to edges of each unit to form a tight seal as units are shoved into place. Fill voids in completed installation with adhesive, mastic, or sealant as recommended by insulation manufacturer.

3.5 INSTALLATION OF SAFING INSULATION

A. Stuff safing insulation to fill miscellaneous voids and cavity spaces. Compact to approximately 40 percent of normal maximum volume.

3.6 PROTECTION

A. General: Protect installed insulation and vapor retarders from damage due to harmful weather exposures, physical abuse, and other causes. Provide temporary coverings or enclosures where insulation will be subject to abuse and cannot be concealed and protected by permanent construction immediately after installation.

- END OF SECTION -

SECTION 07320 - ROOF TILES

PART 1 -- GENERAL

1.1 THE REQUIREMENT

A. Work includes, but is not necessarily limited to:

1. Barrel (Spanish) Clay roof tile system.
2. Mortar set ridge and random tiles.
3. Booster tiles at starter course, hip, and ridge.
4. All attachments and accessories as required for a complete installation.
5. Underlayment and flashing as required.
6. Pre-finished metal bird stop at eave

1.2 QUALITY ASSURANCE

A. **Manufacturer:** Roofing tiles to be installed per manufacturer's installation procedures.

B. Installer: Work to be performed only by workers with a minimum of 5 years' experience and specially trained in the techniques of laying roof tile, and who are completely familiar with the published recommendations of the manufacturer of the roofing tile material being used.

C. Pre-installation conference to be held prior to the start of work per Section 01200.

1.3 SUBMITTALS

A. **Product Data:** Submit material specifications, manufacturer's installation, and maintenance instructions under provisions of Section 01300.

B. The CONTRACTOR shall submit samples under provisions of Section 01300 – Contractor Submittals and shall include:

1. Three sample-roofing tiles to ARCHITECT for approval of color range representing the lightest and darkest in the range; all roofing tiles subsequently installed shall be within this color range.

C. Shop drawing under provisions of Section 01300.

1. Ridge, valley, and eave details
2. Attachment
3. details

1.4 PRODUCT HANDLING

A. Protection

1. Roofing tile to be stored at the job site in a safe, dry place with all labels intact and legible at time of installation.

2. Use all means to protect roofing tile before, during, and after installation.

B. Replacement

1. In the event of damage, including water intrusion, immediately make all repairs and replacements necessary to the approval of the ARCHITECT and at no additional cost to the OWNER.

1.5 WARRANTY

A. Warranty provisions shall be in accordance with Section 01700 and shall include:

1. Manufacturer Warranty on Products: 50 years.

B. **Installation Warranty:** Protection against all damages caused by incorrect installation. Provide a written 5-year well-crafted installation warranty.

PART 2 -- PRODUCTS

2.1 MANUFACTURERS

A. The design of the roof tiles are based on the products of MCA as a standard of quality. Substitutions shall be considered under provisions of Section 01030.

2.2 ROOF MATERIAL

A. **Manufacturer:** MCA, or approved equal prior to bidding

B. **Type**: Corona Tapered Mission

C. **Color:** Old Mission Blend, #B301

D. **Approvals:** ICBO Evaluation Report #4202

E. Mortar Set Ridge and Eaves

F. Mortar Set 20% random field tiles

G. Booster tile (2 – 3 random) at starter course, hip and ridge condition.

H. Mortar type "O"

2.3 UNDERLAYMENT

A. Two layers of 30# asphaltic impregnated building paper. 1 additional underlayment layer shall be used at ridge.

2.4 NAILS AND FASTENERS

A. All nails, fastener types, and number of fasteners are to be installed per UBC Section 1507.7 and Tables 15-D-1 and Tables 15-D-2 and manufacturer's specifications. All nails and fasteners are to be stainless steel.

2.5 OTHER MATERIALS

A. All other materials, not specifically described, but required for a complete and proper installation of tile roofing, shall be as selected by the Contractor subject to the approval of the ARCHITECT.

PART 3 -- EXECUTION

3.1 SURFACE CONDITIONS

A. Inspection

1. Prior to all work of this section, carefully inspect the installed work of all other trades and verify that all such work is complete to the point where this installation may properly commence.

2. Verify that tile roofing may be installed in complete accordance with all pertinent codes and regulations, the original design, and the manufacturer's current recommendations.

B. Discrepancies

1. In the event of discrepancy, immediately notify the ARCHITECT.

2. Do not proceed with installation in areas of discrepancy until all such discrepancies have been fully resolved.

3.2 COORDINATION

A. Coordinate tile installation to minimize roof deck to weather exposure.

3.3 INSTALLATION

A. **General**: Install all components of the tile roofing in strict accordance with the current recommendations of the manufacturer.

B. Underlayment

1. Install underlayment under all tile roofing, using roofing nails of adequate length and design to hold the membrane in place.

2. Install all underlayment in full accordance with UBC Section 1507.

C. Tiles

1. Provide headlap at all tile per manufacturer's recommendations.

2. 2.Each tile to be fastened to roof surface with specified nail per UBC Section 1507.7 and Tables 15-D-1 and Tables 15-D-2.

3. Secure all accessory tiles in place by nailing.

4. Perform all cutting of tiles in a manner to provide neat edges and a uniformly straight line.

5. Finish tile roofs as a completely weatherproof and waterproof system requiring only normal maintenance.

6. Cut all exposed nail "shiners" at roof plywood eaves flush with underside of deck surface.

7. Install with battens if required by manufacturer.

D. **Cleaning Up:** Upon completion of this portion of the work, the CONTRACTOR shall remove from the site all tools, equipment, surplus materials of this section, tile-ends, and debris resulting from the tile roofing installation.

E. **Extra Stock:** The CONTRACTOR shall provide OWNER with extra tile, as specified, sufficient to re-roof 100 square feet of surface, in addition to any extra ridge pieces or stock paid for. Deliver tile to OWNER as directed at time of substantial completion.

- END OF SECTION -

SECTION 07600 – PRE FINISHED FASCIA, FLASHING AND SHEET METAL

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to work of this Section.

1.2 SUMMARY

A. This Section includes the following:

1. Pre-finished metal fascia, flashings, counter flashing and base flashing.

2. Pre-finished perforated metal soffit material.

3. Miscellaneous sheet metal accessories.

B. Integral masonry flashings are specified as masonry work in sections of Division 4.

C. Roofing accessories installed integral with roofing membrane are specified in roofing system sections as roofing work.

D. Roof accessory units of premanufactured, set-on type are specified in Division 7 Section "Roof Accessories."

1.3 SUBMITTALS

A. **General:** Submit the following in accordance with Conditions of Contract and Division 1 Specification Sections.

B. Product data, Flashing, Sheet Metal, and Accessories: Manufacturer's technical product data, installation instructions and general recommendations for each specified sheet material and fabricated product.

C. Samples of the following flashing, sheet metal, and accessory items:

1. 8-inch (200-mm) square samples of specified sheet materials to be exposed as finished surfaces.
2. 12-inch (300-mm) long samples of factory-fabricated products exposed as finished work. Provide complete with specified factory finish.

D. Shop drawings showing layout, profiles, methods of joining, and anchorages details, including major counterflashings, trim/fascia units, skylights and expansion joint systems. Provide layouts at 1/4 inch equals 1 foot (1:50) scale and details at 3 inch equals 1 foot (1:4) scale.

1.4 PROJECT CONDITIONS

A. Coordinate work of this section with interfacing and adjoining work for proper sequencing of each installation. Ensure best possible weather resistance and durability of work and protection of materials and finishes.

PART 2 - PRODUCTS

2.1 SHEET METAL FLASHING AND TRIM MATERIALS

A. Sheet Aluminum: ASTM B 209 (ASTM B 209M), alloy 3003, temper H14, 0.032-inch (0.8-mm) thick except as otherwise indicated.

B. Finish:

1. Metal Fascia, Soffits, Flashing Trim Accessories and exposed metal work: Manufacturers standard two-coat, thermo-cured, full strength, Kynar 500 Fluorocarbon Coating with 30 percent reflecting gloss in accordance with ASTM D 523. Color as selected by Architect, from standard colors.

2. All other non-exposed metal work: Aluminum, ASTM B 209, alloy 3003, temper H14, AA-C22A41 clear anodized finish; 0.032- inch thick, except as otherwise indicated.

C. Miscellaneous Materials and Accessories:

1. **Fasteners:** Same metal as flashing/sheet metal or other non- corrosive metal as recommended by sheet manufacturer. Match finish of exposed heads with material being fastened.

2. **Bituminous Coating:** SSPC - Paint 12, solvent-type bituminous mastic, nominally free of sulfur, compounded for 15-mil (0.4 mm) dry film thickness per coat.

3. **Mastic Sealant:** Polyisobutylene; nonhardening, nonskinning, non- drying, nonmigrating sealant.

4. **Elastomeric Sealant:** Generic type recommended by manufacturer of metal and fabricator of components being sealed and complying with requirements for joint sealants as specified in Division 7 Section "Joint Sealers."

5. **Epoxy Seam Sealer:** 2-part noncorrosive metal seam cementing compound, recommended by metal manufacturer for exterior/interior nonmoving joints including riveted joints.

6. **Adhesives:** Type recommended by flashing sheet manufacturer for waterproof/weather-resistant seaming and adhesive application of flashing sheet.

D. **Metal Accessories:** Provide sheet metal clips, straps, anchoring devices, and similar accessory units as required for installation of work, matching or compatible with material being installed, noncorrosive, size and gage required for performance.

E. **Elastic Flashing Filler:** Closed-cell polyethylene or other soft closed-cell material recommended by elastic flashing manufacturer as filler under flashing loops to ensure movement with minimum stress on flashing sheet.

2.2 FABRICATED UNITS

A. **General Metal Fabrication:** Shop-fabricate work to greatest extent possible. Comply with details shown and with applicable requirements of SMACNA "Architectural Sheet

Metal Manual" and other recognized industry practices. Fabricate for waterproof and weather-resistant performance, with expansion provisions for running work, sufficient to permanently prevent leakage, damage, or deterioration of the work. Form work to fit substrates. Comply with material manufacturer instructions and recommendations for forming material. Form exposed sheet metal work without excessive oil-canning, buckling, and tool marks, true to line and levels indicated, with exposed edges folded back to form hems.

B. **Seams:** Fabricate nonmoving seams in sheet metal with flat-lock seams. For metal other than aluminum, tin edges to be seamed, form seams, and solder. Form aluminum seams with epoxy seam sealer; rivet joints for additional strength where required.

C. **Expansion Provisions:** Where lapped or bayonet-type expansion provisions in work cannot be used or would not be sufficiently water/weatherproof, form expansion joints of intermeshing hooked flanges, not less than 1 inch (25 mm) deep, filled with mastic sealant (concealed within joints).

D. **Sealant Joints:** Where movable, nonexpansion type joints are indicated or required for proper performance of work, form metal to provide for proper installation of elastomeric sealant, in compliance with SMACNA standards.

E. **Separations:** Provide for separation of metal from noncompatible metal or corrosive substrates by coating concealed surfaces at locations of contact, with bituminous coating or other permanent separation as recommended by manufacturer/fabricator.

PART 3 - EXECUTION

3.1 INSTALLATION REQUIREMENTS

A. **General:** Except as otherwise indicated, comply with manufacturer's installation instructions and recommendations and with SMACNA "Architectural Sheet Metal Manual." Anchor units of work securely in place by methods indicated, providing for thermal expansion of metal units; conceal fasteners where possible, and set units true to line and level as indicated. Install work with laps, joints, and seams that will be permanently watertight and weatherproof.

B. Bed flanges of work in a thick coat of bituminous roofing cement where required for waterproof performance.

C. Install reglets to receive counterflashing in manner and by methods indicated. Where shown in concrete, furnish reglets to trades of concrete work for installation as work of Division 3 sections. Where shown in masonry, furnish reglets to trades of masonry work, for installation as work of Division 4 sections.

D. Install counterflashing in reglets, either by snap-in seal arrangement or by welding in place for anchorage and filling reglet with mastic or elastomeric sealant, as indicated and depending on degree of sealant exposure.

E. Nail flanges of expansion joint units to curb nailers, at maximum spacing of 6 inches (150 mm) o.c. Fabricate seams at joints between units with minimum 3-inch (75-mm) overlap, to form a continuous, waterproof system.

3.2 CLEANING AND PROTECTION

A. Clean exposed metal surfaces, removing substances that might cause corrosion of metal or deterioration of finishes.

B. Protection: Advise Contractor of required procedures for surveillance and protection of flashings and sheet metal work during construction to ensure that work will be without damage or deterioration other than natural weathering at time of Substantial Completion.

- END OF SECTION -

SECTION 07720 - ROOF ACCESSORIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following:

1. Low Profile Gravity Roof Vents.
2. Roof Hatches

1.3 SUBMITTALS

A. General: Submit the following according to Conditions of Contract and Division 1 Specification Sections.

B. Product data for each type of product specified. Submit manufacturer's detailed technical product data, installation instructions and recommendations, including details of construction relative to materials, dimensions of individual components, profiles, and finishes.

C. Shop drawings showing fabrication and installation of each roof accessory specified including fully dimensioned plans, elevations, sections, details of components, and attachments to other units of Work. Also show layout, anchorage details, rough-in requirements, and conditions on the roof or for other accessories.

D. Samples for verification purposes in full-size units or representative section of each type of roof accessory indicated for each color, texture, shape, and sizes specified.

1.4 QUALITY ASSURANCE

A. Standards: Comply with the following:

1. SMACNA "Architectural Sheet Metal Manual" details for fabrication of units, including flanges and cap-flashing to coordinate with type of roofing indicated.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Low-Profile Gravity Ventilators:

a. Ampcor, Div. of The Solar Group.
b. Bristolite Skylights.

c. other available manufactures approved prior to bidding, under Division 01300 requirements.

2.2 MATERIALS, GENERAL

A. Structural-Quality Galvanized Steel Sheet: ASTM A 446 (ASTM A 446M) with G90 (Z275) coating complying with ASTM A 525 (ASTM A 525M), Grade C, or to suit manufacturer's standards.

2.3 LOW-PROFILE GRAVITY VENTILATORS

A. General: Provide units of sizes, style, and profile indicated, fabricated from the following materials and including the following features:

1. Material: Aluminum sheet, prime painted.
2. Insect Screens: 14-by-18 (1.5-by-1.1 mm) mesh with 0.0123-inch (0.3-mm) diameter anodized aluminum wire in removable, rewirable frames.

2.4 ROOF HATCHES

A. Manufacturer: Products listed herein, unless otherwise designated are based on the products of Bilco as a basis of specification, Other manufacturers are subject to review as per section 01600 Request for Substitutions, provided they meet the quality and intent of the specified item, material or product.

Product: Type GS, size width: 3'-0" x length: 3'-0" (non-standard size). The roof hatch shall be single leaf. The roof hatch shall be pre-assembled from the manufacturer.

B. Performance characteristics:

1. Cover shall be reinforced to support a minimum live load of 40 psf (195kg/m2) with a maximum deflection of 1/150th of the span or 20 psf wind uplift.

2. Operation of the cover shall be smooth and easy with controlled operation throughout the entire arc of opening and closing.

3. Operation of the cover shall not be affected by temperature.

4. Entire unit shall be weathertight with fully welded corner joints on cover and curb.

C. Cover: Shall be 11 gauge aluminum with a 3" (76mm) beaded flange and a polycarbonate dome framed with rigid extruded aluminum and coated for UV resistance. Cover shall have a heavy extruded EPDM rubber gasket that s bonded to the cover interior to assure a continuous seal when compressed to the top surface of the curb.

D. Curb: Shall be 12" (305mm) in height and of 11 gauge aluminum. The curb shall be formed with a 3-1/2" (89mm) flange with 7/16" (11.1mm) holes provided for securing to the roof deck. The curb shall be equipped with an integral metal capflashing of the same gauge and material as the curb, fully welded at the corners, that features the Posi-Flash® flashing system, including stamped tabs, 6" (153mm) on center, to be bent inward to hold roofing material securely in place.

E. Curb insulation: Shall be rigid, high-density fiberboard of 1" (25.4mm) thickness on outside of curb.

F. Lifting mechanisms: Manufacturer shall provide compression spring operators enclosed in telescopic tubes to provide, smooth, easy, and controlled cover operation throughout the entire arc of opening and closing. The upper tube shall be the outer tube to prevent accumulation of moisture, grit, and debris inside the lower tube assembly. The lower tube shall interlock with a flanged support shoe.

G. Hardware:

1. Heavy pintle hinges shall be provided

2. Cover shall be equipped with a spring latch with interior and exterior push handle.

2. Roof scuttle shall be equipped with interior and exterior padlock hasps.

4. The latch strike shall be a stamped component bolted to the curb assembly.

5. Cover shall automatically lock in the open position with a rigid hold open arm equipped with a 1" (25.4mm) diameter red vinyl grip handle to permit easy release for closing.

6. Compression spring tubes shall be an anti-corrosive composite material and all other hardware shall be zinc plated and chromate sealed. Springs shall have an electrocoated acrylic finish for corrosion resistance. [For installation in corrosive environments, specify Type 316 stainless hardware].

7. Cover hardware shall be bolted into heavy gauge channel reinforcing welded to the underside of the cover and concealed within the insulation space.

H. Finish: Factory finish shall be mill finish aluminum.

PART 3 - EXECUTION

3.1 INSTALLATION

A. General: Comply with manufacturer's instructions and recommendations. Coordinate with installation of roof deck and other substrates to receive accessory units, vapor barriers, roof insulation, roofing and flashing, as required, to ensure that each element of the Work performs properly and that combined elements are waterproof and weathertight. Anchor units securely to supporting structural substrates, adequate to withstand lateral and thermal stresses, as well as inward and outward loading pressures.

B. Isolation: Where metal surfaces of units are to be installed in contact with incompatible metal or corrosive substrates, including wood, apply bituminous coating on concealed metal surfaces, or provide other permanent separation.

C. Operational Units: Test operate units with operable components. Clean and lubricate joints and hardware. Adjust for proper operation.

3.2 CLEANING AND PROTECTION

A. Clean exposed metal and plastic surfaces according to manufacturer's instructions. Touch up damaged metal coatings.

- END OF SECTION -

SECTION 07901 - JOINT SEALANTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes joint sealants for the following locations:

1. **Exterior Vertical of building:** Joints and cracks around windows, aluminum entrances, door frames, columns, louvers, wall penetrations, connections, both sides and other joints necessary to seal off building from outside air and moisture. Perimeter edges of exterior insulation and finish system.

2. Exterior Horizontal Surface

   a. Sidewalk/pavement joints.

   b. Other joints as indicated.

3. Interior Vertical and Horizontal of building:

   a. Joints and cracks around wall, ceiling, and floor penetrations.

   b. Both sides of exterior and interior hollow metal door frames.

   c. Inside corners of gypsum board and concrete block walls.

   d. Other joints as indicated.

B. **Related Sections:** The following Sections contain requirements that relate to this Section:

1. Division 7 Section "Flashing and Sheet Metal" for sealing joints related to flashing and sheet metal for roofing.

2. Division 8 "Standard Steel Doors and Frames" for sealants used in door frames.

3. Division 9 Section "Gypsum Drywall" for sealing concealed perimeter joints of gypsum board partitions to reduce sound transmission.

1.3 SYSTEM PERFORMANCE REQUIREMENTS

A. Provide joint sealants for interior applications that have been produced and installed to establish and maintain airtight continuous seals that are water resistant and cause no staining or deterioration of joint substrates.

1.4 SUBMITTALS

A. General: Submit the following in accordance with Conditions of Contract and Division 1 Specification Sections.

B. Product data from manufacturers for each joint sealant product required.

1. Certification by joint sealant manufacturer that sealants plus the primers and cleaners required for sealant installation comply with local regulations controlling use of volatile organic compounds.

C. Samples for initial selection purposes in form of manufacturer's standard bead samples, consisting of strips of actual products showing full range of colors available, for each product exposed to view.

D. Samples for verification purposes of each type and color of joint sealant required. Install joint sealant samples in 1/2-inch (13-mm) wide joints formed between two 6-inch (150-mm) long strips of material matching the appearance of exposed surfaces adjacent to joint sealants.

E. Certificates from manufacturers of joint sealants attesting that their products comply with specification requirements and are suitable for the use indicated.

F. Product test reports for each type of joint sealants indicated, evidencing compliance with requirements specified.

1.5 QUALITY ASSURANCE

A. **Installer Qualifications:** Engage an experienced Installer who has completed joint sealant applications similar in material, design, and extent to that indicated for Project that have resulted in construction with a record of successful in-service performance, total of 3 years or more.

B. **Single Source Responsibility for Joint Sealant Materials:** Obtain joint sealant materials from a single manufacturer for each different product required.

C. **Preconstruction Compatibility and Adhesion Testing**: Submit to joint sealant manufacturers samples of materials that will contact or affect joint sealants for compatibility and adhesion testing as indicated below:

1. Use test methods standard with manufacturer to determine if priming and other specific joint preparation techniques are required to obtain rapid, optimum adhesion of joint sealants to joint substrates.

   a. Perform tests under normal environmental conditions that will exist during actual installation.

2. Testing will not be required when joint sealant manufacturer is able to submit joint preparation data required above that are acceptable to Architect and are based on previous testing of current sealant products for adhesion to, and compatibility with, joint substrates and other materials matching those submitted.

D. **Preconstruction Field Testing:** Prior to installation of joint sealants, field-test their adhesion to joint substrates as follows:

1. Locate test joints where indicated or, if not indicated, as directed by Architect.

2. Conduct field tests for each application indicated below:

3. Notify Architect one week in advance of the dates and times when mock-ups will be erected.

E. **Pre-Installation Conference:** Conduct conference at Project site to comply with requirements of the Division 1 Section covering this activity.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials to Project site in original unopened containers or bundles with labels indicating manufacturer, product name and designation, color, expiration period for use, pot life, curing time, and mixing instructions for multicomponent materials.

B. Store and handle materials in compliance with manufacturer's recommendations to prevent their deterioration or damage due to moisture, high or low temperatures, contaminants, or other causes.

1.7 PROJECT CONDITIONS

A. **Environmental Conditions:** Do not proceed with installation of joint sealants under the following conditions:

1. When ambient and substrate temperature conditions are outside the limits permitted by joint sealant manufacturer.

B. **Joint Width Conditions:** Do not proceed with installation of joint sealants where joint widths are less than allowed by joint sealant manufacturer for application indicated.

C. **Joint Substrate Conditions:** Do not proceed with installation of joint sealants until contaminants capable of interfering with their adhesion are removed from joint substrates.

PART 2 - PRODUCTS

2.1 MATERIALS, GENERAL

A. **Compatibility:** Provide joint sealants, joint fillers, and other related materials that are compatible with one another and with joint substrates under conditions of service and application, as demonstrated by sealant manufacturer based on testing and field experience.

B. **Colors:** Provide color of exposed joint sealants to comply with the following:

1. Provide selections made by Architect from manufacturer's full range of standard colors for products of type indicated.

2.2 ELASTOMERIC JOINT SEALANTS

A. **Elastomeric Sealant Standard:** Provide manufacturer's standard chemically curing elastomeric sealants that comply with ASTM C 920 and other requirements indicated on

each Elastomeric Joint Sealant Data Sheet at end of this Section, including those requirements referencing ASTM C 920 classifications for Type, Grade, Class, and Uses.

B. Products: Subject to compliance with requirements, provide one of the products specified in each Elastomeric Joint Sealant Data Sheet.

1. Vertical

a. Silca ZC N/S: Silca Corp.

b. Vulkem A22: Mameco, Inc.

c. N.P. II: Sonneborn.

2.3 JOINT SEALANTS

1. Traffic

a. Silca 2C S/L: Silca Corp.

b. Vulkem 245: Mameco, Inc.

c. N.R. 200: Pecora.

A. Acrylic Sealant: Manufacturer's standard one-part, nonsag, solvent-release-curing acrylic terpolymer sealant complying with AAMA 808.3 or FS TT-S-00230 or both, with capability when tested for adhesion and cohesion under maximum cyclic movement per ASTM C 719, to withstand the following percentage change in joint width existing at time of application and remain adhered to joint substrates indicated for Project without failing cohesively:

1. 7-1/2 percent movement in both extension and compression for a total of 15 percent.

2. 12-1/2 percent movement in both extension and compression for a total of 25 percent.

B. **Butyl Sealant:** Manufacturer's standard one-part, nonsag, solvent-release-curing, polymerized butyl sealant complying with ASTM C 1085 and formulated with minimum of 75 percent solids to be nonstaining, paintable, and have a tack-free time of 24 hours or less.

C. **Pigmented Narrow Joint Sealant:** Manufacturer's standard, solvent-release-curing, pigmented synthetic rubber sealant complying with AAMA 803.3 and formulated for sealing joints 3/16 inch (5 mm) or smaller in width.

2.4 JOINT SEALANT BACKING

A. **General:** Provide sealant backings of material and type that are nonstaining; are compatible with joint substrates, sealants, primers and other joint fillers; and are approved for applications indicated by sealant manufacturer based on field experience and laboratory testing.

B. **Plastic Foam Joint Fillers:** Preformed, compressible, resilient, nonstaining, nonwaxing, nonextruding strips of flexible plastic foam of material indicated below and of size, shape, and density to control sealant depth and otherwise contribute to producing optimum sealant performance:

1. Open-cell polyurethane foam.

2. Closed-cell polyethylene foam, nonabsorbent to liquid water and gas, nonoutgassing in unruptured state.

3. Any material indicated above.

C. **Bond-Breaker Tape:** Polyethylene tape or other plastic tape as recommended by sealant manufacturer for preventing sealant from adhering to rigid, inflexible joint filler materials or joint surfaces at back of joint where such adhesion would result in sealant failure. Provide self-adhesive tape where applicable.

2.5 MISCELLANEOUS MATERIALS

A. **Primer:** Material recommended by joint sealant manufacturer where required for adhesion of sealant to joint substrates indicated, as determined from preconstruction joint sealant-substrate tests and field tests.

B. **Cleaners for Nonporous Surfaces:** Chemical cleaners acceptable to manufacturers of sealants and sealant backing materials, free of oily residues or other substances capable of staining or harming in any way joint substrates and adjacent nonporous surfaces, and formulated to promote optimum adhesion of sealants with joint substrates.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine joints indicated to receive joint sealants, with Installer present, for compliance with requirements for joint configuration, installation tolerances, and other conditions affecting joint sealant performance. Do not proceed with installation of joint sealants until unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Surface Cleaning of Joints: Clean out joints immediately before installing joint sealants to comply with recommendations of joint sealant manufacturer and the following requirements:

1. Remove all foreign material from joint substrates that could interfere with adhesion of joint sealant, including dust, paints (except for permanent, protective coatings tested and approved for sealant adhesion and compatibility by sealant manufacturer), old joint sealants, oil, grease, waterproofing, water repellents, water, surface dirt, and frost.

2. Clean concrete, masonry, unglazed surfaces of ceramic tile, and similar porous joint substrate surfaces by brushing, grinding, blast cleaning, mechanical abrading, or a combination of these methods to produce a clean, sound substrate capable of developing optimum bond with joint sealants. Remove loose particles remaining from above cleaning operations by vacuuming or blowing out joints with oil-free compressed air.

3. Remove laitance and form release agents from concrete.

4. Clean metal, glass, porcelain enamel, glazed surfaces of ceramic tile, and other nonporous surfaces with chemical cleaners or other means that do not stain, harm substrates, or leave residues capable of interfering with adhesion of joint sealants.

B. **Joint Priming:** Prime joint substrates where indicated or where recommended by joint sealant manufacturer based on preconstruction joint sealant-substrate tests or prior experience. Apply primer to comply with joint sealant manufacturer's recommendations. Confine primers to areas of joint sealant bond; do not allow spillage or migration onto adjoining surfaces.

3.3 INSTALLATION OF JOINT SEALANTS

A. **General:** Comply with joint sealant manufacturer's printed installation instructions applicable to products and applications indicated, except where more stringent requirements apply.

B. **Sealant Installation Standard:** Comply with recommendations of ASTM C 1193 for use of joint sealants as applicable to materials, applications, and conditions indicated.

C. **Installation of Sealant Backings:** Install sealant backings to comply with the following requirements:

1. Install joint fillers of type indicated to provide support of sealants during application and at position required to produce the cross-sectional shapes and depths of installed sealants relative to joint widths that allow optimum sealant movement capability.

a. Do not leave gaps between ends of joint fillers.

b. Do not stretch, twist, puncture, or tear joint fillers.

c. Remove absorbent joint fillers that have become wet prior to sealant application and replace with dry material.

2. Install bond breaker tape between sealants where backer rods are not used between sealants and joint fillers or back of joints.

D. **Installation of Sealants:** Install sealants by proven techniques that result in sealants directly contacting and fully wetting joint substrates, completely filling recesses provided for each joint configuration, and providing uniform, cross-sectional shapes and depths relative to joint widths that allow optimum sealant movement capability. Install sealants at the same time sealant backings are installed.

E. **Tooling of Nonsag Sealants:** Immediately after sealant application and prior to time skinning or curing begins, tool sealants to form smooth, uniform beads of configuration indicated, to eliminate air pockets, and to ensure contact and adhesion of sealant with sides of joint. Remove excess sealants from surfaces adjacent to joint. Do not use tooling agents that discolor sealants or adjacent surfaces or are not approved by sealant manufacturer.

1. Provide concave joint configuration per Figure 5A in ASTM C 1193, unless otherwise indicated.

3.4 CLEANING

A. Clean off excess sealants or sealant smears adjacent to joints as work progresses by methods and with cleaning materials approved by manufacturers of joint sealants and of products in which joints occur.

3.5 PROTECTION

A. Protect joint sealants during and after curing period from contact with contaminating substances or from damage resulting from construction operations or other causes so that they are without deterioration or damage at time of Substantial Completion. If, despite such protection, damage or deterioration occurs, cut out and remove damaged or deteriorated joint sealants immediately so that and installations with repaired areas are indistinguishable from original work.

- END OF SECTION -

SECTION 07920 - SEALANTS AND CAULKING

PART 1 -- GENERAL

1.1 THE REQUIREMENT

A. The CONTRACTOR shall provide caulking, sealing, and appurtenant work, complete and in place, in accordance with the Contract Documents.

1.2 REFERENCE STANDARDS

A. **General:** Portions of the following standards are incorporated into this Section by references below. The standards are listed here for convenience.

B. Federal Specifications

TT-S-001543A	Sealing Compound, Silicone Rubber Base, (For Caulking, Sealing and Glazing in Buildings and Other Structures)
SS-S-200D	Sealants, Joint, Two Compound, Jet Blast Resistant, Cold Applied for Portland Cement Concrete Pavement.
TT-S-00227E	Sealing Compound, Elastomeric Type, Multi-Component, (For Caulking, Sealing and Glazing in Buildings and Other Structures)
TT-S-00230C	Sealing Compound, Elastomeric Type, Single Component, (For Caulking, Sealing, and Glazing in Buildings and Other Structures)

C. Commercial Standards

ASTM C 557	Adhesives for Fastening Gypsum Wallboard to Wood Framing
ASTM C 834	Latex Sealants
ASTM C 919	Standard Practice for Use of Sealants in Acoustical Applications
ASTM C 920	Elastomeric Joint Sealants
ASTM D 1752	Preformed Sponge Rubber and Cork Expansion Joint Fillers for Concrete Paving and Structural Construction
ASTM E 84	Standard Test Methods for Surface Burning Characteristics of Building Materials
ASTM E 814	Standard Test Methods for Fire Tests of Through Penetrations: Firestops
UL 1479	Underwriter's Laboratory Standard for Safety Fire Tests of Through Penetration Firestops.

1.3 CONTRACTOR SUBMITTALS

A. Furnish submittals in accordance with Section 01300 - Contractor Submittals.

B. **Technical Data:** A complete materials list along with the manufacturer's technical data and literature, specifications, joint width and depth tables, and installation instructions.

C. **Samples:** Samples (including color samples) of all the caulking and sealant materials and other materials proposed for use on the WORK. The samples shall be clearly marked with the manufacturer's name and product identification.

D. **Certificates:** If requested by the ENGINEER, certificates from an independent testing laboratory approved by the ENGINEER, certifying that the submitted materials meet all the requirements of the ASTM and Federal Specifications cited.

E. **Warranty:** A copy of the manufacturer's warranty covering all sealants, caulking materials, and other materials against defects in materials.

PART 2 -- PRODUCTS

2.1 SEALANTS AND CAULKING MATERIALS

A. General

1. Manufacturer's Standards: In addition to the standards listed below, the sealants and caulking products and application shall be in accordance with the manufacturer's published recommendations and specifications.

2. Wherever manufacturer's names and products are listed in this Section, "or equal" products will be considered in accordance with Section 01300 - Contractor Submittals.

B. Materials shall conform to the following requirements:

1. Significant Movement Sealants (plus or minus 25 percent movement capability)

a. For expansion wall joints; masonry and metal curtainwall joints; precast concrete joints and concrete panels; perimeter sealing (windows, doors, and panels); control joints; interior and non-traffic horizontal joints.

1) Two component, non-sag, polyurethane or polysulfide sealant conforming to Federal Specification TT-S-227E, Class A, Type II, and ASTM C 920, Type M, Class 25, Grade NS.

Products Research & Chemical Corp. "RC-2"
Progress Unlimited "Iso-Flex 2000"

2) One component, non-sag, low modulus, polyurethane or polysulfide sealant conforming to Federal Specification TT-S230C, Class A, Type II, and ASTM C 920, Type S, Class 25, Grade NS.

Products Research & Chemical Corp. "RC-1"
Tremco "Dymonic"

3) One component, non-sag, medium modulus, neutral cure, silicone sealant conforming to Federal Specification TT-S-1543A, Class A, and ASTM C 920, Type S, Class 25, Grade NS.

Products Research & Chemical Corp. "PRC-4000"
Dow Corning "795"

b. For horizontal joints exposed to fuel spillage.

1) Two component, self-leveling, fuel resistant, polyurethane or polysulfide sealant conforming to Federal Specification SS-S-200D, Type H, and ASTM C 920, Type M, Class 25, Grade P.

Products Research & Chemical Corp. "3105-S"

c. For horizontal joints not exposed to fuel spillage.

1) Two component, self-leveling, polyurethane or polysulfide sealant conforming to Federal Specification TT-S-227E, Class A, Type I, and ASTM C 920, Type M, Class 25, Grade P.

Products Research & Chemical Corp. "RC-2SL"
Bostic "Chem-Calk 550"

2) One component, self-leveling, polyurethane or polysulfide sealant conforming to Federal Specification TT-S-230C, Class A, Type I, and ASTM C 920, Type S, Class 25, Grade P.

Products Research & Chemical Corp. "6006"
Mameco "Vulkem 45"

2. Glazing Sealants

a. For non-structural applications

1) One component, non-sag, medium modulus, neutral cure, silicone sealant conforming to Federal Specification TT-S-1543A, Class A, and ASTM C 920, Type S, Class 25, Grade NS.

Products Research & Chemical Corp. "4000"
Dow Corning "795"

2) One component, non-sag, high modulus, acetoxy cure, silicone sealant conforming to Federal Specification TT-S-1543A, Class A, and ASTM C 920, Type S, Class 25, Grade NS.

3. Interior Sealant and Caulking

a. For general applications

1) One component, acrylic latex caulking conforming to ASTM C 834

Pecora Corp. "AC-20"
Bostic "Chem-Calk 600"

b. For non-exposed acoustical applications

1) One component, non-drying, non-hardening, non-shrinking, acoustical caulking conforming to ASTM C 557 and ASTM C 919.

Inmont Company "Prestite 579.64"
Tremco, "Acoustical Sealant"
United States Gypsum, "Acoustical Sealant"
W.W. Henry, "Type 313, Acoustical Sealant"

4. Acoustic Sheet Caulking: For use on all outlet boxes including intercoms, telephone or other services that require penetrations in the walls, acoustic sheet caulking shall be resilient synthetic polymer, self-adhesive, 1/8-inch thick, 6-inch x 8-inch sheet acoustic sealer. Pads shall be **Lowry's Electrical Box Pads** as manufactured by **Harry A. Lowry & Associates, Inc.,** 11176 Penrose Street, Sun Valley, CA 91352; or equal.

5. Firestop Sealant: Where piping, conduit, wire, or other materials pass through fire rated walls, floors, ceilings or roofs, provide a 3-hour fire rated sealant in accordance with ASTM E 814 and UL 1479. Fire-resistant penetration sealant shall be a medium density fire-resistant foam that retains form and stability at high temperature. Fire-resistant sealant shall be **Dow-Corning Corporation "3-6548 Silicone RTV" foam; 3M Corporation "Fire Barrier Caulk CP25N, No-sag"** or **"CP25 S/L, Self-Leveling",** as appropriate for the use intended. Equivalent products of **General Electric** and **Metalines, Inc.** will also be considered.

6. Preformed Sealants: Preformed sealant shall be polybutylene or isoprene-butylene based pressure sensitive weather resistant tape or bead sealant capable of sealing out moisture, air, and dust when installed as recommended by the manufacturer. At temperatures from minus 30 to plus 160 degrees F, the sealant shall be non-bleeding and shall have no loss of adhesion.

7. Tape Sealant: Dimensions shall be as required for application conditions. Tape sealants shall be type recommended by tape manufacturer for connecting and bonding to surfaces.

8. Joint backing (backer rod) material shall be resilient, closed-cell polyethylene foam conforming to ASTM D 1752, Type II or III, and/or bond breakers of proper size for joint widths. Joint backing shall be compatible with sealant manufacturer's product and shall not stain the sealant nor the materials to which applied.

9. Primer: Primers shall be as recommended in the manufacturer's printed instructions for caulking and sealants, and shall not stain the sealant nor the materials to which applied. Manufacturer shall be consulted for all surfaces not specifically covered in submittal application instructions. Primer shall be used in accordance with manufacturer's instructions with all primers being applied prior to the installation of any backer rod or bond breaker tape.

10. Cleaning and cleanup solvents, agents, and accessory materials shall be as recommended in the manufacturer's printed instructions for cleaning up.

2.2 COLOR OF SEALANTS

A. Color of sealants that are visible after installation shall match adjacent building finish. If in doubt of color match, obtain color approval from ENGINEER.

PART 3 -- EXECUTION

3.1 PRODUCT DELIVERY, STORAGE, AND HANDLING

A. **Delivery of Materials:** Manufactured materials shall be delivered in original, unbroken packages or containers bearing the manufacturer's label. Packages or containers shall be delivered to the Site with seals unbroken.

B. **Shelf Life:** Materials whose shelf life dates have expired shall not be used in the WORK. Such materials shall be promptly removed from the Site.

C. **Storage:** All materials shall be carefully stored in accordance with the manufacturer's instructions, in an area that is protected from deleterious elements, and in a manner that will prevent damage to the product. Materials shall be stored at temperatures between 40 and 90 degrees unless otherwise specified by the manufacturer.

3.2 INSTALLATION

A. **Manufacturer's Recommendations:** All work under this Section and all testing, where applicable, shall be performed in accordance with manufacturer's printed recommendations, specifications, and installation instructions except where more stringent requirements are indicated herein; and, except where project conditions require extra precautions or provisions to assure performance of the waterproofing system.

B. **Authorized Installers:** Caulking and sealants shall be complete systems and be installed only by installers authorized and approved by the respective manufacturers.

C. Surface Preparation

1. General: The surfaces of joints to be sealed shall be dry. Oil, grease, dirt, chalk, particles of mortar, dust, loose rust, loose mill scale, and other foreign substances shall be removed from surfaces of joints which will be in contact with the sealant. Ferrous metal surfaces shall be cleaned of all rust, mill scale, and other coatings by wire brush, grinding, or sandblasting. Oil and grease shall be removed by cleaning in accordance with sealant manufacturer's printed recommendations. Protective coatings shall be removed from all aluminum surfaces against which caulking or sealing compound is to be placed. Bituminous or resinous materials shall be removed from surfaces to receive caulking or sealants.

2. Concrete and Masonry Surfaces: Where surfaces have been treated with curing compounds, oil, or other such materials, the materials shall be removed by sandblasting or wire brushing. Laitance, efflorescence, and loose mortar shall be removed from the joint cavity.

3. Steel Surfaces: Steel surfaces to be in contact with sealant shall be sandblasted or, if sandblasting would not be practical or would damage adjacent finish WORK, the metal shall be scraped and wire brushed to remove loose mill scale. Protective coatings on steel surfaces shall be removed by sandblasting or by a solvent that leaves no residue.

4. Aluminum Surfaces: Aluminum surfaces to be in contact with sealants shall be cleaned of temporary protective coatings. When masking tape is used for a protective cover, the tape and any residual adhesive shall be removed just prior to applying the sealant. Solvents used to remove protective coating shall be as recommended by the manufacturer of the aluminum work and shall be non-staining.

5. Wood Surfaces: Wood surfaces to be in contact with sealants shall be free of splinters and sawdust or other loose particles.

D. **Joint Types and Sizes:** Joint shapes and sizes shall be as indicated or as necessary for job conditions where not indicated. Joints to be caulked or sealed include through-bolt holes, door frames, louver and ventilator frames, joints between openings where items pass through exterior walls, concrete masonry, or combination of these surfaces, and as otherwise indicated or required for watertightness, weatherproofing, or airtightness. Use sealing compound at both exterior and interior surfaces of exterior wall penetrations.

3.3 SEALANT FILLED JOINTS

A. **Manufacturer's Representative:** The CONTRACTOR shall furnish the on-site services of the sealant manufacturer's representative prior to sealant work for inspection of the joints to be sealed and for instructing the installer in the proper use of the materials.

B. **Sealant:** Sealant shall be used before expiration of shelf life. Multi-component sealants shall be mixed according to manufacturer's printed instructions. Sealant in guns shall be applied with a nozzle of proper size to fit the width of joint. Sealant shall be installed to the required depth without displacing the backing. Unless otherwise indicated or recommended by the manufacturer, the installed sealant shall be tooled so that the surface is uniformly smooth and free of wrinkles and to assure full adhesion to the sides of the joint. Sealants shall be installed free of air pockets, foreign embedded matter, ridges, and sags. Sealer shall be applied over the sealant if recommended by the sealant manufacturer.

C. **Sealant Depth:** Sealant depth in joints shall be 1/2 the width of joint, but not less than 1/8-inch deep and 1/4-inch wide nor more than 1/2-inch deep and 1-inch wide. All joints shall have a rigid filler material installed to proper depth prior to application of sealant.

D. **Masking Tape:** Masking tape shall be placed on the finish surface on one or both sides of a joint cavity to protect adjacent finish surfaces from primer or sealant smears. Masking tape shall be removed within 10 minutes after joint has been filled and tooled.

E. **Backing:** Backing shall be installed to provide the indicated sealant depth. The installation tool shall be shaped to avoid puncturing the backing.

F. **Bond-Breaker:** Bond-breaker shall be applied to fully cover the bottom of the joint without contaminating the sides where sealant adhesion is required.

G. **Primer:** Primer shall be used on concrete masonry units, wood, or other porous surfaces in accordance with instructions furnished with the sealant. Primer shall be applied to the joint surfaces to be sealed. Surfaces adjacent to joints shall not be primed.

H. **Applications:** A full bead of sealant shall be applied into the joint under sufficient pressure, with the nozzle drawn across sealant, to completely fill the void space and to ensure complete wetting of contact area to obtain uniform adhesion. During application, the tip of the nozzle shall be kept at the bottom of the joint thereby forcing the sealant to fill from the bottom to the top. Sealants shall be tooled immediately after exposure with a caulking tool or soft bristled brush moistened with solvent. The finished sealant-filled joint shall be slightly concave unless otherwise indicated.

I. **Acoustic Partition Joints:** Acoustic partition joints shall be made air and sound-tight with acoustic caulking material.

1. Partitions shall be sealed where indicated on the Drawings. Gypsum panels may have joint treatment applied in the normal manner over sealed joints, or panels may be finished with base or trim as required.

2. A 1/4-inch minimum round bead of sealant shall be applied around all cut-outs, such as at electrical boxes and air conditioning ducts, sufficient to seal the openings.

3.4 ACOUSTIC CAULKING

A. **Preparation:** Joints and surfaces to be sealed shall be clean, dry, and free of loose materials.

B. **Concealed Joints:** Concealed joints in acoustic partitions including perimeters and intersections of walls and penetrations through finish work and at conduit ends with boxes shall be sealed with acoustic caulking compound. Backs of electrical boxes shall be sealed with acoustic sheet caulking, covering all holes and knock-outs.

3.5 CLEANING

A. After application of sealant and caulking materials, adjacent materials which have been soiled shall be cleaned and left in a neat, clean, undamaged, or unstained condition. On porous surfaces, excess sealant shall be removed per sealant or caulking manufacturer's printed instructions.

- END OF SECTION -

SECTION 08111 - STANDARD STEEL DOORS AND FRAMES

PART 1 -- GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following products manufactured in accordance with SDI Recommended Standards:

1. Doors: Seamless, hollow or composite construction standard steel doors for interior and exterior locations.

2. Frames: Pressed steel frames for doors, transoms, sidelights, mullions, interior glazed panels, and other interior and exterior openings of following type:

   a. Welded unit type.

3. Assemblies: Provide standard steel door and frame assemblies as required for the following:

   a. Thermal rated (insulated).

4. Provide factory primed doors and frames to be field painted.

B. Painting primed doors and frames is specified in Division 9 Section "Painting."

C. Door hardware is specified in another Division 8 Section.

D. Building in of anchors and grouting of frames in masonry construction is specified in Division 4.

1.3 SUBMITTALS

A. General: The CONTRACTOR shall submit the following in accordance with Section 01300 – Contractor Submittals.

B. The CONTRACTOR shall submit product data for each type of door and frame specified, including details of construction, materials, dimensions, hardware preparation, core, label compliance, sound ratings, profiles, and finishes.

C. Shop drawings showing fabrication and installation of standard steel doors and frames. Include details of each frame type, elevations of door design types, conditions at openings, details of construction, location and installation requirements of door and frame hardware and reinforcements, and details of joints and connections. Show anchorage and accessory items.

1. Provide schedule of doors and frames using same reference numbers for details and openings as those on contract drawings.

2. Indicate coordinate of glazing frames and stops with glass and glazing requirements.

D. Samples for verification purposes of each type of exposed finish required, prepared on samples not less than 3 x 5 inches (75 x 125 mm) and of same thickness and material indicated for final unit of Work. Where finishes involve normal color and texture variations, include sample sets showing full range of variations expected.

1.4 QUALITY ASSURANCE

A. CONTRACTOR shall provide doors and frames complying with Steel Door Institute "Recommended Specifications Standard Steel Doors and Frames" ANSI/SDI-100 and as herein specified.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Deliver doors and frames cardboard-wrapped or crated to provide protection during transit and job storage. Provide additional protection to prevent damage to finish of factory-finished doors and frames.

B. Inspect doors and frames upon delivery for damage. Minor damages may be repaired provided refinished items are equal in all respects to new work and acceptable to Architect; otherwise, remove and replace damaged items as directed.

C. Store doors and frames at building site under cover. Place units on minimum 4 inches (100-mm) high wood blocking. Avoid use of non-vented plastic or canvas shelters which could create humidity chamber. If cardboard wrapper on door becomes wet, remove carton immediately. Provide 1/4-inch (6-mm) spaces between stacked doors to promote air circulation.

PART 2 -- PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Manufacturer: Subject to compliance with requirements, provide standard steel doors and frames by one of the following:

1. Standard Steel Doors and Frames:

a. **Amweld Building Products, Inc.**;

b. **Ceco Corp.**;

c. **Fenestra Corp.**;

d. **Mesker Door Co.**;

e. **Republic Builders Products.**;

f. **Steelcraft Manufacturing Co.**;

2.2 MATERIALS

A. Hot-Rolled Steel Sheets and Strip: Commercial quality carbon steel, pickled and oiled, complying with ASTM A 569 and ASTM A 568 (ASTM A 568M).

B. Cold-Rolled Steel Sheets: Commercial quality carbon steel, complying with ASTM A 366 (ASTM A 366M) and ASTM A 568 (ASTM A 568M).

C. Galvanized Steel Sheets: Zinc-coated carbon steel sheets of commercial quality, complying with ASTM A 526 (ASTM A 526M), or drawing quality, ASTM A 642 (ASTM A 642M), hot dipped galvanized in accordance with ASTM A 525 with A60 or G60 (ASTM A 525M with ZF180 or Z180) coating designation, mill phosphatized.

D. Supports and Anchors: Fabricate of not less than 0.05-inch (3-mm) sheet steel; galvanized where used with galvanized frames.

E. Inserts, Bolts, and Fasteners: Manufacturer's standard units. Where items are to be built into exterior walls, hot-dip galvanize in compliance with ASTM A 153, Class C or D as applicable.

F. Shop Applied Paint: Apply after fabrication.

1. Primer: Rust-inhibitive enamel or paint, either air-drying or baking, suitable as a base for specified finish paints complying with ANSI A224.1, "Test Procedure and Acceptance Criteria for Prime Painted Steel Surfaces for Steel Doors and Frames."

2.3 DOORS

A. Provide metal doors of SDI grades and models specified below or as indicated on drawings or schedules:

1. Exterior Doors: ANSI/SDI-100, Grade III, extra heavy-duty, Model 4, minimum 0.06-inch (1.5-mm) galvanized steel faces.

2.4 FRAMES

A. Provide metal frames for doors, transoms, sidelights, borrowed lights, and other openings, of types and styles as shown on drawings and schedules. Conceal fastenings, unless otherwise indicated. Fabricate frames of minimum 16-gauge cold-rolled steel.

1. Fabricate frames with mitered, coped, or welded corners.

2. Form exterior frames from 0.06-inch (1.5-mm) galvanized steel.

2.5 FABRICATION

A. Fabricate steel door and frame units to be rigid, neat in appearance and free from defects, warp or buckle. Wherever practicable, fit and assemble units in manufacturer's plant. Clearly identify work that cannot be permanently factory-assembled before shipment, to assure proper assembly at project site. Comply with ANSI/SDI-100 requirements.

1. Internal Construction: Manufacturer's standard honeycomb, polyurethane, polystyrene, unitized steel grid, vertical steel stiffeners, or rigid mineral fiber core with internal sound deadener on inside of face sheets where appropriate in accordance with SDI standards.

2. Clearances: Not more than 1/8-inch (3 mm) at jambs and heads except between non-fire-rated pairs of doors not more than 1/4-inch (6 mm). Not more than 3/4-inch (19 mm) at bottom.

B. Fabricate exposed faces of doors and panels, including stiles and rails of nonflush units, from only cold-rolled steel.

C. Tolerances: Comply with SDI 117 "Manufacturing Tolerances Standard Steel Doors and Frames."

D. Fabricate frames, concealed stiffeners, reinforcement, edge channels, louvers and moldings from either cold-rolled or hot-rolled steel.

E. Fabricate exterior doors, panels, and frames from galvanized sheet steel in accordance with SDI-112. Close top and bottom edges of exterior doors as integral part of door construction or by addition of minimum 14-gauge inverted steel channels.

F. Exposed Fasteners: Unless otherwise indicated, provide countersunk flat or oval heads for exposed screws and bolts.

G. Thermal-Rated (Insulating) Assemblies: At exterior locations and elsewhere as shown or scheduled, provide doors fabricated as thermal insulating door and frame assemblies and tested in accordance with ASTM C 236 or ASTM C 976 on fully operable door assemblies.

   1. Unless otherwise indicated, provide thermal-rated assemblies with U factor of 0.41 Btu/hr x sq. ft. x degrees F (2.3 W/sq. m x K) or better.

H. Hardware Preparation: Prepare doors and frames to receive mortised and concealed hardware in accordance with final Door Hardware Schedule and templates provided by hardware supplier. Comply with applicable requirements of ANSI A115 Series Specifications for door and frame preparation for hardware.

I. Reinforce doors and frames to receive surface-applied hardware. Drilling and tapping for surface-applied hardware may be done at project site.

J. Locate hardware as indicated on final shop drawings or, if not indicated, in accordance with "Recommended Locations for Builder's Hardware on Standard Steel Doors and Frames," published by Door and Hardware Institute.

K. Shop Painting: Clean, treat, and paint exposed surfaces of steel door and frame units, including galvanized surfaces.

   1. Clean steel surfaces of mill scale, rust, oil, grease, dirt, and other foreign materials before application of paint.

   2. Apply shop coat of prime paint of even consistency to provide a uniformly finished surface ready to receive finish paint.

L. Glazing Stops: Minimum 0.04-inch (1.0-mm) steel or .040-inch (1.0- mm) thick aluminum.

   1. Provide non-removable stops on outside of exterior doors and on secure side of interior doors for glass, louvers, and other panels in doors.

   2. Provide screw applied removable glazing beads on inside of glass, louvers, and other panels in doors.

PART 3 -- EXECUTION

3.1 INSTALLATION

A. General: Install standard steel doors, frames, and accessories in accordance with final shop drawings, manufacturer's data, and as herein specified.

B. Placing Frames: Comply with provisions of SDI-105 "Recommended Erection Instructions For Steel Frames," unless otherwise indicated.

   1. In masonry construction, locate 4 wall anchors per jamb adjacent to hinge location on hinge jamb and at corresponding heights on strike jamb. Acceptable anchors include masonry wire anchors and masonry Tee anchors.

C. Door Installation: Fit hollow metal doors accurately in frames, within clearances specified in ANSI/SDI-100.

3.2 ADJUST AND CLEAN

A. Prime Coat Touch-up: Immediately after erection, sand smooth any rusted or damaged areas of prime coat and apply touch-up of compatible air-drying primer.

B. Final Adjustments: Check and readjust operating hardware items, leaving steel doors and frames undamaged and in complete and proper operating condition.

- END OF SECTION -

SECTION 08710 - DOOR HARDWARE

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes items known commercially as finish or door hardware that are required for swing, sliding, and folding doors, except special types of unique hardware specified in the same sections as the doors and door frames on which they are installed.

B. Acceptable Manufacturers/Products: Acceptable manufacturers for various types of products are listed below. An asterisk (*) following a manufacturers name designates manufacturer whose products are indicated in Finish Hardware Schedule. Such products are listed in the schedule by specific reference to manufacturers catalog numbers. Except as otherwise indicated, products of equivalent quality, design and function by other listed manufacturers may be used, subject to approval of Architect.

C. Submit final hardware schedule organized by "hardware sets", to indicate specifically the product to be furnished for each item required on each door.

1. Furnish templates to each fabricator of doors and frames, as required for preparation to receive hardware.

D. Related Sections: The following Sections contain requirements that relate to this Section:

1. Division 8 Section "Standard Steel Doors and Frames" for silencers integral with hollow metal frames.

1.3 SUBMITTALS

A. General: Submit the following in accordance with Conditions of Contract and Division 1 Specification sections.

B. Product data including manufacturers' technical product data for each item of door hardware, installation instructions, maintenance of operating parts and finish, and other information necessary to show compliance with requirements.

C. Final hardware schedule coordinated with doors, frames, and related work to ensure proper size, thickness, hand, function, and finish of door hardware.

1. Final Hardware Schedule Content: Based on hardware indicated, organize schedule into "hardware sets" indicating complete designations of every item required for each door or opening. Include the following information:

a. Type, style, function, size, and finish of each hardware item.
b. Name and manufacturer of each item.
c. Fastenings and other pertinent information.
d. Location of each hardware set cross referenced to indications on Drawings both on floor plans and in door and frame schedule.
e. Explanation of all abbreviations, symbols, and codes contained in schedule.
f. Mounting locations for hardware.
g. Door and frame sizes and materials.
h. Keying information.

2. Submittal Sequence: Submit final schedule at earliest possible date particularly where acceptance of hardware schedule must precede fabrication of other work that is critical in the Project construction schedule. Include with schedule the product data, samples, shop drawings of other work affected by door hardware, and other information essential to the coordinated review of schedule.

D. Samples of each type of exposed hardware unit in finish indicated and tagged with full description for coordination with schedule. Submit samples prior to submission of final hardware schedule.

E. Templates for doors, frames, and other work specified to be factory prepared for the installation of door hardware. Check shop drawings of other work to confirm that adequate provisions are made for locating and installing door hardware to comply with indicated requirements.

1.4 QUALITY ASSURANCE

A. Single Source Responsibility: Obtain each type of hardware (latch and lock sets, hinges, closers, etc.) from a single manufacturer.

B. Supplier Qualifications: A recognized architectural door hardware supplier, with warehousing facilities in the Project's vicinity, that has a record of successful in-service performance for supplying door hardware similar in quantity, type, and quality to that indicated for this Project and that employs an experienced architectural hardware consultant (AHC) who is available to Owner, Architect, and Contractor, at reasonable times during the course of the Work, for consultation.

1. Require supplier to meet with Owner to finalize keying requirements and to obtain final instructions in writing.

C. Fire-Rated Openings: Provide door hardware for fire-rated openings that complies with NFPA Standard No. 80 and requirements of authorities having jurisdiction. Provide only items of door hardware that are listed and are identical to products tested by UL, Warnock Hersey, FM, or other testing and inspecting organization acceptable to authorities having jurisdiction for use on types and sizes of doors indicated in compliance with requirements of fire-rated door and door frame labels.

1.5 PRODUCT HANDLING

A. Tag each item or package separately with identification related to final hardware schedule, and include basic installation instructions with each item or package.

B. Packaging of door hardware is responsibility of supplier. As material is received by hardware supplier from various manufacturers, sort and repackage in containers clearly marked with appropriate hardware set number to match set numbers of approved hardware schedule. Two or more identical sets may be packed in same container.

C. Inventory door hardware jointly with representatives of hardware supplier and hardware installer until each is satisfied that count is correct.

D. Deliver individually packaged door hardware items promptly to place of installation (shop or Project site).

1.6 MAINTENANCE

A. Maintenance Tools and Instructions: Furnish a complete set of specialized tools and maintenance instructions as needed for Owner's continued adjustment, maintenance, and removal and replacement of door hardware.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

B. Products:

1. Finish: Shall be US 626, unless otherwise noted.

2. Manufacture Standard:

a.	Butts:	Bommer*, McKinney, Hager, Stanley
b.	Locksets:	Schlage*, Best, Yale
c.	Trim & Accessories:	Quality*, BBW
d.	Weatherstrip:	NG* Pemko

2.2 SCHEDULED HARDWARE

A. Requirements for design, grade, function, finish, size, and other distinctive qualities of each type of finish hardware are indicated in the "Hardware Schedule" at the end of this Section. Products are identified by using hardware designation numbers of the following:

1. Manufacturer's Product Designations: The product designation and name of one manufacturer are listed for each hardware type required for the purpose of establishing minimum requirements. Provide either the product designated or, where more than one manufacturer is specified under the Article "Manufacturers" in Part 2 for each hardware type, the comparable product of one of the other manufacturers that complies with requirements.
2. ANSI/BHMA designations used elsewhere in this Section or in schedules to describe hardware items or to define quality or function are derived from the

following standards. Provide products complying with these standards and requirements specified elsewhere in this Section.

a. Butts and Hinges: ANSI A156.1.
b. Bored and Preassembled Locks and Latches: ANSI/BHMA A156.2.
c. Template Hinge Dimensions: ANSI A156.7.
d. Materials and Finishes: ANSI A156.18.

2.3 MATERIALS AND FABRICATION

A. Base Metals: Produce hardware units of basic metal and forming method indicated, using manufacturer's standard metal alloy, composition, temper, and hardness, but in no case of lesser (commercially recognized) quality than specified for applicable hardware units by applicable ANSI/BHMA A156 series standards for each type of hardware item and with ANSI/BHMA A156.18 for finish designations indicated. Do not furnish "optional" materials or forming methods for those indicated, except as otherwise specified.

B. Fasteners: Provide hardware manufactured to conform to published templates, generally prepared for machine screw installation. Do not provide hardware that has been prepared for self-tapping sheet metal screws, except as specifically indicated.

C. Furnish screws for installation with each hardware item. Provide Phillips flat-head screws except as otherwise indicated. Finish exposed (exposed under any condition) screws to match hardware finish or, if exposed in surfaces of other work, to match finish of this other work as closely as possible including "prepared for paint" surfaces to receive painted finish.

D. Provide concealed fasteners for hardware units that are exposed when door is closed except to the extent no standard units of type specified are available with concealed fasteners. Do not use thru-bolts for installation where bolt head or nut on opposite face is exposed in other work unless their use is the only means of reinforcing the work adequately to fasten the hardware securely. Where thru-bolts are used as a means of reinforcing the work, provide sleeves for each thru-bolt or use sex screw fasteners.

2.4 LOCK CYLINDERS AND KEYING

A. Review the keying system with the Owner and provide the type required (master or grandmaster), either new or integrated with Owner's existing system.

B. Metals: Construct lock cylinder parts from brass or bronze, stainless steel, or nickel silver.

C. Comply with Owner's instructions for masterkeying and, except as otherwise indicated, provide individual change key for each lock that is not designated to be keyed alike with a group of related locks.

1. Permanently inscribe each key with number of lock that identifies cylinder manufacturer's key symbol, and notation, "DO NOT DUPLICATE."

D. Key Material: Provide keys of nickel silver only.

E. Key Quantity: Furnish 3 change keys for each lock, 5 master keys for each master system, and 5 grandmaster keys for each grandmaster system.

1. Deliver keys to Owner with copy of transmittal to Architect.

2.5 KEY CONTROL SYSTEM

A. Provide a key control system including envelopes, labels, tags with self-locking key clips, receipt forms, 3-way visible card index, temporary markers, permanent markers, and standard metal cabinet, all as recommended by system manufacturer, with capacity for 200 percent of the number of locks required for the Project.

1. Provide complete cross index system set up by key control manufacturer, and place keys on markers and hooks in the cabinet as determined by the final key schedule.
2. Provide hinged-panel type cabinet for wall mounting.

2.6 LOCKS, LATCHES, AND BOLTS

A. Strikes: Provide manufacturer's standard wrought box strike for each latch or lock bolt, with curved lip extended to protect frame, finished to match hardware set, unless otherwise indicated.

B. Lock Throw: Provide 5/8-inch (16-mm) minimum throw of latch on pairs of doors. Comply with UL requirements for throw of bolts and latch bolts on rated fire openings.

C. Flush Bolt Heads: Minimum of 1/2-inch- (13-mm-) diameter rods of brass, bronze, or stainless steel with minimum 12-inch- (300-mm-) long rod for doors up to 84 inches (2100 mm) in height. Provide longer rods as necessary for doors exceeding 84 inches (2100 mm) in height.

2.7 WEATHERSTRIPPING AND SEALS

A. General: Provide continuous weatherstripping on exterior doors and smoke, light, or sound seals on interior doors where indicated or scheduled. Provide noncorrosive fasteners for exterior applications and elsewhere as indicated.

2.8 THRESHOLDS

A. General: Except as otherwise indicated, provide standard metal threshold unit of type, size, and profile as shown or scheduled.

2.9 HARDWARE FINISHES

A. Match items to the manufacturer's standard color and texture finish for the latch and lock

sets.

B. Provide finishes that match those established by BHMA or, if none established, match the Architect's sample.

C. Provide quality of finish, including thickness of plating or coating (if any), composition, hardness, and other qualities complying with manufacturer's standards, but in no case less than specified by referenced standards for the applicable units of hardware.

D. The designations used in schedules and elsewhere to indicate hardware finishes are those listed in ANSI/BHMA A156.18, "Materials and Finishes," including coordination with the traditional U.S. finishes shown by certain manufacturers for their products.

1. Rust-Resistant Finish: For iron and steel base metal is required for exterior work, provide 0.2-mil- (0.005-mm-) thick copper coating on base metal before applying brass, bronze, nickel, or chromium plated finishes.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Mount hardware units at heights indicated in following applicable publications, except as specifically indicated or required to comply with governing regulations and except as otherwise directed by Architect.

1. "Recommended Locations for Builders Hardware for Standard Steel Doors and Frames" by the Door and Hardware Institute.
2. NWWDA Industry Standard I.S.1.7, "Hardware Locations for Wood Flush Doors."

B. Install each hardware item in compliance with the manufacturer's instructions and recommendations. Where cutting and fitting is required to install hardware onto or into surfaces that are later to be painted or finished in another way, coordinate removal, storage, and reinstallation or application of surface protection with finishing work specified in the Division 9 Sections. Do not install surface-mounted items until finishes have been completed on the substrates involved.

C. Set units level, plumb, and true to line and location. Adjust and reinforce the attachment substrate as necessary for proper installation and operation.

D. Drill and countersink units that are not factory prepared for anchorage fasteners. Space fasteners and anchors in accordance with industry standards.

E. Set thresholds for exterior doors in full bed of butyl-rubber or polyisobutylene mastic sealant complying with requirements specified in Division 7 Section "Joint Sealers."

F. Weatherstripping and Seals: Comply with manufacturer's instructions and recommendations to the extent installation requirements are not otherwise indicated.

3.2 ADJUSTING, CLEANING, AND DEMONSTRATING

A. Adjust and check each operating item of hardware and each door to ensure proper operation or function of every unit. Replace units that cannot be adjusted to operate freely and smoothly or as intended for the application made.

1. Where door hardware is installed more than one month prior to acceptance or occupancy of a space or area, return to the installation during the week prior to acceptance or occupancy and make final check and adjustment of all hardware items in such space or area. Clean operating items as necessary to restore proper function and finish of hardware and doors. Adjust door control devices to compensate for final operation of heating and ventilating equipment.

B. Clean adjacent surfaces soiled by hardware installation.

C. Six-Month Adjustment: Approximately six months after the date of Substantial Completion, the Installer, accompanied by representatives of the manufacturers of latchsets and locksets and of door control devices, and of other major hardware suppliers, shall return to the Project to perform the following work:

1. Examine and re-adjust each item of door hardware as necessary to restore function of doors and hardware to comply with specified requirements.
2. Consult with and instruct Owner's personnel in recommended additions to the maintenance procedures.
3. Replace hardware items that have deteriorated or failed due to faulty design, materials, or installation of hardware units.
4. Prepare a written report of current and predictable problems (of substantial nature) in the performance of the hardware.

3.3 HARDWARE SCHEDULE

A. General: Provide hardware for each door to comply with requirements of Section "Door Hardware," hardware set numbers indicated in door schedule, and in the following schedule of hardware sets.

1. Hardware Groups: The following groups are listed to indicate type and quality of hardware required. This supplier is responsible to furnish all hardware to complete each opening. See plans for hardware set indication by each door opening.

GROUP 1

3	PAIR	BUTTS	BB5001 4.5 X 4.5 NRP	26D	BOMMER
1	EACH	LOCKSET	D96PD RHO	626	SCHLAGE
2	EACH	FLUSH BOLTS	1358 12"	26D	QUALITY
2	EACH	THRESHOLD	425	NG	
2	EACH	STOP	307	26D	QUALITY
1	EACH	WEATHERSTRIP	160 X 139	NG	
2	EACH	SWEEP	200	NG	

GROUP 2

1.5 PAIR	BUTTS	BB5001 4.5 X 4.5 NRP	26D BOMMER
1 EACH	LOCKSET	D92PD RHO	26 SCHLAGE
1 EACH	THRESHOLD	425	NG
1 EACH	WEATHERSTRIP	160	NG
1 EACH	SWEEP	200	NG

END OF SECTION 08710

SECTION 09255 - GYPSUM BOARD

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following:

1. Gypsum board attached to wood or steel framing.

B. Related Sections: The following Sections contain requirements that relate to this Section:

1. Division 7 Section "Firestopping" for firestopping systems and fire-resistive-rated joint sealants.

2. Division 7 Section "Insulation" for sound attenuation batts.

1.3 DEFINITIONS

A. Gypsum Board Construction Terminology: Refer to ASTM C 11 and GA-505 for definitions of terms related to gypsum board assemblies not defined in this Section or in other referenced standards.

1.4 SUBMITTALS

A. General: Submit the following according to Conditions of the Contract and Division 1 Specification Sections.

B. Product data for each type of product specified.

C. Product certificates signed by manufacturers of gypsum board assembly components certifying that their products comply with specified requirements.

1.5 QUALITY ASSURANCE

A. Single-Source Responsibility for Panel Products: Obtain each type of gypsum board and other panel products from a single manufacturer.

B. Single-Source Responsibility for Finishing Materials: Obtain finishing materials from either the same manufacturer that supplies gypsum board and other panel products or from a manufacturer acceptable to gypsum board manufacturer.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials in original packages, containers, or bundles bearing brand name and identification of manufacturer or supplier.

B. Store materials inside under cover and keep them dry and protected against damage from weather, direct sunlight, surface contamination, corrosion, construction traffic, and other causes. Neatly stack gypsum panels flat to prevent sagging.

C. Handle gypsum board to prevent damage to edges, ends, and surfaces. Do not bend or otherwise damage metal corner beads and trim.

1.7 PROJECT CONDITIONS

A. Environmental Conditions, General: Establish and maintain environmental conditions for applying and finishing gypsum board to comply with ASTM C 840 and with gypsum board manufacturer's recommendations.

B. Room Temperatures: For nonadhesive attachment of gypsum board to framing, maintain not less than 40 deg F (4 deg C). For adhesive attachment and finishing of gypsum board, maintain not less than 50 deg F (10 deg C) for 48 hours prior to application and continuously after until dry. Do not exceed 95 deg F (35 deg C) when using temporary heat sources.

C. Ventilation: Ventilate building spaces, as required, for drying joint treatment materials. Avoid drafts during hot dry weather to prevent finishing materials from drying too rapidly.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Products listed herein, unless otherwise designated are based on the products of Georgia Pacific Company as a basis of specification, Other manufacturers may be approved, provided they meet the quality and intent of the specified item, material or product and are approved per section 01640

2.2 GYPSUM BOARD PRODUCTS

A. General: Provide gypsum board of types indicated in maximum lengths available to minimize end-to-end butt joints.

1. Thickness: Provide gypsum board 5/8 inch (16 mm) thicknesses to comply with ASTM C 840 for application system and support spacing indicated.

B. Gypsum Wallboard Materials: Georgia Pacific, G-P Gypsum Corp. "Dens Armor Plus Interior Guard"; Glass-Mat, Mold & Mildew Resistant Interior Wall Panel: ASTM C 1177, coated inorganic glass mat-faced water-resistant treated gypsum core wallboard. Conforming to the physical properties of ASTM C 630 and ASTM C 1177. Rating of 10 "No Mold Growth" as tested for 4 weeks according to ASTM D 3273.

1. Core: 1/2 inch regular, 5/8 inch Type X.

2. Long Edges: Tapered.

2.3 TRIM ACCESSORIES

A. Accessories for Interior Installation: Corner beads, edge trim, and control joints complying with ASTM C 1047 and requirements indicated below:

1. Material: Formed metal, plastic, or metal combined with paper, with metal complying with the following requirement:

    a. Sheet steel coated with zinc by hot-dip or electrolytic processes.

2. Shapes indicated below by reference to Fig. 1 designations in ASTM C 1047:

    a. Cornerbead on outside corners, unless otherwise indicated.

    b. LC-bead with both face and back flanges; face flange formed to receive joint compound. Use LC-beads for edge trim unless otherwise indicated.

2.4 JOINT TREATMENT MATERIALS

A. General: Provide joint treatment materials complying with ASTM C 475 and the recommendations of both the manufacturers of sheet products and of joint treatment materials for each application indicated.

B. Joint Tape for Gypsum Board: Paper reinforcing tape, unless otherwise indicated.

C. Setting-Type Joint Compounds for Gypsum Board: Factory-packaged, job-mixed, chemical-hardening powder products formulated for uses indicated.

1. For prefilling gypsum board joints, use formulation recommended by gypsum board manufacturer for this purpose.

D. Drying-Type Joint Compounds for Gypsum Board: Factory-packaged vinyl-based products complying with the following requirements for formulation and intended use.

1. Ready-Mixed Formulation: Factory-mixed product.

2. Taping compound formulated for embedding tape and for first coat over fasteners and face flanges of trim accessories.

3. Topping compound formulated for fill (second) and finish (third) coats.

2.5 MISCELLANEOUS MATERIALS

A. General: Provide auxiliary materials for gypsum board construction that comply with referenced standards and recommendations of gypsum board manufacturer.

B. Laminating Adhesive: Special adhesive or joint compound recommended for laminating gypsum panels.

C. Spot Grout: ASTM C 475, setting-type joint compound recommended for spot grouting hollow metal door frames.

D. Corrosion-resistant-coated steel drill screws of size and type recommended by board manufacturer for fastening to wood framing members. ASTM C 514.

2.6 TEXTURE FINISH PRODUCTS

A. Primer: Of type recommended by texture finish manufacturer.

1. Fine textured finish.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates to which gypsum board assemblies attach or abut, installed hollow metal frames, cast-in-anchors, and structural framing with Installer present for compliance with requirements for installation tolerances and other conditions affecting performance of assemblies specified in this Section. Do not proceed with installation until unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Ceiling Anchorages: Coordinate installation of ceiling with installation of overhead structural assemblies to ensure that inserts and other provisions for anchorages to building structure have been installed to receive ceiling hangers that will develop their full strength and at spacing required to support ceilings.

3.3 APPLYING AND FINISHING GYPSUM BOARD, GENERAL

A. Gypsum Board Application and Finishing Standards: Install and finish gypsum panels to comply with ASTM C 840 and GA-216.

B. Install sound attenuation blankets and insulation where indicated prior to installing gypsum panels unless blankets are readily installed after panels have been installed on one side.

C. Install ceiling board panels across framing to minimize the number of abutting end joints and avoid abutting end joints in the central area of each ceiling. Stagger abutting end joints of adjacent panels not less than one framing member.

D. Install wall/partition board panels to minimize the number of abutting end joints or avoid them entirely. Stagger abutting end joints not less than one framing member in alternate courses of board. At stairwells and other high walls, install panels horizontally with end abutting joints over studs and staggered.

E. Install gypsum panels with face side out. Do not install imperfect, damaged, or damp panels. Butt panels together for a light contact at edges and ends with not more than 1/16 inch (1.5 mm) of open space between panels. Do not force into place.

F. Locate both edge or end joints over supports, except in ceiling applications where intermediate supports or gypsum board back-blocking is provided behind end joints. Position adjoining panels so that tapered edges abut tapered edges, and field-cut edges abut field-cut edges and ends. Do not place tapered edges against cut edges or ends. Stagger vertical joints over different studs on opposite sides of partitions. Avoid joints at corners of framed openings where possible.

G. Attach gypsum panels so that the leading edge or end of each panel is attached to open (unsupported) edges of stud flanges first.

H. Attach gypsum panels to framing provided at openings and cutouts.

I. Isolate perimeter of non-load-bearing gypsum board partitions at structural abutments. Provide 1/4-to-1/2-inch- (6-to-13-mm-) wide spaces at these locations and trim edges with U-bead edge trim where edges of gypsum panels are exposed. Seal joints between edges and abutting structural surfaces with acoustical sealant.

J. Space fasteners in gypsum panels according to referenced gypsum board application and finishing standard and manufacturer's recommendations.

3.4 GYPSUM BOARD APPLICATION METHODS

A. On ceilings, apply gypsum panels prior to wall/partition board application to the greatest extent possible and at right angles to framing, unless otherwise indicated.

B. On partitions/walls, apply gypsum panels vertically (parallel to framing), unless otherwise indicated, and provide panel lengths that will minimize end joints.

C. Fasten with corrosion-resistant screws.

3.5 INSTALLING TRIM ACCESSORIES

A. General: For trim accessories with back flanges, fasten to framing with the same fasteners used to fasten gypsum board. Otherwise, fasten trim accessories according to accessory manufacturer's directions for type, length, and spacing of fasteners.

B. Install corner beads at external corners.

C. Install edge trim where edge of gypsum panels would otherwise be exposed or semi-exposed. Provide edge trim type with face flange formed to receive joint compound except where other types are indicated.

1. Install LC-bead where gypsum panels are tightly abutted to other construction and back flange can be attached to framing or supporting substrate.

2. Install L-bead where edge trims can only be installed after gypsum panels are installed.

D. Install control joints at locations indicated, and where not indicated according to ASTM C 840, and in locations approved by Architect for visual effect.

3.6 FINISHING GYPSUM BOARD ASSEMBLIES

A. General: Apply joint treatment at gypsum board joints (both directions); flanges of corner bead, edge trim, and control joints; penetrations; fastener heads, surface defects, and elsewhere as required to prepare gypsum board surfaces for decoration and levels of gypsum board finish indicated.

B. Prefill open joints, rounded or beveled edges, and damaged areas using setting-type joint compound.

C. Apply joint tape over gypsum board joints except those with trim accessories having concealed face flanges not requiring taping to prevent cracks from developing in joint treatment at flange edges.

D. Levels of Gypsum Board Finish: Provide the following levels of gypsum board finish per GA-214.

E. For level 4 gypsum board finish, embed tape in joint compound and apply three separate coats of joint compound over joints, angles, fastener heads, and accessories. Touch up and sand between coats and after last coat as needed to produce a surface free of visual defects and ready for decoration. Use one of the following joint compound combinations:

1. Fill (Second) Coat: Job-mixed, drying-type topping compound.

2. Finish (Third) Coat: Job-mixed, drying-type topping compound.

3. Embedding and First Coat: Job-mixed, drying-type, all-purpose compound.

4. Fill (Second) Coat: Job-mixed, drying-type, all-purpose compound.

5. Finish (Third) Coat: Job-mixed, drying-type, all-purpose compound.

6. Embedding and First Coat: Setting-type compound.

7. Fill (Second) Coat: Setting-type compound.

8. Finish (Third) Coat: Job-mixed, drying-type, all-purpose compound.

3.7 APPLYING TEXTURE FINISHES

A. Surface Preparation and Primer: Prepare and apply primer to gypsum panels and other surfaces receiving texture finishes according to texture finish manufacturer's instructions. Apply primer only to surfaces that are clean, dry, and smooth.

B. Texture Finish Application: Mix and apply finish to gypsum panels and other surfaces indicated to receive texture finish according to texture finish manufacturer's directions. Using powered spray equipment acceptable to texture finish manufacturer, produce a uniform texture matching approved field samples and free of starved spots or other evidence of thin application or of application patterns.

C. Prevent texture finishes from coming into contact with surfaces not indicated to receive texture finish by covering them with masking agents, polyethylene film, or other means. If despite these precautions, texture finishes contact these surfaces, immediately remove droppings and overspray as recommended by texture finish manufacturer to prevent damage.

3.8 CLEANING AND PROTECTION

A. Promptly remove any residual joint compound from adjacent surfaces.

B. Provide final protection and maintain conditions, in a manner suitable to Installer, that ensures gypsum board assemblies remain without damage or deterioration at time of Substantial Completion.

- END OF SECTION -

SECTION 09800 - PROTECTIVE COATING

PART 1 -- GENERAL

1.1 THE REQUIREMENT

A. The CONTRACTOR shall provide protective coatings, complete and in place, in accordance with the Contract Documents.

B. Definitions

1. The term "paint," "coatings," or "finishes" as used herein, shall include surface treatments, emulsions, enamels, paints, epoxy resins, and all other protective coatings, excepting galvanizing or anodizing, whether used as a pretreatment, primer, intermediate coat, or finish coat.

2. The term "DFT" means minimum dry film thickness, without any negative tolerance.

C. The following surfaces shall not be protective coated:

1. Concrete, unless required by items on the concrete coating schedule below or the Drawings.

2. Stainless steel

3. Machined surfaces

4. Grease fittings

5. Glass

6. Equipment nameplates

7. Platform gratings, stair treads, door thresholds, and other walk surfaces, unless specifically indicated to be coated.

D. The coating system schedules summarize the surfaces to be coated, the required surface preparation, and the coating systems to be applied. Coating notes on the Drawings are used to show or extend the limits of coating schedules, to show exceptions to the schedules, or to clarify or show details for application of the coating systems.

E. Where protective coatings are to be performed by a subcontractor, the subcontractor shall provide 5 references which show that the painting subcontractor has previous successful experience with the indicated or comparable coating systems. Include the name, address, and the telephone number for the OWNER of each installation for which the painting subcontractor provided the protective coating.

1.2 CONTRACTOR SUBMITTALS

A. **General:** Submittals shall be furnished in accordance with Section 01300 - Contractor Submittals, unless indicated otherwise below.

B. Submittals shall include the following information and be submitted at least 30 days prior to protective coating work:

1. Coating Materials List: Eight copies of a coating materials list showing the manufacturer and the coating number, keyed to the coating systems herein. The list shall be submitted prior to or at the time of submittal of samples.

2. Paint Manufacturer's Information: For each coating system to be used, the following data:

   a. Paint manufacturer's data sheet for each product proposed, including statements on the suitability of the material for the intended use.

   b. Technical and performance information that demonstrates compliance with the system performance and material requirements.

   c. Paint manufacturer's instructions and recommendations on surface preparation and application.

   d. Colors available for each product (where applicable).

   e. Compatibility of shop and field applied coatings (where applicable).

   f. Material Safety Data Sheet for each product used.

C. Samples

1. Samples of all paint, finishes, and other coating materials shall be submitted on 8-1/2 inch by 11-inch sheet metal. Each sheet shall be completely coated over its entire surface with one protective coating material, type, and color.

2. Two sets of color samples to match each color selected by the ENGINEER from the manufacturer's standard color sheets. If custom mixed colors are indicated, the color samples shall be made using color formulations prepared to match the color samples furnished by the ENGINEER. The color formula shall be shown on the back of each color sample.

3. One 15 pound sample of each abrasive proposed to be used for surface preparation for submerged and severe service coating systems.

1.3 SPECIAL CORRECTION OF DEFECTS REQUIREMENTS

A. **Warranty Inspection:** A warranty inspection may be conducted during the eleventh month following completion of all coating and painting work. The CONTRACTOR and a representative of the coating material manufacturer shall attend this inspection. All defective work shall be repaired in accordance with these specifications and to the satisfaction of the OWNER. The OWNER may, by written notice to the CONTRACTOR, reschedule the warranty inspection to another date within the one-year correction period, or may cancel the warranty inspection altogether. If a warranty inspection is not held, the CONTRACTOR is not relieved of its responsibilities under the Contract Documents.

PART 2 -- PRODUCTS

2.1 GENERAL

A. **Suitability:** The CONTRACTOR shall use suitable coating materials as recommended by the manufacturer. Materials shall comply with Volatile Organic Compound (VOC) limits applicable at the Site.

B. **Material Sources:** Where manufacturers and product numbers are listed, it is to show the type and quality of coatings that are required. If a named product does not comply with VOC limits in effect at the time of bid opening, that product will not be accepted, and the CONTRACTOR shall propose a substitution product of equal quality that does comply. Unless indicated otherwise, proposed substitute materials will be considered as indicated above. Coating materials shall be materials that have a record of satisfactory performance in industrial plants, manufacturing facilities, and water and wastewater treatment plants.

C. **Compatibility:** In any coating system only compatible materials from a single manufacturer shall be used in the work. Particular attention shall be directed to compatibility of primers and finish coats. If necessary, a barrier coat shall be applied between existing prime coat and subsequent field coats to ensure compatibility.

D. **Containers:** Coating materials shall be sealed in containers that plainly show the designated name, formula or specification number, batch number, color, date of manufacture, and name of manufacturer, all of which shall be plainly legible at the time of use.

E. Substitute or "Or-Equal" Products

1. To establish equality under Section 01600 - Products, Materials, Equipment and Substitutions, the CONTRACTOR shall furnish satisfactory documentation from the manufacturer of the proposed substitute or "or-equal" product that the material meets the indicated requirements and is equivalent or better in the following properties:

   a. Quality

   b. Durability

   c. Resistance to abrasion and physical damage

   d. Life expectancy

   e. Ability to recoat in future

   f. Solids content by volume

   g. Dry film thickness per coat

   h. Compatibility with other coatings

   i. Suitability for the intended service

   j. Resistance to chemical attack

k. Temperature limitations in service and during application

l. Type and quality of recommended undercoats and topcoats

m. Ease of application

n. Ease of repairing damaged areas

o. Stability of colors

2. Protective coating materials shall be standard products produced by recognized manufacturers who are regularly engaged in production of such materials for essentially identical service conditions. Where requested, the CONTRACTOR shall provide the ENGINEER with the names of not less than 10 successful applications of the proposed manufacturer's products that comply with these requirements.

3. If a proposed substitution requires changes in the WORK, the CONTRACTOR shall bear all such costs involved as part of the WORK.

2.2 INDUSTRIAL COATING SYSTEMS

A. **System 1 - Alkyd Enamel:** High quality, gloss or semi-gloss, medium long oil alkyd finish shall have a minimum solids content of 49 percent by volume. Primer shall be as recommended by manufacturer.

1. Prime coat DFT = 3 mils **Ameron 5105, Tnemec 4-55,** or equal.

2. Finish coats (two or more, DFT = 3 mils), **Ameron 5401 HSA or 5405, Tnemec 2H,** or equal.

3. Total system DFT = 6 mils.

B. System 2 - Not Used

C. **System 4 - Aliphatic Polyurethane:** Two component aliphatic acrylic polyurethane coating material shall provide superior color and gloss retention, resistance to splash from acid and alkaline chemicals, resistance to chemical fumes and severe weathering and with a minimum solids content of 58 percent by volume. Primer shall be a rust inhibitive two component epoxy coating with a minimum solids content of 68 percent by volume.

1. Prime coat DFT = 4 mils, **Ameron 385, Carboline 893, Tnemec 69**, or equal.

2. Finish coat (one or more, DFT = 3 mils), **Ameron Amershield, Carboline 134 HS, Tnemec 74,** or equal.

3. Total system DFT = 7 mils.

4. More than one finish coat shall be applied as necessary to produce a finish with uniform color and texture.

D. **System 5 - Inorganic Zinc/Polyurethane:** The inorganic zinc primer shall be a water or solvent based, self-curing, zinc silicate two-component inorganic coating which contains at least 85 percent of metallic zinc by weight in the dried film, and is recommended by the coating manufacturer as a primer for this system. The

intermediate coat shall be a high-build two component epoxy with a solids content of at least 70 percent by volume. Finish coats shall be a 2-component aliphatic acrylic or polyester polyurethane coating material that provides superior color and gloss retention, resistance to chemical fumes and severe weathering, and a minimum solids content of 58 percent by volume.

1. Prime coat DFT = 3 mils, **Ameron Dimetcote 21-5 or 21-9, Inorganic Coatings 531,** or equal.

2. Intermediate coat DFT = 4 mils, **Ameron 385, Inorganic Coatings P24,** or equal.

3. Finish coats (one or more, DFT = 3 mils), **Ameron Amershield, Inorganic Coatings 64,** or equal.

4. Total system DFT = 10 mils.

5. Intermediate coat shall be applied in excess of 4 mils DFT or in more than one coat as necessary to completely cover the inorganic zinc primer and prevent application bubbling of the polyurethane finish coat.

6. More than one finish coat shall be applied as necessary to produce a finish with uniform color and texture. If the inorganic zinc primer is used as a pre-construction or shop applied primer, all damaged and uncoated areas shall be spot abrasive blasted and coated after construction using the indicated material.

E. **System 6 - Inorganic Zinc, Water Based:** Water based, self curing, zinc silicate coating material shall be a two component inorganic coating material that contains at least 85 percent of metallic zinc by weight in the dried film.

1. Prime coat and finish coat (One, DFT = 3 mils), **Ameron Dimetcote 21-5, Inorganic Coatings 531,** or equal.

2. Total system DFT = 3 mils.

F. **System 7 - Acrylic Latex:** Single component, water based acrylic latex with a fungicide additive shall have a minimum solids content of 35 percent by volume. Prime coat shall be as recommended by manufacturer. The coating material shall be available in the ANSI safety colors.

1. Prime coat DFT = 2 mils, as recommended by manufacturer.

2. Finish coats (2 or more, DFT = 6 mils), **Ameron Amercoat 220, Carboline 3359, Tnemec 6,** or equal.

3. Total system DFT = 8 mils.

G. **System 8 - Epoxy, Equipment:** Two component, rust inhibitive polyamide cured epoxy coating material shall provide a recoatable finish that is available in a wide selection of colors. The coating material shall have a minimum solids content of 66 percent by volume and be resistant to service conditions of condensing moisture, splash and spillage of lubricating oils, and frequent washdown and cleaning.

1. Prime coat DFT = 3 mils, **Ameron 385, Tnemec 69,** or equal.

2. Prime coat, where shop applied. (DFT = 3 mils), universal primer, **Ameron 185 HS, Tnemec 50-330 or 161,** or equal.

3. Finish coats (2 or more, DFT = 6 mils), **Ameron 385, Tnemec 69,** or equal.

4. Total system DFT = 9 mils.

H. **System 9 - Inorganic Zinc/Epoxy, Equipment:** The inorganic zinc primer shall be a water or solvent based, self curing, zinc silicate, two-component inorganic coating that contains at least 85 percent of metallic zinc by weight in the dried film, and is recommended by the coating manufacturer as a primer for this system. The finish coats shall be a polyamide cured epoxy material with a minimum solids content of at least 80 percent by volume, and available in a large selection of colors.

1. Prime coat DFT = 3 mils **Ameron Dimetcote 21-5 or 21-9, Carboline Carbozinc 7 WB,** or equal.

2. Finish coats (2 or more, DFT = 9 mils) **Ameron 400, Carboline 890,** or equal.

3. Total system DFT = 12 mils.

I. **System 10 - Acrylic, Concrete:** The acrylic coating material shall be a single component, industrial grade, high molecular weight, waterborne acrylic material with a solids content of at least 35 percent by volume. The filler-sealer shall be a two component epoxy masonry sealer for wet and exterior exposure, with a solids content of at least 64 percent by volume. A 100 percent solids epoxy surfacer shall be used to fill holes and patch the concrete surface after abrasive blasting.

1. Prime coat (filler-sealer), applied in two coats to the entire surface and worked into the surface with a squeegee to achieve a smooth, void-free surface, **Tnemec 54-660, Ameron Nu-Klad 105A** followed by **Nu-Klad 114A (2 coats**) or equal.

2. Finish coats (2 or more, DFT = 6 mils), **Tnemec 6, Ameron Amercoat 220,** or equal.

J. **System 11 - Aliphatic Polyurethane, Concrete:** Two component aliphatic polyurethane coating material shall provide superior color and gloss retention, resistance to splash from acid and alkaline chemicals, resistance to chemical fumes and severe weathering, and contain a minimum solids content of 65 percent by volume. Filler-sealer compound shall be a two component epoxy material used to provide a smooth surface for the epoxy intermediate coat. The filler-sealer is applied to the entire concrete surface and worked into the concrete surface with a wide blade putty knife or squeegee. The intermediate coat shall be a high-build epoxy coating with a minimum solids content of 70 percent by volume.

1. Prime coat (Filler-sealer**), Ameron Nu-Klad 105A followed by Nu-Klad 114, Tnemec 54-660,** or equal.

2. Intermediate coat DFT = 4 mils, **Ameron Amerlock 400, Tnemec 104 HS,** or equal.

3. Finish coats (2 or more, DFT = 3 mils), **Ameron Amershield, Tnemec 74,** or equal.

K. **System 12 - Aliphatic Polyurethane, Fiber Glass:** Two-component aliphatic polyurethane coating material shall provide superior color and gloss retention, resistance to splash from acid and alkaline chemicals, and resistance to chemical fumes and

severe weathering. A primer, tie coat, or mist coat shall be used as recommended by the manufacturer.

1. Prime coat (Tie coat), **Ameron 385, Tnemec 66**, or equal.

2. Finish coats (2 or more, DFT = 3 mils), **Ameron Amershield, Tnemec 74,** or equal.

2.3 SUBMERGED AND SEVERE SERVICE COATING SYSTEMS

A. **Material Sources:** The manufacturers' products listed in this paragraph are materials which satisfy the material descriptions of this paragraph and have a documented successful record for long term submerged or severe service conditions. Proposed substitute products will be considered as indicated above.

B. **System 100 - Amine Cured Epoxy:** High build, amine cured, epoxy resin shall have a solids content of at least 80 percent by volume, and shall be suitable for long-term immersion service in potable water and municipal wastewater. For potable water service, the coating material shall be listed by the NSF International as in compliance with NSF Standard 61 - Drinking Water System Components - Health Effects.

1. Prime coat and finish coats (3 or more, DFT = 16 mils), **Ameron 395, Tnemec 139,** or equal.

2. For coating of valves and non-submerged equipment, DFT = 12 mils.

C. **System 101 - Cold-Applied Tape:** Tape coating materials and procedures shall be in accordance with ANSI/AWWA C209. Prefabricated tape shall be Type II. The system shall consist of a primer layer, inner layer tape (35 mils), and an outer layer tape (35 mils). Total system DFT = 70 mils.

D. **System 102 - Polyamide Cured Epoxy:** High build, polyamide epoxy resin shall have a solids content of at least 56 percent by volume, and shall be suitable for long-term immersion in potable water and municipal wastewater. For potable water service, the coating material shall be listed by the NSF International as in compliance with NSF Standard 61.

1. Prime coat and finish coats (3 or more, DFT = 12 mils), **Tnemec Pota-Pox N140,** or equal.

E. System 103 - Not Used

F. System 104 - Not Used

G. **System 106 - Fusion Bonded Epoxy:** The coating material shall be a 100 percent powder epoxy, certified as compliant with NSF Standard 61, applied in accordance with the ANSI/AWWA C213 - Fusion-Bonded Epoxy Coating for the Interior and Exterior of Steel Water Pipelines, except that the surface preparation shall be as listed in the coating system schedule of this Section. The coating shall be applied using the fluidized bed or electrostatic spray process.

1. Coating DFT = 16 mils, **Scotchkote 134 or 206N,** or equal.

2. For coating of valves, DFT = 12 mils.

3. Liquid Epoxy: For field repairs, the use of a liquid epoxy will be permitted, applied in not less than 3 coats to provide a DFT of 15 mils. The liquid epoxy shall be a 100 percent solids epoxy recommended by the powder epoxy manufacturer.

H. System 107 - Chemical Resistant Sheet Lining:

1. Materials: The CONTRACTOR shall use natural rubber, chlorobutyl rubber, ethylene propylene diene monomer (EPDM) rubber, chloroprene polymer (neoprene) rubber, or chlorosulfonated polyethylene (Hypalon) rubber sheet lining materials as indicated. The Shop Drawing submittal shall contain technical information that confirms the suitability of the lining material system for long-term immersion in each chemical to be stored. The service temperatures are expected to be up to 150 degrees F.

2. Neoprene sheet lining material shall be synthetic rubber formulated for steam curing at atmospheric pressure. The minimum lining thickness shall be 3/16 - inch. The lining material shall be **Polymeric Protective Linings BFG 2011 (59688),** or equal.

3. Chlorobutyl sheet lining material shall be synthetic rubber formulated for steam curing at atmospheric pressure. The minimum lining thickness shall be 3/16-inch. The lining material shall be **Polymeric BFG 1051 (60924),** or equal.

4. Natural rubber (soft) sheet lining material shall be soft natural rubber formulated for steam curing at atmospheric pressure. The minimum lining thickness shall be 3/16-inch. The lining material shall be **Polymeric BFG 2004 (83160),** or equal.

5. Natural rubber (hard) sheet lining material shall be a hard, natural rubber resistant to oxidizing agents and formulated for autoclave curing. The minimum lining thickness shall be 3/16-inch. The lining material shall be **Polymeric BFG 1006 (8631),** or equal.

6. EPDM sheet lining material shall be synthetic rubber suitable for use as a lining for 50 percent sulfuric acid solution and formulated for autoclave or steam curing under pressure. The lining material shall be **Polymeric BFG 1039 (EP156),** or equal.

7. Hypalon sheet lining material shall be synthetic rubber suitable for use as a lining for 50 percent sulfuric acid solution. The lining material shall be **Polymeric BFG 2045 (8706),** or equal.

8. Primers, adhesives, activators, accelerators and other necessary materials shall be as required by the sheet material manufacturer.

9. Metal Surface Preparation: Prior to abrasive blast cleaning the base metal shall be prepared as required by the sheet lining material manufacturer's installation instructions. If the instructions differ from these specifications, the highest degree of cleaning and surface preparation shall be provided. Abrasive blast cleaning shall be done in accordance with this Section.

10. Installation of lining materials shall be in accordance with the material manufacturer's written installation instructions. All interior surfaces shall be lined, including all piping, vents, fittings, flange faces, manhole covers, and blind flanges.

11. The lining system shall be holiday tested in accordance with this Section before and after curing.

12. The lining system shall be cured by steam using the time and temperature as required by the material manufacturer.

I. **System 108 - Epoxy, Concrete:** The coating material shall be an amino cured epoxy material suitable for long-term immersion in water and wastewater and for service where subjected to occasional splash and spillage of water and wastewater treatment chemicals. The finish coating material shall have a minimum solids content of 80 percent by volume. If used for potable water service the finish coating material shall be listed by the NSF International as in compliance with NSF Standard 61, and shall conform with state and local health regulations and policies for service in potable water. The filler-sealer shall be a 100 percent solids amine-cured epoxy material with silica and inert fillers. A 100 percent solids epoxy surfacer shall be used to fill holes and patch the concrete surface after abrasive blasting.

1. Filler-sealer: Plasite 9029 (applied by squeegee): **Tnemec 69-1211** (6-8 mils) followed by **Tnemec 63-1500; Ameron Nu-Klad 105A followed by Nu-Klad 114A (two coats)** or equal.

2. Finish coats (2 or more, DFT = 12 mils): **Plasite 9133; Tnemec 69; Ameron Amercoat 395**, or equal. On walking surfaces use a non-skid additive such as **Ameron 886** in the final coat.

J. System 109 - Not Used

K. System 110 - Not Used

L. **System 111 - Vinyl Ester:** Vinyl ester resin coating material with an inert flake pigment suitable for immersion service in 30 percent hydrochloric acid and 30 percent sulfuric acid solutions.

1. Two or more coats (DFT = 40 mils), **Plasite 4100,** or equal. Use a prime coat as recommended by the material manufacturer.

M. **System 112 - Vinyl Ester, Concrete:** Vinyl ester resin coating material with an inert flake pigment suitable for immersion service in hydrochloric acid and sulfuric acid solutions. The filler-sealer shall be a 100 percent solids amine-cured epoxy or vinyl ester material with silica and inert fillers. The filler-sealer is applied to the entire concrete surface. A 100 percent solids epoxy or vinyl ester surfacer shall be used to fill holes and patch the concrete surface after abrasive blasting.

1. Prime coat (filler-sealer), applied in two coats using a squeegee to achieve a smooth void-free surface, **Plasite 9028 MI,** or equal.

2. Finish coats (two or more, DFT = 40 mils), **Plasite 4100,** or equal.

2.4 SPECIAL COATING SYSTEMS

A. **System 200 - PVC Tape:** Prior to wrapping the pipe with PVC tape, the pipe and fittings first shall be primed using a primer recommended by the PVC tape manufacturer. After being primed, the pipe shall be wrapped with a 20-mil adhesive PVC tape, half-lapped, to a total thickness of 40 mils.

B. **System 201 - Rich Portland Cement Mortar:** Rich portland cement mortar coating shall have a minimum thickness of 1/8-inch, followed by enclosure in an 8-mil thick polyethylene sheet with all joints and edges lapped and sealed with tape.

C. **System 203 - Epoxy Surfacing:** Two-component epoxy floor surfacing shall be formulated to resist many acids, alkalies, and solvents. Material shall be resistant to liquid alum, sodium hydroxide, and 50 percent sulfuric acid. Products shall be as follows, or equal:

1. Prime coat **Nu-Klad 105;** finish coat **Nu-Klad 110** (1/4-inch thick), or equal.

D. System 204 - Water-Retardant:

1. Two coats (or single coat if manufacturer recommends in writing) of a clear, non-staining, silane-modified-siloxane masonry water-retardant material. The water-retardant system after application shall be provided with not less than a five-year warranty on the performance of the product.

2. Surfaces shall be cleaned with a chemical cleaner approved by the manufacturer and power wash. Surfaces shall be clean and dry before application of the material. Method and rate of application shall be in accordance with manufacturer's published instructions. A manufacturer's representative shall be present during applications if necessary for warranty.

3. TAMMS Barricade Series, **Rainguard "Blok-Lok";** or equal.

E. **System 205 - Polyethylene Encasement:** Application of polyethylene encasement shall be in accordance with ANSI/AWWA C105 using Method C.

F. **System 206 - Cement Mortar Coating:** A 1-1/2-inch minimum thickness mortar coating reinforced with 3/4-inch galvanized welded wire fabric shall be provided. The cement mortar shall contain no less than one part Type V cement to 3 parts sand. The cement mortar shall be cured by a curing compound meeting the requirements of "Liquid Membrane Forming Compounds for Curing Concrete," ASTM C 309, Type II, white pigmented, or by enclosure in an 8-mil thick polyethylene sheet with all edges and joints lapped by at least 6-inches.

G. System 207 - Not Used

H. **System 208 - Aluminum Metal Isolation:** Two coats of a high build polyamide epoxy paint, such as **Tnemec 66,** or equal (8 mils). Total thickness of system DFT = 8.0 mils.

PART 3 -- EXECUTION

3.1 MANUFACTURER'S SERVICES

A. The CONTRACTOR shall require the protective coating manufacturer to furnish a qualified technical representative to visit the Site for technical support as may be necessary to resolve field problems attributable or associated with the manufacturer's products.

B. For submerged and severe service coating systems, the CONTRACTOR shall require the paint manufacturer to furnish the following services:

1. The manufacturer's representative shall provide at least 6 hours of on-site instruction in the proper surface preparation, use, mixing, application, and curing of the coating systems.

2. The manufacturer's representative shall observe the start of surface preparation, mixing, and application of the coating materials for each coating system.

3.2 WORKMANSHIP

A. Skilled craftsmen and experienced supervision shall be used on all WORK.

B. Coating shall be done in a workmanlike manner so as to produce an even film of uniform thickness. Edges, corners, crevices, and joints shall receive special attention to insure thorough cleaning and an adequate thickness of coating material. The finished surfaces shall be free from runs, drops, ridges, waves, laps, brush marks, and variations in color, texture, and finish. The hiding shall be so complete that the addition of another coat would not increase the hiding. Special attention shall be given to insure that edges, corners, crevices, welds, and similar areas receive a film thickness equivalent to adjacent areas, and installations shall be protected by the use of drop cloths or other precautionary measures.

C. All damage to surfaces resulting from the WORK shall be cleaned, repaired, and refinished to original condition.

3.3 STORAGE, MIXING, AND THINNING OF MATERIALS

A. **Manufacturer's Recommendations:** Unless otherwise indicated, the coating manufacturer's printed recommendations and instructions for thinning, mixing, handling, applying, and protecting its coating materials, for preparation of surfaces for coating, and for all other procedures relative to coating shall be strictly observed.

B. All protective coating materials shall be used within the manufacturer's recommended shelf life.

C. **Storage and Mixing:** Coating materials shall be stored under the conditions recommended by the Material Safety Data Sheets, and shall be thoroughly stirred, strained, and kept at a uniform consistency during application. Coatings of different manufacturers shall not be mixed together.

3.4 PREPARATION FOR COATING

A. **General:** All surfaces to receive protective coatings shall be cleaned as indicated prior to application of coatings. The CONTRACTOR shall examine all surfaces to be coated, and shall correct all surface defects before application of any coating material. All marred or abraded spots on shop-primed and on factory-finished surfaces shall receive touch-up restoration prior to any coating application. Surfaces to be coated shall be dry and free of visible dust.

B. **Protection of Surfaces Not to be Coated:** Surfaces that are not to receive protective coatings shall be protected during surface preparation, cleaning, and coating operations.

C. All hardware, lighting fixtures, switchplates, machined surfaces, couplings, shafts, bearings, nameplates on machinery, and other surfaces not to be painted shall be removed, masked or otherwise protected. Drop cloths shall be provided to prevent coating materials from falling on or marring adjacent surfaces. The working parts of all mechanical and electrical equipment shall be protected from damage during surface preparation and coating operations. Openings in motors shall be masked to prevent entry of coating or other materials.

D. Care shall be exercised not to damage adjacent work during blast cleaning operations. Spray painting shall be conducted under carefully controlled conditions. The CONTRACTOR shall be fully responsible for and shall promptly repair any and all damage to adjacent work or adjoining property occurring from blast cleaning or coating operations.

E. **Protection of Painted Surfaces:** Cleaning and coating shall be coordinated so that dust and other contaminants from the cleaning process will not fall on wet, newly coated surfaces.

3.5 SURFACE PREPARATION STANDARDS

A. The following referenced surface preparation specifications of the Steel Structures Painting Council shall form a part of this specification:

1. Solvent Cleaning (SSPC SP1): Removal of oil, grease, soil, salts, and other soluble contaminants by cleaning with solvent, vapor, alkali, emulsion, or steam.

2. Hand Tool Cleaning (SSPC SP2): Removal of loose rust, loose mill scale, loose paint, and other loose detrimental foreign matter, by hand chipping, scraping, sanding, and wire brushing.

3. Power Tool Cleaning (SSPC SP3): Removal of loose rust, loose mill scale, loose paint, and other loose detrimental foreign matter, by power tool chipping, descaling, sanding, wire brushing, and grinding.

4. White Metal Blast Cleaning (SSPC SP5): Removal of all visible rust, oil, grease, soil, dust, mill scale, paint, oxides, corrosion products and foreign matter by blast cleaning.

5. Commercial Blast Cleaning (SSPC SP6): Removal of all visible oil, grease, soil, dust, mill scale, rust, paint, oxides, corrosion products, and other foreign matter, except that staining shall be limited to no more than 33 percent of each square inch of surface area.

6. Brush-Off Blast Cleaning (SSPC SP7): Removal of all visible oil, grease, soil, dust, loose mill scale, loose rust, and loose paint.

7. Near-White Blast Cleaning (SSPC SP10): Removal of all visible oil, grease, soil, dust, mill scale, rust, paint, oxides, corrosion products, and other foreign matter, except that staining shall be limited to no more than 5 percent of each square inch of surface area.

3.6 METAL SURFACE PREPARATION (UNGALVANIZED)

A. The minimum abrasive blasting surface preparation shall be as indicated in the coating system schedules included at the end of this Section. Where there is a conflict between these specifications and the coating manufacturer's printed recommendations for the intended service, the higher degree of cleaning shall apply.

B. Workmanship for metal surface preparation shall be in conformance with the current SSPC Standards and this Section. Blast cleaned surfaces shall match the standard samples available from the National Association of Corrosion Engineers, NACE Standard TM-01-70 - Visual Standard for Surfaces of New Steel Airblast Cleaned with

Sand Abrasive and TM-01-75 - Visual Standard for Surfaces of New Steel Centrifugally Blast Cleaned with Steel Grit.

C. All oil, grease, welding fluxes, and other surface contaminants shall be removed by solvent cleaning per SSPC SP1 - Solvent Cleaning prior to blast cleaning.

D. All sharp edges shall be rounded or chamfered and all burrs, and surface defects and weld splatter shall be ground smooth prior to blast cleaning.

E. The type and size of abrasive shall be selected to produce a surface profile that meets the coating manufacturer's recommendation for the particular coating and service conditions. Abrasives for submerged and severe service coating systems shall be clean, hard, sharp cutting crushed slag. Automated blasting systems shall not be used for surfaces that will be in submerged service. Metal shot or grit shall not be used for surfaces that will be in submerged service, even if subsequent abrasive blasting is planned to be one with hard, sharp cutting crushed slag.

F. The abrasive shall not be reused unless an automated blasting system is used for surfaces that will be in non-submerged service. For automated blasting systems, clean oil-free abrasives shall be maintained. The abrasive mix shall include at least 50 percent grit.

G. The CONTRACTOR shall comply with the applicable federal, state, and local air pollution control regulations for blast cleaning.

H. Compressed air for air blast cleaning shall be supplied at adequate pressure from well maintained compressors equipped with oil and moisture separators that remove at least 95 percent of the contaminants.

I. Surfaces shall be cleaned of all dust and residual particles of the cleaning operation by dry air blast cleaning, vacuuming, or another approved method prior to painting.

J. Enclosed areas and other areas where dust settling is a problem shall be vacuum cleaned and wiped with a tack cloth.

K. Damaged or defective coating shall be removed by the blast cleaning to meet the clean surface requirements before recoating.

L. If the required abrasive blast cleaning will damage adjacent work, the area to be cleaned is less than 100 square feet, and the coated surface will not be submerged in service, then SSPC SP2 or SSPC SP3 be used.

M. Shop applied coatings of unknown composition shall be completely removed before the indicated coatings are applied. Valves, castings, ductile or cast iron pipe, and fabricated pipe or equipment shall be examined for the presence of shop-applied temporary coatings. Temporary coatings shall be completely removed by solvent cleaning per SSPC SP1 before the abrasive blast cleaning work has been started.

N. Shop primed equipment shall be solvent cleaned in the field before finish coats are applied.

3.7 SURFACE PREPARATION FOR GALVANIZED FERROUS METAL

A. Galvanized ferrous metal shall be alkaline cleaned per SSPC SP1 to remove oil, grease, and other contaminants detrimental to adhesion of the protective coating system to be used, followed by brush off blast cleaning per SSPC SP7.

B. Pretreatment coatings of surfaces shall be in accordance with the printed recommendations of the coating manufacturer.

3.8 SURFACE PREPARATION OF FERROUS SURFACES WITH EXISTING COATINGS, EXCLUDING STEEL RESERVOIR INTERIORS

A. **General:** All grease, oil, heavy chalk, dirt, or other contaminants shall be removed by solvent or detergent cleaning prior to abrasive blast cleaning. The generic type of the existing coatings shall be determined by laboratory testing.

B. **Abrasive Blast Cleaning:** The CONTRACTOR shall provide the degree of cleaning indicated in the coating system schedule for the entire surface to be coated. If the degree of cleaning is not indicated in the schedule, deteriorated coatings shall be removed by abrasive blast cleaning to SSPC SP6. Areas of tightly adhering coatings shall be cleaned to SSPC SP7, with the remaining thickness of existing coating not to exceed 3 mils.

C. **Incompatible Coatings:** If coatings to be applied are not compatible with existing coatings the CONTRACTOR shall apply intermediate coatings per the paint manufacturer's recommendation for the indicated coating system or shall completely remove the existing coating prior to abrasive blast cleaning. A small trial application shall be conducted for compatibility prior to painting large areas.

D. **Unknown Coatings:** Coatings of unknown composition shall be completely removed prior to application of new coatings.

E. **Water Abrasive or Wet Abrasive Blast Cleaning:** Where indicated or where Site conditions do not permit dry abrasive blasting for industrial coating systems due to dust or air pollution considerations, water abrasive blasting or wet abrasive blasting may be used. In both methods, paint-compatible corrosion inhibitors shall be used, and coating application shall begin as soon as the surfaces are dry. Water abrasive blasting shall be done using high pressure water with sand injection. In both methods, the equipment used shall be commercially produced equipment with a successful service record. Wet blasting methods shall not be used for submerged and severe service coating systems unless indicated.

3.9 CONCRETE AND CONCRETE BLOCK MASONRY SURFACE PREPARATION

A. Surface preparation shall not begin until at least 30 days after the concrete or masonry has been placed.

B. All oil, grease, and form release and curing compounds shall be removed by detergent cleaning per SSPC SP1 before abrasive blast cleaning.

C. Concrete, concrete block masonry surfaces and deteriorated concrete surfaces to be coated shall be abrasive blast cleaned to remove existing coatings, laitance, deteriorated concrete, and to roughen the surface equivalent to the surface of the No. 80 grit flint sandpaper.

D. If acid etching is required by the coating application instructions, the treatment shall be made after abrasive blasting. After etching, rinse surfaces with water and test the pH. The pH shall be between neutral and 8.

E. Surfaces shall be clean and as recommended by the coating manufacturer before coating is started.

F. Unless required for proper adhesion, surfaces shall be dry prior to coating. The presence of moisture shall be determined with a moisture detection device such as **Delmhorst Model DB,** or equal.

3.10 PLASTIC, FIBER GLASS AND NONFERROUS METALS SURFACE PREPARATION

A. Plastic and fiber glass surfaces shall be sanded or brush off blast cleaned prior to solvent cleaning with a chemical compatible with the coating system primer.

B. Non-ferrous metal surfaces shall be solvent-cleaned SSPC SP1 followed by sanding or brush-off blast cleaning SSPC SP7.

C. All surfaces shall be clean and dry prior to coating application.

3.11 SHOP COATING REQUIREMENTS

A. Unless otherwise indicated, all items of equipment, or parts of equipment which are not submerged in service, shall be shop primed and then finish coated in the field after installation with the indicated or selected color. The methods, materials, application equipment and all other details of shop painting shall comply with this section. If the shop primer requires topcoating within a specified period of time, the equipment shall be finish coated in the shop and then touch-up painted after installation.

B. All items of equipment, or parts and surfaces of equipment which are submerged or inside an enclosed hydraulic structure when in service, with the exception of pumps and valves, shall have all surface preparation and coating work performed in the field.

C. The interior surfaces of steel water reservoirs, except for Part A surfaces, shall have all surface preparation and coating work performed in the field.

D. For certain pieces of equipment it may be undesirable or impractical to apply finish coatings in the field. Such equipment may include engine generator sets, equipment such as electrical control panels, switchgear or main control boards, submerged parts of pumps, ferrous metal passages in valves, or other items where it is not possible to obtain the indicated quality in the field. Such equipment shall be primed and finish coated in the shop and touched up in the field with the identical material after installation. The CONTRACTOR shall require the manufacturer of each such piece of equipment to certify as part of its Shop Drawings that the surface preparation is in accordance with these specifications. The coating material data sheet shall be submitted with the Shop Drawings for the equipment.

E. For certain small pieces of equipment the manufacturer may have a standard coating system that is suitable for the intended service conditions. In such cases, the final determination of suitability will be made during review of the Shop Drawing submittals. Equipment of this type generally includes only indoor equipment such as instruments, small compressors, and chemical metering pumps.

F. Shop painted surfaces shall be protected during shipment and handling by suitable provisions including padding, blocking, and the use of canvas or nylon slings. Primed surfaces shall not be exposed to the weather for more than 2 months before being topcoated, or less time if recommended by the coating manufacturer.

G. Damage to shop-applied coatings shall be repaired in accordance with this Section and the coating manufacturer's printed instructions.

H. The CONTRACTOR shall make certain that the shop primers and field topcoats are compatible and meet the requirements of this Section. Copies of applicable coating manufacturer's data sheets shall be submitted with equipment Shop Drawings.

3.12 APPLICATION OF COATINGS

A. The application of protective coatings to steel substrates shall be in accordance with SSPC PA1 - Paint Application Specification No. 1.

B. Cleaned surfaces and all coats shall be inspected prior to each succeeding coat. The CONTRACTOR shall schedule such inspection with the ENGINEER in advance.

C. Blast cleaned ferrous metal surfaces shall be painted before any rusting or other deterioration of the surface occurs. Blast cleaning shall be limited to only those surfaces that can be coated in the same working day.

D. Coatings shall be applied in accordance with the manufacturer's instructions and recommendations, and this Section, whichever has the most stringent requirements.

E. Special attention shall be given to edges, angles, weld seams, flanges, nuts and bolts, and other places where insufficient film thicknesses are likely to be present. Use stripe painting for these areas.

F. Special attention shall be given to materials that will be joined so closely that proper surface preparation and application are not possible. Such contact surfaces shall be coated prior to assembly or installation.

G. Finish coats, including touch-up and damage repair coats shall be applied in a manner that will present a uniform texture and color matched appearance.

H. Coatings shall not be applied under the following conditions:

1. Temperature exceeding the manufacturer's recommended maximum and minimum allowable.

2. Dust or smoke laden atmosphere.

3. Damp or humid weather.

4. When the substrate or air temperature is less than 5 degrees F above dewpoint.

5. When air temperature is expected to drop below 40 degrees F or less than 5 degrees F above the dewpoint within 8 hours after application of coating.

6. When wind conditions are not calm.

I. Dewpoint shall be determined by use of a sling psychrometer in conjunction with U.S. Dept. of Commerce, Weather Bureau psychometric tables.

J. Unburied steel piping shall be abrasive blast cleaned and primed before installation.

K. The finish coat on all work shall be applied after all concrete, masonry, and equipment installation is complete and the work areas are clean and dust free.

3.13 CURING OF COATINGS

A. The CONTRACTOR shall maintain curing conditions in accordance with the conditions recommended by the coating material manufacturer or by this Section, whichever is the most stringent, prior to placing the completed coating system into service.

B. In the case of enclosed areas, forced air ventilation, using heated air if necessary, may be required until the coatings have fully cured.

3.14 IDENTIFICATION OF PIPING

A. Identification of piping shall be in accordance with Section 15005 - Piping Identification Systems.

B. Every valve or connection, where it may be possible for a worker to be exposed to a hazardous substance, shall be labeled per General Industry Safety Orders, Articles 112 and 5194.

C. All unburied chemical pipes, including chemical pipes in structures and chemical pipe trenches shall be color-code painted. Colors shall be as selected by the ENGINEER, or as indicated.

3.15 SHOP AND FIELD INSPECTION AND TESTING

A. General: The CONTRACTOR shall give the ENGINEER a minimum of 3 days advance notice of the start of any field surface preparation work or coating application work, and a minimum of 7 days advance notice of the start of any shop surface preparation work.

B. All such work shall be performed only in the presence of the ENGINEER, unless the ENGINEER has granted prior approval to perform such work in its absence.

C. Inspection by the ENGINEER, or the waiver of inspection of any particular portion of the WORK, shall not relieve the CONTRACTOR of its responsibility to perform the work in accordance with these Specifications.

D. Scaffolding shall be erected and moved to locations where requested by the ENGINEER to facilitate inspection. Additional illumination shall be furnished to cover all areas to be inspected.

E. **Inspection Devices:** The CONTRACTOR shall furnish, until final acceptance of such coatings, inspection devices in good working condition for the detection of holidays and measurement of dry-film thicknesses of protective coatings. Dry-film thickness gauges shall be made available for the ENGINEER'S use at all times while coating is being done, until final acceptance of such coatings. The CONTRACTOR shall furnish the services of a trained operator of the holiday detection devices until the final acceptance of such coatings. Holiday detection devices shall be operated only in the presence of the ENGINEER.

F. **Holiday Testing:** The CONTRACTOR shall holiday test all coated ferrous surfaces inside a steel reservoir, other surfaces which will be submerged in water or other liquids, or surfaces which are enclosed in a vapor space in such structures and surfaces coated with any of the submerged and severe service coating systems. Areas that contain holidays shall be marked and repaired or recoated in accordance with the coating manufacturer's printed instructions and then retested.

1. Coatings With Thickness Exceeding 20 Mils: For surfaces having a total dry film coating thickness exceeding 20 mils: pulse-type holiday detector such as **Tinker & Rasor Model AP-W, D.E. Stearns Co. Model 14/20,** or equal shall be used. The unit shall be adjusted to operate at the voltage required to cause a spark jump across an air gap equal to twice the required coating thickness.

2. Coatings With Thickness of 20 Mils or Less: For surfaces having a total dry film coating thickness of 20 mils or less: **Tinker & Rasor Model M1 non-destructive type holiday detector, K-D Bird Dog,** or equal shall be used. The unit shall operate at less than 75-volts. For thicknesses between 10 and 20 mils, a non-sudsing type wetting agent, such as **Kodak Photo-Flo,** or equal, shall be added to the water prior to wetting the detector sponge.

G. **Film Thickness Testing:** On ferrous metals, the dry film coating thickness shall be measured in accordance with the SSPC "Paint Application Specification No. 2" using a magnetic-type dry film thickness gauge such as **Mikrotest model FM, Elcometer model 111/1EZ,** or equal. Each coat shall be tested for the correct thickness. No measurements shall be made until at least 8 hours after application of the coating. On non-ferrous metals and other substrates, the coating thicknesses shall be measured at the time of application using a wet film gauge.

H. **Surface Preparation:** Evaluation of blast cleaned surface preparation work will be based upon comparison of the blasted surfaces with the standard samples available from the NACE, using NACE standards TM-01-70 and TM-01-75.

3.16 COATING SYSTEM SCHEDULES - FERROUS METALS

A. Coating System Schedule, Ferrous Metal - Not Galvanized:

	Item	**Surface Prep.**	**System No.**
FM-1	All surfaces indoors and outdoors, exposed or covered, except those included below.	Commercial blast cleaning SSPC SP6	(1) alkyd enamel
FM-1	All surfaces indoors and outdoors, exposed or covered, except those included below.	Commercial blast cleaning SSPC SP6	(4) aliphatic polyurethane
FM-1	All surfaces indoors and outdoors, exposed or covered, except those included below.	Near white metal blast cleaning SSPC SP10	(5) inorganic zinc/polyurethane
FM-2	Surfaces in chlorination room, chlorine storage room.	Commercial blast cleaning SSPC SP6	(100) amine-cured epoxy

FM-3	Surfaces of equipment and ferrous surfaces submerged or intermittently submerged in potable water, utility water, and wastewater including all surfaces lower than 2 feet above high water level in hydraulic structures, and all surfaces inside enclosed hydraulic structures and vents (excluding shop-coated valves, couplings, pumps).	White metal blast cleaning SSPC SP5	(100) amine-cured epoxy
FM-4	Surfaces exposed to high temperature (between 150 and 600 degrees F).	Near white metal blast cleaning SSPC SP10	(6) inorganic zinc, water-based
FM-6	Buried small steel pipe.	Removal of dirt, grease, oil	(200) PVC tape
FM-7	Where indicated, ferrous surfaces in water passages of all valves 2-inch size and larger, exterior surfaces of submerged valves.	White metal blast cleaning SSPC SP5	(102) polyamide-cured epoxy
FM-8	Where indicated, ferrous surfaces in water passages and submerged surfaces of all pumps which have discharge size of 4 inches or larger.	White metal blast cleaning SSPC SP5	(100) amine-cured epoxy
FM-9	Ferrous surfaces of sleeve couplings.	Solvent cleaning SSPC SP1, followed by white metal blast cleaning SSPC-SP10	(106) fusion-bonded epoxy
FM-10	All ferrous surfaces of sluice gates, flap gates, and shear gates, including wall thimbles.	White metal blast cleaning SSPC SP5	(102) polyamide-cured epoxy
FM-11	Buried surfaces that are not indicated to be coated elsewhere.	Near white metal blast cleaning SSPC SP10	(100) amine-cured epoxy

FM-12	Interior surfaces of all chemical tanks, including tank nozzles, manholes, nozzle necks, flange faces.	White metal blast cleaning SSPC SP5	(107) chemical-resistant sheet lining
FM-15	Structural steel, miscellaneous metalwork, and supports for roof and face support systems for buildings.	Commercial blast cleaning SSPC-SP6	Alkyd enamel
FM-16	Surfaces of indoor equipment, not submerged	Commercial blast cleaning SSPC SP6	(8) epoxy, equipment
FM-17	Specifier list of existing ferrous equipment or surfaces which are required to be re-coated as part of this WORK.	Specifier enter	Specifier enter
FM-18	Buried pipe couplings, valves, fittings, and flanged joints (where piping is plastic).	Removal of dirt, grease, oil	(201) rich portland cement mortar
FM-19	Buried pipe couplings, valves, and flanged joints (where piping is ductile or cast iron, not tape-coated), including factory-coated surfaces.	As specified by reference specification	(205) polyethylene encasement
FM-20	Buried pipe couplings, valves, and flanged joints (where piping is mortar-coated steel or reinforced concrete), including factory-coated surfaces.	Removal of dirt, grease, oil	(206) cement-mortar coating

In the following paragraph for ferrous metal-galvanized, select one version of entry FMG-1 to serve as the basic default coating system for all galvanized surfaces.

B. **Coating System Schedule, Ferrous Metal - Galvanized:** Pretreatment coatings, barrier coatings, or washes shall be applied as recommended by the coating manufacturer. All galvanized surfaces shall be coated.

	Item	Surface Prep.	System No.
FMG-1	All exposed surfaces indoors and outdoors, except those included below.	Solvent cleaning SSPC SP1	(1) alkyd ename
FMG-2	Surfaces in chlorinator room, chlorine storage room.	Solvent cleaning SSPC SP1	(100) amine-cured epoxy
FMG-3	Buried small steel pipe.	Removal of dirt, grease, oil	(200) PVC tape
FMG-4	Surfaces buried or submerged in water or wastewater, including all surfaces lower than two feet above high water level and all surfaces inside enclosed hydraulic structures and vents.	Solvent cleaning SSPC SP1 followed by brush-off grade blast cleaning SSPC SP7	(100) amine-cured epoxy

3.17 COATING SYSTEM SCHEDULE, NON-FERROUS METAL, PLASTIC, FIBER GLASS

A. Where isolated non-ferrous parts are associated with equipment or piping, the CONTRACTOR shall use the coating system for the adjacent connected surfaces. Do not coat handrails, gratings, frames or hatches. Only primers recommended by the coating manufacturer shall be used.

	Item	Surface Prep.	System No.
NFM-1	All exposed surfaces, indoors and outdoors, except those included below.	Solvent cleaned SSPC SP1	(1) alkyd enamel
NFM-1	All exposed surfaces, indoors and outdoors, except those included below.	Solvent cleaned SSPC SP1	(4) aliphatic polyurethane
NFM-2	Chlorination room, chlorine storage room.	Solvent cleaned SSPC SP1	(100) amine-cured epoxy
NFM-3	Aluminum surfaces in contact with concrete, or with any other metal except galvanized ferrous metal.	Solvent cleaned SSPC SP1	(208) aluminum metal isolation
NFM-4	Polyvinyl chloride plastic piping, indoors and outdoors, or in structures, not submerged.	Solvent cleaned SSPC SP1	(7) acrylic latex

NFM-5	Fiber glass surfaces.	Per paragraph 3.10	(12) aliphatic polyurethane fiber glass
NFM-6	Buried non-ferrous metal pipe.	Removal of dirt, grease, oil	(200) PVC tape
NFM-7	Specifier list of existing equipment or surfaces which are required to be recoated as part of this WORK.	Specifier enter	Specifier enter

3.18 COATING SYSTEM SCHEDULE-CONCRETE

	Item	**Surface Prep.**	**System No.**
C-1	All surfaces indoors and outdoors, where indicated.	Per paragraph 3.9	(10) acrylic, concrete
C-1	All surfaces indoors and outdoors, where indicated.	Per paragraph 3.9	(11) aliphatic polyurethane, concrete
C-2	Submerged in water or wastewater including surfaces up to 2 feet above high water line and down to 2 feet below low water line and all surfaces in an enclosed structure.	Per paragraph 3.9	(108) epoxy, concrete
C-2	Submerged in wastewater including surfaces up to 2 feet above high water line and down to 2 feet below low water line and all surfaces in an enclosed structure.	Per paragraph 3.9	(112) vinyl ester, concrete
C-3	Floor slab and walls, exposure to chemicals, where indicated.	Per paragraph 3.9	(108) epoxy, concrete
C-4	Walls, floors, exposure to chemical splash, washdown, where indicated	Per paragraph 3.9	(11) aliphatic polyurethane, concrete

C-5	Interior surfaces of sewer manholes, including sidewalls, bottom, and metal appurtenances, for manholes indicated.	Per paragraph 3.9	(112) vinyl ester, concrete

3.19 COATING SYSTEM SCHEDULE-CONCRETE BLOCK MASONRY

	Item	**Surface Prep.**	**System No.**
CBM-1	All surfaces, indoors and outdoors, where indicated.	Per paragraph 3.9	(11) aliphatic polyurethane, concrete
CBM-3	Exterior surfaces, above grade, where indicated.	Per paragraph 3.11	(204) water-retardant

3.20 COATING SYSTEM SCHEDULE - MISCELLANEOUS SURFACES

	Item	**Surface Prep.**	**System No.**
MS-1	Wood, indoors and outdoors.	Per manufacturer's printed instructions	(209) alkyd-wood
MS-1	Wood, indoors and outdoors.	Per manufacturer's printed instructions	(210) alkyd-wood
MS-2	Drywall	Per manufacturer's printed instructions	(211) acrylic-drywall]

- END OF SECTION -

SECTION 09900 - PAINTING

PART 1 -- GENERAL

1.1 **Work Included** – Work includes, but is not necessarily limited to:

A. Exterior and interior louvers and vents

B. All doors and frames

C. Concrete wall base

D. Concrete floor sealer

E. Interior gypsum drywall ceilings

F. Exposed gluelams, rafters, and framing elements

G. Interior wood trim,

H. Exposed piping

I. All other exterior and interior attachments and accessories adjacent to painted surfaces

1.2 Quality Assurance

A. Manufacturer – As approved by ARCHITECT. Colors selected are from a single manufacturer.

B. Installer – Work to be performed only by workers thoroughly skilled and specially trained in the techniques of painting, and who are completely familiar with the published recommendations of the manufacturer of the paint material being used.

C. Single-Source Responsibility – Provide primers and undercoat paint produced by the same manufacturer as the finish coats.

1.3 **References** – In addition to complying with all pertinent codes and regulations:

A. Woodworking Institute of California (WIC).

B. Specification manual of selected manufacturer

C. Air Pollution Control District regulations and federal lead content laws.

D. VOC Compliance regulations

1.4 Submittals

A. Product Data – Submit material specifications, manufacturer's installation, and maintenance instructions under provisions of Section 01300.

B. Samples under provisions of Section 01300 to include:

1. Two 8-inch x 8-inch brush-outs of each color and finish specified.

C. Sample of quality control log

1.5 Product Handling

A. Protection

1. Paints to be stored at the job site in a safe, dry place with all labels intact and legible at time of installation.

2. Use all means to protect paint before, during and after installation.

B. Replacements – In the event of damage, including water intrusion, immediately make all repairs and replacements necessary to the approval of the ARCHITECT and at no additional cost to the OWNER.

1.6 **Warranty** – Under provisions of Section 01700.

1.7 **Extra Stock** – Provide OWNER with extra stock of two 1-gallon containers of each paint type and color used. All containers are to be tightly sealed and clearly marked.

1.8 Environmental Requirements

A. Exterior

1. No exterior painting shall be undertaken if air or surface temperature is below 50 degrees F, or is anticipated to be below 50 degrees F within 24 hours.

2. No coating is to be applied if the temperature is less than 5 degrees F above the dew point and rising.

3. No coating is to be applied immediately following rain, power washing, or until frost, dew, or condensation has evaporated.

4. Surfaces must always be tested with a moisture meter and surface temperature gauge before proceeding. Do not apply finishes unless moisture is below:

a. Exterior Masonry : 17%

b. Exterior Wood: 15%

5. Record moisture test result and location of tests in daily work log.

6. Newly applied coatings, which are damaged by the elements, shall be replaced by the contractor at no additional charge.

7. No exterior painting shall be done under windy or dusty conditions.

8. Avoid painting surfaces while they are exposed directly to the hot sun.

B. Interior

1. Interior temperature must be above 50 degrees F for 24 hours before, during, and for 48 hours after application of finishes or longer to obtain full cure as indicated by manufacturer's instructions.

2. Provide temporary lighting to achieve a well-lit surface with a level of at least 80-foot candles measured mid-height.

3. Provide continuous ventilation and heating to prevent accumulation of hazardous fumes and to maintain surface and ambient temperatures.

4. Surfaces must always be tested with a moisture meter and surface temperature gauge before proceeding. Do not apply finishes unless moisture is below:

   a. Interior Plaster and Wallboard: 12%

   b. Interior Wood: 12%

5. Record moisture test result and location of tests in daily work log.

PART 2 -- PRODUCTS

2.1 Paint Materials

A. Manufacturer

1. All paint materials selected for coating systems for each type of surface shall be the product of a single manufacturer.

2. Paints listed herein, unless otherwise designated in the "Painting Schedule", are based on the products of Benjamin Moore as a basis of specification, Other manufacturers listed below are approved, provided they meet the quality and intent of the specified item, material or product.

   a. **Devoe and Raynolds Co**;

   b. Fuller O'Brien;

   c. ICI Dulux;

   d. PPG Industries, Pittsburgh Paints;

   e. Pratt and Lambert;

   f. The Sherwin-Williams Company;

   g. Frazee Paint;

   h. Other manufacturers complying with Section 01030.

B. Compatibility

1. All paint materials and equipment shall be compatible in use: finish coats shall be compatible with prime coats; prime coats shall be compatible with the surface to be coated; all tools and equipment shall be compatible with the coating to be applied.

2. Thinners, when used, shall be only those thinners recommended for that purpose by the manufacturer of the material to be thinned.

C. Color

1. Color of all paints and products shall be per approved samples, as prepared from manufacturer's standard color line.

2. All primers and undercoats are to be tinted to the approximate shade of the selected finish coat. Where the color schedule calls for the use of DEEP TONES, it is the responsibility of the painting contractor to utilize appropriate DEEP BASE PRIMER as manufactured by BENJAMIN MOORE & CO. for use on the surface for which they are intended.

D. Work Quality

1. All materials shall be applied free from runs, sags, wrinkles, streaks, shiners, holidays, and brush marks.

2. All materials shall be applied uniformly. If any reduction on the coating's viscosity is necessary, it shall be done in accordance with the manufacturer's label directions.

3. Carry all finish coats to natural breaks and transitions.

4. Allow each coat to dry before re-coating, adjusting manufacturer's MINIMUM time recommendations between coats to job conditions.

5. Apply each coat to achieve the specified dry film thickness per coat. Achieving the total system recommended dry mil thickness with application rates in excess of those recommended and fewer coats than specified will not be accepted.

6. Apply each coat of paint slightly darker (or lighter depending on the finish color) than the preceding coat unless otherwise approved.

7. Enamels and undercoats are to be sanded smooth prior to topcoating.

8. Tops, bottoms, and sides of doors and garage doors are to be finished with the same number of coats as the face.

9. Where spray application is used, backrolling should immediately follow. Spraying alone without backrolling is unacceptable. Wet film gauges are to be used after backrolling to insure acceptable wet film thickness.

10. A quality control log, recording weather and surface conditions must be completed each day prior to beginning painting. Paint batches are to be recorded as used showing which building each is applied to and when.

PART 3 -- EXECUTION

3.1 Surface Conditions

A. Inspection

1. Prior to all work of this section, carefully inspect the installed work of all other trades and verify that all such work is complete to the point where this installation may properly commence.

2. Verify that all paint finishes may be applied in strict accordance with all pertinent codes and regulations and the requirements of these specifications.

B. Discrepancies

1. In the event of discrepancy, immediately notify the ARCHITECT.

2. Do not proceed with installation in areas of discrepancy until all such discrepancies have been fully resolved.

3.2 Site Preparation

A. Exterior

1. Trench all ground contact surfaces down to the foundation prior to power washing. Pay special attention to wood surfaces coming into ground contact.

2. Remove spider webs by brush prior to power washing.

3. All existing surfaces are to be cleaned by power washing with a commercial mildew wash. Remove all mildew and chalking by scrubbing or power washing. Power washing alone without mildew wash is not acceptable. Chalk deposits must be removed, down to a sound substrate.

4. Surfaces under caves, or other areas protected from weathering, must be carefully washed. Crystalline deposits that develop on these areas are a major cause of peeling.

5. Any plant residue on surfaces is to be completely removed. If for any reason a surface cannot be cleaned, this condition shall be promptly reported to the OWNER.

6. Remove attached light fixtures electrical plates, hardware, and other fittings before preparing, priming, or finishing surfaces.

7. Exercise care not to deface adjoining work. Use suitable cover cloths or other protection materials to cover adjoining work, and surfaces not to be painted. Avoid wind carried overspray.

8. The Contractor will be liable for any and all claims arising from overspray or otherwise misapplied paint.

9. Where rust, water, or bleeding stains are present, the source of these stains must be identified and corrected. Surfaces should then be cleaned and spot primed with a stain sealer.

B. Interior

1. Remove attached light fixtures electrical plates, hardware, and other fittings before preparing, priming, or finishing surfaces.

2. Exercise care not to deface adjoining work. Use suitable cover cloths or other protection materials to cover adjoining work, and surfaces not to be painted.

3. The Contractor will be liable for any and all claims arising from overspray or otherwise misapplied paint.

4. Where rust, water, or bleeding stains are present the source of these stains must be identified and corrected. Surfaces should then be cleaned and spot primed with a stain sealer.

3.3 Preparation of Surfaces, General

A. Protection – Prior to all surface preparation and painting operations, completely mask, remove, or otherwise adequately protect all hardware, accessories, machined surfaces, plates, lighting fixtures, and similar items in contact with painted surfaces but not schedule to receive paint.

B. Spot prime all exposed nails and other exposed metals.

C. Cleaning

1. Before applying paint or other surface treatment, thoroughly clean all surfaces involved.

2. Schedule all cleaning and painting so that dust and other contaminants from the cleaning process will not fall on wet, newly painted surfaces.

D. Prime coat should be applied soon after the surface preparation has been completed to prevent contamination of the substrate.

3.4 Preparation of Wood Surfaces for Paint or Stain Application

A. Cleaning – Clean all wood surfaces until they are free from dirt, oil, and all other foreign substance.

B. Smoothing

1. Unless specifically noted to be left rough, smooth all finished wood surfaces exposed to view, using the proper sandpaper.

2. Where so required, use varying degrees of coarseness in sandpaper to product uniformly smooth and unmarred wood surfaces.

3. Smooth planed clapboards or siding must be sanded thoroughly to break the "mill glaze" to allow proper penetration and adhesion.

C. Knots

1. On small, dry, seasoned knots, thoroughly scrape and clean the surface and apply one coat of compatible knot-sealer before application of the priming coat.

2. On large, open, unseasoned knots, scrape off all pitch and thoroughly clean the area, followed by an application of one coat of compatible knot-sealer.

3. Remove and treat all pitch surfaces as required for large knots.

D. Dryness

1. Unless specifically approved by the ARCHITECT, do not proceed with the painting of wood surfaces until the moisture content of the wood is 15 percent or less.

2. Pressure Treated Wood (PTW) must be tested prior to coating to determine proper penetration of coating. Surface must be sprinkled with water to determine absorption into substrate. If water drops remain on PTW surface, do not paint. If water drops penetrate immediately into surface, prepare surface as you would any wood and then prime.

E. Trim

1. Trim must be re-primed on all sides.

2. Thorough caulking of horizontal applications or any areas where water may collect is essential.

3. Fill all joints, nail holes, cracks, and blemishes after undercoater has been applied.

4. Countersink, prime, and fill all nails or screws to retard rust stains.

F. Primer

1. Cedar and Redwood are bleeding woods, they must be primed to help retard bleed.

2. Prime and countersink all nails or screws to retard rust stains.

3. If nails are rusted, coat with RUST CONVERTER.

4. Fill all joints, nail holes, cracks, and blemishes after undercoater has been applied.

3.5 Preparation of Masonry, Precast Concrete, Concrete Block, and Fiber Cement Surfaces

A. Precast concrete must be allowed to cure for 60 – 90 days; block and fiber cement surfaces must be allowed to cure for 30 – 60 days.

B. New fiber cement or other masonry surfaces shall not be primed until it has been determined these surfaces have dried sufficiently to safely accept paint.

C. Alkalinity must be approved prior to priming.

D. Form release agents are to be removed with appropriate solvents.

E. All surfaces must be thoroughly brushed with a stiff fiber brush to remove loose particles, with particular emphasis on stucco surfaces and mortar courses.

F. Laitance deposits must be removed by hand or power wire brushing, or other appropriate means.

G. If efflorescence is present, first dampen the wall with water, then scrub the surface with a 10% solution of muriatic acid. Caution: Wear rubber boots and gloves, work goggles, and protective clothing. After treatment, thoroughly flush the surface with clean water to remove all acid and allow to dry thoroughly before painting.

H. Prime all bare surfaces and opened cracks.

I. Cracks, joints, and large voids are to be filled by repointing, caulking, or other approved means.

J. Care must be taken to blend patches into surrounding texture and minimize their appearance in the finished project.

K. Cracks over 1/4-inch are defined as structural cracks and must be reviewed by a structural engineer prior to painting.

L. Spot prime surface repairs after they have been patched, sandwiching repairs between two layers of primer.

3.6 Preparation of Metal Surfaces

A. Galvanized Metal

1. Clean all surfaces thoroughly with solvent until they are completely free from dirt, oil, grease, and contaminants per SSPC-SP1-63.

2. Thoroughly treat the cleaned surface with phosphoric acid etch.

3. Remove all excess etching solution and allow to dry completely before application of paint.

4. Abraded surfaces should be sanded smooth and spot primed.

5. Weathered, unpainted galvanized metal surfaces must be wire brushed or power washed to remove deposits of "white rust", then primed.

6. Note: Some galvanized surfaces have stabilizers. Many of which are not soluble in solvents. These must be removed by either brush blasting or chemical treatment.

B. Other structural steel, miscellaneous metals, doors, exposed ducting, exposed piping, louvers, and miscellaneous metals

1. All metal surfaces shall be washed with solvent to remove extraneous dirt, grease, oil, and contaminants per SSPC-SP1-63 before painting.

2. Allow to dry thoroughly before application of paint.

3. Shop primed doors, vents, access panels and miscellaneous or structural metals surfaces are to be dulled by sanding prior to application of specified prime coat.

4. Where shop coat has abraded and rust developed, remove by sanding and spot prime immediately, prior to full prime coat indicated in the product application section.

C. Aluminum

1. All surfaces must be free of residual deposits of grease and oil, and shall be cleaned in accordance with SSPC-SP1-63, "solvent cleaning".

2. Weathered, unpainted aluminum surfaces must be wire brushed or power washed to remove deposits of "white rust", then primed.

3.7 Paint Application

A. General

1. Paint all surfaces except glass, flat concrete, and similar items, unless otherwise noted.

2. Prime and paint all grilles and other pre-finished items where the factory pre-finish is not in accordance with the painting schedule and color selection. Unless otherwise scheduled, all grilles, frames, roof penetrations and other items shall be painted to match the color of the adjacent surface.

B. Drying

1. Allow sufficient drying time between coats.

2. Modify the period as recommended by the material manufacturer to suit adverse weather conditions.

3. Oil-base and oleo-resinous solvent-type paints shall be considered dry for recoating when the paint feels firm, does not deform or feel sticky under moderate pressure of the thumb, and the application of another coat of paint does not cause lifting or loss of adhesion of the undercoat.

C. Environmental Conditions

1. Comply with the manufacturer's recommendations as to environmental conditions under which the coating system may be applied.

2. Do not apply paint in areas where dust is being generated.

D. Defects – Sand and dust between coats to remove all dust defects visible to the unaided eye from a distance of five (5) feet.

3.8 Drywall

A. All surfaces must be free of sanding dust, and joint treatment cement should be thoroughly dry.

B. Damaged or defective surfaces are to be repaired by spackling or by other appropriate measures.

C. Steel corner beading is to be coated with rust retardate primer prior to a general prime coat being applied.

3.9 **Reinstallation of Removed Items** – Following completion of painting in each space, promptly re-install all items removed for painting, using only workmen skilled in the particular trade.

3.10 Cleaning Up

A. General

1. During progress of the work, do not allow the accumulation of empty containers or other excess items except in areas specifically set aside for that purpose.

2. Prevent accidental spilling of paint materials and in event of such spill, immediately remove all spilled material and the waste or other equipment used to clean up the spill and return the surfaces to their original undamaged condition, all at no additional cost to the OWNER.

B. Prior to Final Inspection – Upon completion of this portion of the work, visually inspect all surfaces and remove all paint and traces of paint from surfaces not schedule to be painted.

3.11 Paint Applications

A. Exterior

1. Galvanized Metal – Flat

a. Primer: Ironclad Galvanized Metal Latex Primer (155)

b. Finish: Two coats Moore's Flat Exterior Latex House Paint (105)

2. Galvanized Metal – Medium Gloss

a. Primer: Ironclad Galvanized Metal Latex Primer (155)

b. Finish: Two coats MoorGlo Latex House and Trim Paint (170)

3. Aluminum – Flat

a. Finish: Two coats Moore's Flat Exterior Latex House Paint (105)

4. Aluminum – Medium Gloss

a. Finish: Two coats MoorGlo Latex House and Trim Paint (170)

5. Ferrous Metal – Flat

a. Primer: Ironclad Retardo Rust Inhibitive Paint (163)

b. Finish: Ironclad Retardo Rust Inhibitive Paint (105)

6. Ferrous Metal – High Gloss (doors, jambs, bollards, exposed metals, etc.)

a. Primer: Ironclad Retardo Rust Inhibitive Paint (163)

b. Finish: Two coats Urethane Alkyd Gloss Enamel (CM22)

7. Exposed Wood Framing and Trim – Two (2) coats Moorwood semi-transparent stain and wood preservative (081)

8. Exterior Concrete Block and Masonry

a. Primer: Acrylic masonry sealer (066)

b. Finish: Moorlastic Acrylic Elastomeric Waterproof Coating

B. Interior

1. Drywall Ceiling – Eggshell

a. Primer: Regal First Coat (216)

b. Finish: Two coats Regal Aqua Velvet (319)

2. Ferrous Metal – Semi-Gloss

a. Primer: Moorecraft Alkyd Enamel Underbody and Primer Sealer (245)

b. Finish: Moorecraft Alkyd Semi-Gloss Enamel (271)

3. Galvanized Metal – Semi-Gloss

4. Primer: Ironclad Galvanized Metal Latex Primer (155)

5. Finish: Two coats Regal AquaGlo (333)

3.12 PREPARATION

A. **General**: Remove hardware and hardware accessories, plates, machined surfaces, lighting fixtures, and similar items already installed that are not to be painted, or provide surface-applied protection prior to surface preparation and painting. Remove these items, if necessary, to completely paint the items and adjacent surfaces. Following completion of painting operations in each space or area, have items reinstalled by workers skilled in the trades involved.

B. Cleaning: Before applying paint or other surface treatments, clean the substrates of substances that could impair the bond of the various coatings. Remove oil and

C. grease prior to cleaning. Schedule cleaning and painting so dust and other contaminants from the cleaning process will not fall on wet, newly painted surfaces.

1. Cementitious Materials: Prepare concrete, concrete masonry block, cement plaster, and mineral-fiber-reinforced cement panel surfaces to be painted. Remove efflorescence, chalk, dust, dirt, grease, oils, and release agents. Roughen, as required, to remove glaze. If hardeners or sealers have been used to improve curing, use mechanical methods of surface preparation.

   a. Use abrasive blast-cleaning methods if recommended by the paint manufacturer.

   b. Determine alkalinity and moisture content of surfaces by performing appropriate tests. If surfaces are sufficiently alkaline to cause the finish paint to blister and burn, correct this condition before application. Do not paint surfaces where moisture content exceeds that permitted in manufacturer's printed directions.

      1) Clean concrete floors to be painted with a 5 percent solution of muriatic acid or other etching cleaner. Flush the floor with clean water to remove acid, neutralize with ammonia, rinse, allow to dry, and vacuum before painting.

   c. Ferrous Metals: Clean ungalvanized ferrous metal surfaces that have not been shop-coated; remove oil, grease, dirt, loose mill scale, and other foreign substances. Use solvent or mechanical cleaning methods that comply with recommendations of the Steel Structures Painting Council (SSPC).

   d. Treat bare and sandblasted or pickled clean metal with a metal treatment wash coat before priming.

2. C Materials Preparation: Carefully mix and prepare paint materials according to manufacturer's directions.

   a. Maintain containers used in mixing and applying paint in a clean condition, free of foreign materials and residue.

   b. Stir material before application to produce a mixture of uniform density; stir as required during application. Do not stir surface film into material. Remove film and, if necessary, strain material before using.

   c. Use only thinners approved by the paint manufacturer and only within recommended limits.

3. Tinting: Tint each undercoat a lighter shade to facilitate identification of each coat where multiple coats of the same material are applied. Tint undercoats to match the color of the finish coat, but provide sufficient differences in shade of undercoats to distinguish each separate coat.

3.13 APPLICATION

A. **General**: Apply paint according to manufacturer's directions. Use applicators and techniques best suited for substrate and type of material being applied.

1. Do not paint over dirt, rust, scale, grease, moisture, scuffed surfaces, or conditions detrimental to formation of a durable paint film.

   a. Paint colors, surface treatments, and finishes are indicated in the schedules.

   b. Provide finish coats that are compatible with primers used.

   c. The number of coats and the film thickness required are the same regardless of the application method. Do not apply succeeding coats until the previous coat has cured as recommended by the manufacturer. Sand between applications where sanding is required to produce a smooth even surface according to the manufacturer's directions.

   d. Apply additional coats if undercoats, stains, or other conditions show through final coat of paint until paint film is of uniform finish, color, and appearance. Give special attention to ensure that surfaces, including edges, corners, crevices, welds, and exposed fasteners, receive a dry film thickness equivalent to that of flat surfaces.

   e. The term exposed surfaces includes areas visible when permanent or built-in fixtures, convector covers, covers for finned tube radiation, grilles, and similar components are in place. Extend coatings in these areas, as required, to maintain the system integrity and provide desired protection.

   f. Paint surfaces behind movable equipment and furniture the same as similar exposed surfaces. Before the final installation of equipment, paint surfaces behind permanently fixed equipment or furniture with prime coat only.

   g. Paint interior surfaces of ducts, where visible through registers or grilles, with a flat, nonspecular black paint.

   h. Paint back sides of access panels and removable or hinged covers to match exposed surfaces.

2. Scheduling Painting: Apply first coat to surfaces that have been cleaned, pretreated, or otherwise prepared for painting as soon as practicable after preparation and before subsequent surface deterioration.

   a. Allow sufficient time between successive coats to permit proper drying. Do not recoat until paint has dried to where it feels firm, does not deform or feel sticky under moderate thumb pressure, and where application of another coat of paint does not cause the undercoat to lift or lose adhesion.

3. Application Procedures: Apply paints and coatings by brush, roller, spray, or other applicators according to the manufacturer's directions.

   a. Brushes: Use brushes best suited for the material applied.

b. Rollers: Use rollers of carpet, velvet back, or high-pile sheep's wool as recommended by the manufacturer for the material and texture required.

c. Spray Equipment: Use airless spray equipment with orifice size as recommended by the manufacturer for the material and texture required.

4. Minimum Coating Thickness: Apply materials no thinner than the manufacturer's recommended spreading rate. Provide the total dry film thickness of the entire system as recommended by the manufacturer.

5. Mechanical and Electrical Work: Painting mechanical and electrical work is limited to items exposed in mechanical equipment rooms and in occupied spaces.

6. Mechanical items to be painted include, but are not limited to, the following:

a. Piping, pipe hangers, and supports.

b. Supports.

c. Motors and mechanical equipment.

d. Accessory items.

B. Electrical items to be painted include, but are not limited to, the following:

1. Conduit and fittings.

2. Switchgear.

C. Prime Coats: Before applying finish coats, apply a prime coat of material, as recommended by the manufacturer, to material that is required to be painted or finished and that has not been prime-coated by others. Recoat primed and sealed surfaces where evidence of suction spots or unsealed areas in first coat appears, to ensure a finish coat with no burn-through or other defects due to insufficient sealing.

3.14 CLEANING

A. Cleanup: At the end of each work day, remove empty cans, rags, rubbish, and other discarded paint materials from the site.

1. After completing painting, clean glass and paint-spattered surfaces. Remove spattered paint by washing and scraping. Be careful not to scratch or damage adjacent finished surfaces.

3.15 PROTECTION

A. Protect work of other trades, whether being painted or not, against damage by painting. Correct damage by cleaning, repairing or replacing, and repainting, as acceptable to ARCHITECT.

B. Provide "Wet Paint" signs to protect newly painted finishes. Remove temporary protective wrappings provided by others to protect their work after completing painting operations.

1. At completion of construction activities of other trades, touch up and restore damaged or defaced painted surfaces.

- END OF SECTION -

SECTION 10200 – LOUVERS AND DAMPERS

PART 1 -- GENERAL

1.1 THE REQUIREMENT

A. The CONTRACTOR shall provide all louvers and dampers, and appurtenant work, complete and in accordance with the Contract Documents.

1.2 REFERENCE SPECIFICATIONS, CODES AND STANDARDS

A. **Codes:** All codes, as referenced herein, are specified in Section 01090 - Reference Standards.

B. **Manufacturer's Standards:** In addition to the standards listed above, the louvers and vents and their installation shall be in accordance with the manufacturer's published recommendations and specifications.

1.3 QUALITY ASSURANCE

A. **Performance Requirements:** Where louvers and dampers are indicated to comply with specific performance requirements, provide units whose performance ratings have been determined in compliance with Air Movement and Control Association (AMCA), "Standard 500".

B. **AMCA Certification:** Where indicated, provide louvers and dampers with AMCA Certified Ratings Seal evidencing that product complies with above requirement.

C. Comply with SMACNA (Sheet Metal and Air Conditioning Contractors National Association) "Architectural Sheet Metal Manual" recommendations for fabrication, construction details, and installation procedures, except as otherwise indicated.

1.4 CONTRACTOR SUBMITTALS

A. **General:** Submittals shall be in accordance with Section 01300 - Contractor Submittals.

1. Manufacturer's Information: Manufacturer's complete technical literature, specifications, certified test data, where applicable, and installation instructions for products, including finishes, shall be submitted to the ENGINEER.

2. Shop Drawings: Submit shop drawings for fabrication and erection of louver and damper units and accessories. Include plans, elevations, and details of sections and connections to adjoining work. Indicate materials, finishes, fasteners, joinery, and other information to determine compliance with requirements.

3. Material and Color Samples: Six-inch square minimum, color and texture samples of each finish shall be submitted to ENGINEER for review. The samples shall be prepared on metal of the same gauge and alloy to be used in the Work. Where normal color and texture variations are to be expected, include two or more units of each sample showing the limits of such variations.

4. Warranties: Furnish copies of the manufacturer's warranties covering the louvers and dampers.

PART 2 -- PRODUCTS

2.1 GENERAL

A. Stationary louvers shall be drainable type with drain gutters in each blade and downspouts in jambs and mullions unless indicated otherwise on Drawings. Head, sills and jambs to be one piece extruded aluminum members, assembled by welded construction. Maximum water penetration 0.01 ounces at 1200 fpm. Stationary louvers shall be contained within a single frame less than 5 inches deep. Provide sill extensions made of the same material as the louvers.

B. Dampers shall be extruded aluminum airfoil type blades unless indicated otherwise on Drawings. Parallel blade operation. Blade seals shall be full length PVC or vinyl. Jamb seals shall be flexible stainless steel compression type. Head, sills and jambs to be one piece extruded aluminum members, assembled by welded construction. Damper shall be motor operated.

C. Louver and damper schedules per the Contract Drawings.

2.2 MATERIALS

A. **Aluminum Sheet:** ASTM B 209-Specification for Aluminum and Aluminum - Alloy Sheet and Plate, Alloy 3003 or 5005 with temper as required for forming, or as otherwise recommended by the metal producer to provide the required finish.

B. **Aluminum Extrusions:** ASTM B 221-Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Shapes, and Tubes, Alloy 6063-T5.

C. **Fastenings:** Fasteners shall be fabricated of the same material as the items fastened, unless otherwise indicated. Fasteners for exterior applications may be stainless steel. Provide types, gauges and lengths to suit unit installation conditions. Use phillips flat-head machine screws for exposed fasteners, unless otherwise indicated.

D. **Anchors and Inserts:** Anchors and inserts shall be non-ferrous metal or for exterior installations and elsewhere as required for corrosion resistance. Steel or lead expansion bolt devices shall be used for drilled-in-place anchors. Concrete inserts shall be provided as required.

2.3 FABRICATION, GENERAL

A. Stationary louver frames and blades shall be constructed of 0.081 extrusion except as noted.

B. Damper frames and blades shall be constructed of 0.125 inch extrusion. Damper blades shall have 1/2-inch diameter axles and sintered bronze bearings. Linkage shall be concealed in the frame.

C. Wind resistance design load shall be as required for building location per UBC and per local site conditions.

D. Fabricate frames including integral sills to suit adjacent construction with tolerances for installation, including application of sealants in joints between louvers and adjoining Work.

E. Include supports, anchorages, and accessories required for complete assembly.

F. Join frame members to one another and to stationary louver blades by welding, except where indicated otherwise. Maintain equal blade spacing, including separation between blades and frames at head and sill, to produce uniform appearance.

2.4 LOUVERS FINISH

A. Louvers, louver frames, screens, and screen frames shall be provided with a **Kynar 500** fluropolymer coating. Coating shall be not less than 1 mil thick and not less than 70 full strength resin fluoropolymer. The coating shall meet or exceed all requirements of American Architectural Manufacturers Association's Specification Section 60512 entitled Voluntary Specification for High Performance Organic Coatings On Architectural Extrusions and Panels." The coating shall have an industry standard 5-year limited warranty against failure of the **Kynar 500** finish.

B. Color shall be custom color as selected by the ARCHITECT.

2.5 LOUVER SCREENS

A. All stationary exterior louvers shall have removable screens unless indicated otherwise.

B. Fabricate screen frames of the same metal and finish as louver units to which they are secured, unless otherwise indicated. Provide frames consisting of U-shaped metal for permanently securing screen mesh.

C. Use bird screens where indicated, of 1/2-inch square mesh, 0.063-inch aluminum wire.

D. Locate screens on inside face of stationary louvers, unless otherwise indicated. Secure screens to louver frames with machine screws, spaced at each corner and at 12-inches on center between corners.

2.6 ACCEPTABLE MANUFACTURERS

A. Manufacturers: **Louvers & Dampers, Inc., Arrow, Ruskin Manufacturing Co.**, or equal.

2.7 MOTOR OPERATORS, DAMPERS

A. Motorized operators for the dampers shall be provided with 120 VAC, 60 Hz, two-position electric motors on a 2 wire circuit. Each motor shall have integral motor overloads. When energized, the operators shall power close the louvers and damper, and when de-energized dampers shall spring return to the open position. Each motor shall have a minimum damper rating of 25 sq. feet of parallel damper area at 1-inch of W.C. pressure and a velocity of 1000 fpm. The motors shall have an "end of travel" switch" which reduces the running power input at the end of the rotation. Each operator shall have an "auxiliary switch" which makes or breaks "proof" circuit at powered end of stroke. Ambient temperature limitations: -40 to 120 degrees F.

B. Manufacturer shall be **Barber-Colman, Siebe or equal.**

PART 3 -- EXECUTION

3.1 PRODUCT DELIVERY, STORAGE, AND HANDLING

A. **Delivery of Materials:** Manufactured materials, products, and prefabricated components shall be delivered in original, unbroken, packages, containers, or bundles bearing the name of the manufacturer.

B. **Storage:** All materials and products shall be carefully stored in conformance with the manufacturer's recommendations. Storage shall be in a manner that will prevent damage or marring of the product and its finishes.

3.2 INSTALLATION

A. Louvers and dampers shall be installed in strict compliance with manufacturer's instructions and with shop drawings.

B. Locate and place louver and damper units plumb, level, and in proper alignment with adjacent Work.

C. Use concealed anchorages wherever possible. Provide brass or lead washers fitted to screws where required to protect metal surfaces and to make a weather tight connection.

D. Form tight joints with exposed connections accurately fitted together. Provide reveals and openings for sealants and joint fillers, as indicated.

E. Repair finishes damaged by cutting, welding, soldering and grinding operations required for fitting and jointing. Restore finishes so there is no evidence of corrective work. Items which cannot be acceptably refinished in the field shall be returned to the shop for required alterations. Such items shall be completely refinished or replaced, at the CONTRACTOR'S option.

F. Protect galvanized and non-ferrous metal surfaces from corrosion or galvanic action by application of a heavy coating of bituminous paint on surfaces which will be in contact with concrete, masonry, or dissimilar metals.

G. Provide concealed gaskets, flashings, joint fillers, and insulations, and install as Work progresses to make installations weather tight.

H. Refer to Section 07920 - Sealants and Caulking, for sealants to be used during installation of louvers.

3.3 PROTECTION

A. As the Work of louver installation progresses, provide suitable protective coverings, barriers, devices, or such other methods or procedures as may be necessary to protect components and materials from damage or deterioration. Such protective measures shall be maintained in place throughout the remainder of the construction period.

3.4 ADJUSTMENT AND CLEANING

A. **Protection Removal:** Immediately prior to final inspection, all protective coverings shall be removed.

B. All exposed and finished surfaces of louver components and materials shall be finally cleaned and inspected for damage, flaws, blemishes or other defects detrimental to appearance. Surfaces, joints and exposed trim shall be in correct position and alignment and be uniform in plane, color, texture and finish.

- END OF SECTION -

SECTION 10522 - FIRE EXTINGUISHERS, CABINETS, AND ACCESSORIES

PART 1 -- GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following:

1. Fire extinguishers.

2. Fire extinguisher mounting brackets.

1.3 SUBMITTALS

A. General: Submit the following according to the Conditions of the Contract and Division 1 Specification Sections.

1.4 QUALITY ASSURANCE

A. Single-Source Responsibility: Obtain extinguishers from a single manufacturer.

B. UL-Listed Products: Fire extinguishers shall be UL listed with UL listing mark for type, rating, and classification of extinguisher.

C. FM-Listed Products: Fire extinguishers approved by Factory Mutual Research Corporation for type, rating, and classification of extinguisher with FM marking.

PART 2 -- PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. **J.L. Industries.**

2. **Larsen's Manufacturing Co.**

3. **Modern Metal Products by Muckle.**

4. **Potter-Roemer, Inc.**

5. **Samson Metal Products, Inc.**

2.2 FIRE EXTINGUISHERS

A. **General**: Provide fire extinguishers from manufacturer's standard, that comply with authorities having jurisdiction.

B. Multipurpose Dry Chemical Type: UL-rated 4-A:60-B:C, 10-lb nominal capacity, in enameled steel container.

2.3 MOUNTING BRACKETS

A. Brackets: Designed to prevent accidentally dislodging extinguisher, of sizes required for type and capacity of extinguisher indicated, in plated finish.

1. Provide brackets for extinguishers not located in cabinets.

B. Identify bracket-mounted extinguishers with FIRE EXTINGUISHER in red letter decals applied to wall surface. Use letter size, style, and location as selected by Architect.

PART 3 -- EXECUTION

3.1 EXAMINATION

A. Examine walls and partitions for thickness and framing for cabinets to verify cabinet depth and mounting prior to cabinet installation.

B. Do not proceed until unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Follow manufacturer's printed instructions for installation.

B. Install in locations and at mounting heights indicated or, if not indicated, at heights to comply with applicable regulations of governing authorities.

1. Fasten mounting brackets and cabinets to structure, square and plumb.

- END OF SECTION -