Midnite Mine Superfund Site

~~100~~90 Percent Design

Appendix K – Technical Specifications

~~June 2015~~

The specifications included in Appendix K have been developed and revised based on the 90% project design and understanding. The specifications at the 90 percent design level include revised specifications to reflect the 90% Midnite Mine design and additional details based on the evolution of the design concepts (e.g., necessary Contractor required work plans, electrical and I&C components, etc.).

July 31 2014

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~~TECHNICAL SPECIFICATIONS~~

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Attachment K-1

Waste Excavation and Consolidation

Provided electronically only

SECTION 01010 - SUMMARY OF WORK

PART 1 -- GENERAL

1.1 THE REQUIREMENT

A. The WORK to be performed under this Contract shall consist of furnishing plant, tools, equipment, materials, supplies, and manufactured articles, and furnishing all labor, transportation, and services, including fuel, power, water, and essential communications, and performing all work or other operations required for the fulfillment of the Contract in strict accordance with the Contract Documents. The WORK shall be complete, and all work, materials, and services not expressly indicated or called for in the Contract Documents which may be necessary for the complete and proper construction of the WORK in good faith shall be provided by the CONTRACTOR as though originally so indicated, at no increase in cost to the COMPANY.

1.2 PROJECT DESCRIPTION

A. The Midnite Mine was an open-pit, hard rock uranium mine that is located approximately 45 miles northwest of Spokane, Washington and 8 miles northwest of Wellpinit, Washington. The Site is approximately 350 acres in size, and includes areas affected by uranium mining which occurred between 1955 and 1981. The Midnite Mine is located on the Spokane Indian Reservation in Stevens County, Washington at an elevation ranging from approximately 2500 to 3400 feet above mean sea level (amsl). Remedial action activities at the Midnite Mine are being conducted under a Consent Decree between the COMPANY and the U.S. Environmental Protection Agency, Region X (EPA).

B. REMEDY COMPONENTS: A detailed description of the overall remedial action components can be found in the Remedial Action Work Plan. The remedial action will consist of the following components:

1. Mine Waste Excavation and Containment - The Mine Waste Excavation work component includes the excavation and removal of all mine wastes exceeding cleanup levels from the Mined Area (MA) and Mine Affected Area (MAA), with the exception of the material currently located in the Backfilled Pits Area (BPA). Mine waste materials include waste rock, low-grade ore or protore, and contaminated sediments and subsoils. Pits 3 and 4 Reclamation work component includes the consolidation and containment of excavated mine wastes in the existing open Pit 3 and Pit 4, except as directed or otherwise approved by EPA. The containment system shall include a drainage layer, a sub-waste liner, a cover system, and groundwater and surface water collection and diversion facilities in and around each pit. The BPA reclamation work component includes the contouring and consolidation of mine wastes in the BPA. The containment system will include a cover system and surface water and groundwater collection and diversion facilities.

2. Water Collection and Treatment - The Water Collection and Treatment work element includes the continued operation of the existing water treatment plant (WTP) and its replacement with a new WTP. The objective of this work element is to prevent releases of water exceeding discharge limits. The Water Collection and Treatment work element includes the following components: Water Collection and Conveyance, Water Storage and Treatment, and Residuals Management.

3. Institutional Controls and Access Restrictions - The Institutional Controls (ICs) and Access Restrictions (ARs) work element includes implementation of effective

controls that achieve the goals stated in Section 12.2.5 of the ROD and requirements set forth in Section IX of the Consent Decree (CD). The primary objectives of this work element are to ensure long-term protection of human health and the environment and to protect the integrity of the remedy.

4. Long-Term Site Management - The Long-Term Site Management work element includes activities necessary to maintain the integrity and function of the remedy, and to support statutory reviews of remedy protectiveness of human health and the environment. The objective of this work element is to ensure integrity and functionality of the implemented remedy and to provide information required for regulatory reviews of the effectiveness of the remedy.

5. Blue Creek and Delta Sediments Contingent Action - Although the Selected Remedy anticipates that sediments in Blue Creek and Delta will meet cleanup standards through natural recovery within a reasonable timeframe (approximately ten years following waste containment), active sediment remediation may be required under certain conditions. This work element includes assessment and, in accordance with the Selected Remedy, removal of in-stream and riparian sediments in Blue Creek and Delta.

1.3 WORK COVERED BY CONTRACT DOCUMENTS

A. Construction WORK covered by the CONTRACT DOCUMENTS and these Specifications includes the following tasks:

1. Construction Support Facilities – Construction support facilities will be built to support construction activities as well as planned remedial actions at the Site. These facilities include laydown, stockpile and storage areas, construction of maintenance and fueling areas, construction of new access roads, improvement of existing access roads, and construction of loadout areas.

2. Demolition – In preparation for the excavation and containment of waste rock and protore piles and construction of the new mine water treatment plant, several existing structures will be demolished. These include the following buildings and areas: (1) the existing water treatment plant equipment and structures, (2) the existing buildings on the west side of the site, (3) seepage collection facilities in the MA drainages, (4) surface pipelines, (5) buried culverts, (6) overhead power lines, and (7) interim decontamination facilities.

3. Mine Surface Material and Sediment Cleanup - Mine Wastes include above-grade mine wastes, contaminated soil and sediment, mine drainage sediments, and mine access road materials. Mine waste generally will be excavated, transported, and placed in the Mine Waste Containment areas without stockpiling or double-handling excavated material. Mine waste excavation and placement within the Mine Waste Containment Areas is scheduled to be conducted in three phases: Phase 1 – Includes excavation and placement of mine wastes in Pit 4; Phase 2 – Includes regrading the Backfilled Pits Area (BPA) and excavation and placement of mine wastes in Pit 3; Phase 3 – Includes regrading of Area 5 (located between Pit 3 and Pit 4), and excavation and placement of remaining mine wastes in the upper portion of the Pit 3 waste containment area. Demolition and removal of temporary support facilities in the construction support zone and other areas of the site will occur near the end of Phase 3. This element also includes surface water control, storage, treatment and disposal. These phases are described in more detail in Section 1.4.

4. Borrow Area Development – Borrow areas for cover material and topsoil/growth media will be developed at the Rhoads property (Rhoads Borrow Area). Work to develop the borrow area will include site preparation including access and SWPPP controls, excavation and separation of materials, and the set-up and operation of screening or processing facilities as necessary to produce suitable material. Restoration of borrow areas will be completed at the end of borrow area use.

5. Groundwater Controls - Groundwater controls will be installed in the Western, Central, and Far East Drainages at the Site to intercept impacted groundwater in the alluvial and shallow weathered bedrock and convey it for treatment to the existing WTP or the new WTP. Groundwater Controls in each of these drainages will consist of an extraction trench installed immediately upslope of a low-permeability barrier wall. The extraction trench will be excavated through the residual soils to competent bedrock downgradient of the Mine Area. The low-permeability barrier wall will be installed immediately downgradient of the extraction trench to increase capture efficiency.

6. Water Treatment Plant – A new WTP will be constructed as part of the Work. The WTP elements consist of a five-hundred gallon per day capacity, including equalization ponds, influent and effluent pipelines, filtration equipment, ion exchange equipment, ion exchange resin regeneration equipment, ion exchange resin handling facilities, chemical storage facilities, slurry dewatering and dewatered filter cake storage facilities, fiberglass tanks, medium voltage power line extension, electrical system, electrical controls, SCADA system, laboratory, office, pre-engineered metal building, concrete foundation and flatwork and appurtenant work. The new WTP Work is outlined under a separate contract and division of specifications and therefore is NOT included in this scope of work.

7. Water Treatment Plant Effluent Pipeline – A treated water effluent pipeline will be used to convey treated water from the new WTP to the Spokane River Arm of Lake Roosevelt. This pipeline also includes a diffuser that will be constructed at the terminal end of the pipeline to aid with mixing the treated effluent with the lake water. The new WTP effluent pipeline work is outlined under a separate contract and division of specifications and therefore is NOT included in this scope of work.

B. The WORK is located at the Midnite Mine site near the town of Wellpinit, Washington on the Spokane Indian Reservation.

1.4 PHASING OF THE WORK

A. Mine waste excavation and placement within the waste containment areas are divided into three phases:

1. Early Work includes activities to prepare the site for construction, processing of earthen materials for use during the RA, and completion of remedial construction activities associated with Pit 4. The locations of work areas included in the Early Works activities are shown on the Contract Drawings. The following tasks shall be completed during the Early Works of the RA:

a. Topsoil Stockpiles: The existing topsoil stockpiles shall be excavated. Material that meets the cleanup standards shall be temporarily stockpiled in a designated area for future use as cover material. Material failing to meet the cleanup standards shall be temporarily stockpiled in a designated area until it can be placed in the waste containment areas as backfill.

b. Construction Support Zone: The area to be used as the Construction Support Zone shall be prepared for use during the RA. Activities shall include removal of the South topsoil stockpile, screening, removal, and temporary stockpiling of contaminated materials, demolition of existing structures, and general site grading. In addition, perimeter security fencing shall be installed and staging of temporary construction support structures shall be completed.

c. Site Access Road: The permanent site access road from the West End Road to the location of the new WTP and Construction Support Zone shall be constructed. Soils stripped from within the limits of the Site Access Road that meet site cleanup standards shall be temporarily stockpiled in a designated area for future use as cover material.

d. West Access Road Removal: The existing West Access Road shall be removed. In addition, impacted materials within Whitetail Creek shall also be removed. Materials failing to meet the cleanup standards shall be temporarily stockpiled in a designated stockpile area within the MA until it can be placed in the waste containment areas as backfill.

e. Decontamination Zone: The decontamination zone shall be constructed, including vehicle and personnel decontamination facilities.

f. Material Processing and Stockpiling Area: Area 5 shall be prepared for processing and stockpiling of material from the Hillside Waste Rock Pile. Preparation activities shall include well abandonment, safety berm augmentation, relocation of ore stock pile #7, and any necessary grading to facilitate work in this area.

2. Phase 1 – Includes excavation and placement of mine wastes in Pit 4. The locations of work areas included in the Phase 1 activities are shown on the Contract Drawings. The following tasks shall be completed during Phase 1 of the RA:

a. Hillside Waste Rock Pile: A sufficient portion of the Hillside Waste Rock Pile shall be processed to produce drain rock and overliner protection material for Pit 4. Rejected material shall be placed in Pit 4 as low-reactivity or low-activity waste backfill.

b. Preparation of Pit 4: Activities to prepare Pit 4 for waste containment include installation of rockfall hazard mitigation measures, dewatering of the pit, remove existing pit bottom sediments, installation of underdrain system and liner system. Note, underdrain risers shall be installed as necessary during waste placement to allow conveyance of water during the RA.

c. Pit 4 Overburden Pile: Remove mine waste and impacted subgrade material and place in Pit 4 as waste backfill. Following removal, the disturbed area shall be covered with suitable clean soil and revegetated.

d. Ore and Protore Stockpiles: The existing ore and protore stockpiles shall be removed and placed in Pit 4 as waste backfill. Please note, these materials may not be placed within 20 feet of the top, bottom, or sides of backfilled Pit 4.

e. South Pond Construction: A double-lined pond shall be constructed within the South Waste Rock Pile for water storage during Phase 2 construction activities. Excavated materials shall be placed in Pit 4 as waste backfill.

f. Western Drainage Waste Rock: A sufficient quantity of waste rock from the Western Drainage shall be excavated and placed in Pit 4 as waste backfill.

g. Adit Pit and Pit 2 West: Materials present in the Adit Pit and Pit 2 West shall be excavated as part of the Phase 1 Western Drainage Waste Rock removal and placed in Pit 4 as waste backfill.

h. Placement of Stockpiled Material from Early Works: At the contractor's discretion, materials failing to meet cleanup standards that were stockpiled during the early works (i.e., topsoil stockpile rejects, material from the West Access Road, and contaminated materials removed from the Construction Support Zone) shall be placed in Pit 4 as waste backfill.

i. ~~North~~ Pit 4 ~~North~~ Area: The ~~North~~ Pit 4 ~~North~~ Area ~~(former Discovery Area)~~ shall be regraded and covered. Cut material failing to meet the cleanup standards shall be temporarily stockpiled in a designated area until it can be placed in the waste containment areas as backfill.

j. Borrow Area Haul Road: A haul road to facilitate transportation of cover material from the Rhoads borrow area to the waste containment areas shall be constructed.

k. Borrow Area Development: The approved borrow area within the Rhoads Property shall be developed and sufficient borrow materials shall be removed to cover Pit 4 and other Phase 1 areas that require growth media. Areas that are no longer needed for borrow development shall be reclaimed as needed.

l. Pit 4 Cover: Following completion of waste backfill placement, a geomembrane cap and geocomposite drainage layer (GDL) shall be installed. Once the GDL has been installed, borrow materials shall be hauled and placed over the GDL to complete the 3 foot thick soil cover.

m. Alluvial Groundwater Controls: Alluvial groundwater extraction trenches and barrier walls shall be constructed in the Far East, Central, and Western Drainages.

n. Temporary Influent Pipelines: Temporary pipelines from Pit 4, the alluvial groundwater controls and the BPA to the new South Pond shall be constructed.

3. Phase 2 –Includes regrading the Backfilled Pits Area (BPA) and excavation and placement of mine wastes in Pit 3. Primary objective of the Phase 2 work is to remove all waste from, and meet soil and sediment cleanup standards in the Western and Eastern Drainages so that surface water runoff in these drainage basins can be released to Blue Creek without retention and treatment at the WTP. Demolition of the existing WTP and associated facilities shall occur during Phase 2 provided the NPDES permit is reissued for the new WTP facility. Areas where final grade has been established in the Pit 3 waste containment area, the BPA, and Area 5 shall be capped and revegetated to the extent practical near the end of Phase 2. It is anticipated that demolition of the other existing site facilities (i.e., Blood Pool structures and pipelines) shall occur during Phase 2.The locations of work areas included in the Phase 2 activities are shown on the Contract Documents. The following tasks shall be completed during Phase 2 of the RA:

a. Preparation of Pit 3: Activities to prepare Pit 3 for waste containment include installation of rockfall hazard mitigation measures, dewatering of the pit,

remove existing pit bottom sediments, installation of underdrain system and liner system. Note, underdrain risers shall be installed as necessary during waste placement to allow conveyance of water during the RA.

b. Hillside Waste Rock Pile: Remove and process the remaining Hillside Waste Rock Pile to produce drain rock and overliner protection material for Pit 3. Rejected material shall be placed in Pit 3 as low-reactivity or low-activity waste backfill.

c. Adit Pit and Pit 2 West: This area which was excavated during Phase 1 shall be regraded, covered, and revegetated.

d. Demolition of Existing WTP: The structures and associated facilities shall be demolished. Materials shall be cut to manageable sizes and placed in Pit 3 as waste backfill. This activity shall occur ONLY if the new WTP has been constructed and is operational.

e. East Waste Rock Pile: The East Waste Rock Pile and impacted subgrade shall be excavated and placed in Pit 3 as waste backfill. The disturbed area shall be covered with suitable material as necessary and revegetated.

f. Existing Site Roads: Contaminated material from the internal mine roads and East Access Road shall be excavated. Materials failing to meet the cleanup standards shall be temporarily stockpiled in a designated stockpile area until it can be placed in Pit 3 as waste backfill.

g. Western Drainage Waste Rock: The remaining waste rock and impacted subgrade present in the Western Drainage shall be excavated and placed in Pit 3 as waste backfill.

h. Area 5: Area 5 shall be regraded and covered following completion of processing drain rock from the Hillside Waste Rock Pile.

i. West Pond Construction: The West Pond and surface water controls shall be constructed for water storage during Phase 3 construction activities.

j. Eastern Drainage Sediment Cleanup: Contaminated sediments from the Eastern Drainage shall be excavated and placed in Pit 3 as waste backfill. Disturbed areas shall be reclaimed with suitable soil and revegetated.

k. Western Drainage Sediment Cleanup: Contaminated sediments from the Western Drainage shall be excavated and placed in Pit 3 as waste backfill. Disturbed areas shall be reclaimed with suitable soil and revegetated.

l. Stormwater Attenuation Berms: Construct four stormwater attenuation berms in the Western, Central and Eastern Drainages. Contaminated soils located within the footprint of the berms shall be excavated and placed in Pit 3 as waste backfill.

m~~l~~. Temporary Influent Pipelines: Following placement of the underdrain system, temporary influent pipelines shall be constructed from Pit 3 to the South Pond. At the completion of the Phase 2 efforts, the temporary influent pipelines from the alluvial groundwater controls, Pit 3 seepage collectors, Pit 3, Pit 4, and the BPA dewatering pipelines shall be redirected to the West Pond.

n~~m~~. Continued Borrow Area Development: The approved borrow area within the Rhoads Property shall continue to be developed to produce borrow materials in order to cover Area 5, a portion of Pit 3 and the BPA and other Phase 2 areas that require growth media. Areas that are no longer needed for borrow development shall be reclaimed as needed.

o~~n~~. Partial Pit 3 Cover: A partial cover consisting of a geomembrane cap and geocomposite drainage layer (GDL) shall be installed following completion of Phase 2 waste backfill placement. Once the GDL has been installed, borrow materials shall be hauled and placed over the GDL to complete the 3 foot thick soil cover.

4. Phase 3 – Includes excavation and placement of remaining mine wastes in the upper portion of the Pit 3 waste containment area. During Phase 3, impacted water collected at the Site shall be stored in a lined, temporary storage pond located in the Western Drainage (West Pond). Upon completion of Phase 3, it is anticipated that the only remaining material on Site requiring relocation and containment shall be any impacted sediment that may have accumulated within the West Pond over its relatively short operational life and the West Pond liner materials. These waste materials from the West Pond shall be relocated to a separate waste containment cell located in the Contingency Storage Area in the upper portion of the Area 5/Pit 3 waste containment area as shown on the Contract Drawings. The West Pond shall not be decommissioned until flows at the Site have decreased to the point where the available storage in the permanent equalization ponds at the new WTP can handle the storage requirements of the Site. Phase 3 activities include removal of the PCP, removal of the South Waste Rock Pile, removal of the South Pond, Central Drainage sediment cleanup, final backfilling and covering of Pit 3 and the BPA. The locations of work areas included in the Phase 3 activities are shown on the Contract Drawings. Phase 3 includes the following tasks:

   a. Pollution Control Pond: The PCP shall be decommissioned and the material including any impacted subgrade soil shall be placed in Pit 3 as waste backfill.

   b. South Pond: The South Pond shall be decommissioned and the material placed in Pit 3 as waste backfill.

   c. South Waste Rock Pile: All remaining waste rock and impacted subgrade material from the South Waste Rock Pile shall be excavated and placed in Pit 3 as waste backfill. Disturbed areas shall be reclaimed with suitable soil and revegetated.

   d. Central Drainage Sediment Cleanup: Contaminated sediments from the Central Drainage shall be excavated and placed in Pit 3 as waste backfill. Disturbed areas shall be reclaimed with suitable soil and revegetated.

   e. Final Pit 3 Cover: Following completion of waste backfill placement in Pit 3, a geomembrane cap and geocomposite drainage layer (GDL) shall be installed. Once the GDL has been installed, borrow materials shall be hauled and placed over the GDL to complete the 3 foot thick soil cover.

   f. Continued Borrow Area Development: The approved borrow area within the Rhoads property shall continue to be developed to produce borrow materials in order to cover Area 5, a portion of Pit 3 and the BPA and other Phase 2 areas

that require growth media. Areas that are no longer needed for borrow development and the haul road shall be reclaimed as needed.

g. Permanent Influent Pipelines and Site Maintenance Roads: Following placement of the final Pit 3 cover, permanent WTP influent pipelines and site maintenance roads shall be constructed.

h. Access Controls: Construct final site access controls.

1.5 CONTRACT METHOD

A. Contracting will be done by the COMPANY's contracting department.

1.6 WORK BY OTHERS

A. Where 2 or more contracts are being performed at one time on the same Site or adjacent land in such manner that work under one contract may interfere with work under another, the COMPANY will determine the sequence and order of the Work in either or both contracts. When the Site of one contract is the necessary or convenient means of access for performance of work under another, the COMPANY may grant privilege of access or other reasonable privilege to the contractor so desiring, to the extent, amount, and in manner and at time that the COMPANY may determine. No COMPANY determination of method or time or sequence or order of the work or access privilege shall be the basis for a claim for delay or damage except under provisions of the General Conditions for temporary suspensions of the work. The CONTRACTOR shall conduct its operations so as to cause a minimum of interference with the work of such other contractors, and shall cooperate fully with such contractors to allow continued safe access to their respective portions of the Site, as required to perform work under their respective contracts.

B. Interference With Work On Utilities: The CONTRACTOR shall cooperate fully with all utility components of the COMPANY or other public or private agencies engaged in the relocation, altering, or otherwise rearranging of any facilities which interfere with the progress of the WORK, and shall schedule the WORK so as to minimize interference with said relocation, altering, or other rearranging of facilities.

1.7 SITE ACCESS TIME

A. The CONTRACTOR shall propose working hours and days of operation for review and approval by the COMPANY.

1.8 CONTRACTOR USE OF SITE

A. The CONTRACTOR's use of the Site shall be limited to its construction operations, including on-site storage of materials, on-site fabrication facilities, and field offices.

1.9 OUTAGE PLAN AND REQUESTS

A. Unless the Contract Documents indicate otherwise, the CONTRACTOR shall not remove from service, de-energize, or modify settings for any existing operating tank pipeline, valve, channel, equipment, structure, road, or any other facility without permission from the COMPANY.

B. Where the WORK requires modifications to existing facilities or construction of new facilities and connection of new facilities to existing facilities, the CONTRACTOR shall

submit a detailed outage plan and schedule for the ENGINEER'S approval a minimum of 2 weeks in advance of the time that such outage is planned.

C. A completed System Outage Request form (blank furnished by the ENGINEER) shall accompany each outage plan. The outage plans shall be coordinated with the construction schedule and shall meet the restrictions and conditions of the Contract Documents. The outage plan shall describe the CONTRACTOR's method for preventing bypassing of other treatment units; the length of time required to complete said operation; any necessary temporary power, controls, instrumentation or alarms required to maintain control, monitoring, and alarms for the treatment plant processes; and the manpower, plant, and equipment which the CONTRACTOR will furnish for proper operation of associated treatment units. All costs for preparing and implementing the outage plans shall be at no increase in cost to the COMPANY.

D. The ENGINEER shall be notified in writing at least one week in advance of the required outage if the schedule for performing the work has changed or if revisions to the outage plan are required.

E. The CONTRACTOR shall provide written confirmation of the shutdown date and time two working days prior to the actual shutdown.

1.10 COMPANY USE OF THE SITE

A. The COMPANY may utilize all or part of the Site during the entire period of construction for the conduct of the COMPANY's normal operations. The CONTRACTOR shall cooperate and coordinate with the COMPANY to facilitate the COMPANY's operations and to minimize interference with the CONTRACTOR's operations at the same time. In any event, the COMPANY shall be allowed access to the Site during the period of construction.

1.11 PROJECT MEETINGS

A. Project meetings shall be conducted in accordance with Section 01200 – Project Meetings.

PART 2 -- PRODUCTS (NOT USED)

PART 3 -- EXECUTION (NOT USED)

- END OF SECTION -

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SECTION 01018 – CONSTRUCTION SURVEYING AND STAKING

PART 1 -- GENERAL

1.1 THE REQUIREMENT

A. The WORK under this Section includes providing all labor, materials, tools and equipment necessary to perform all surveying and staking necessary for the completion of the Project in conformance with the Drawings and Specifications and standard engineering and surveying practices, including all calculations required to accomplish the WORK.

B. Primary grade control for fill placement and cover placement in waste containment areas shall be by GPS guidance systems for the heavy equipment conducting the WORK. ~~THIS REQUIREMENT NEEDS TO BE COORDINATED WITH THE FINAL BID DOCUMENTS/RFP~~

C. The Construction Survey work shall include:

1. Staking, referencing and all other actions as may be required to preserve and restore land monuments and property corners which are situated within the Project area

2. Establishing control points as shown on the Drawings and as otherwise needed to provide adequate staking as to perform the WORK.

3. Performing construction staking.

4. Performing construction as-built surveys.

5. Performing construction quantity surveys.

6. Settlement monitoring shall be conducted in accordance with Specification Section 01535S – Settlement Monitoring.

D. The Construction Staking work shall include slope staking for grading operations and offset staking for grades, structures and alignments and other items shown on the Drawings and as required to perform the WORK.

E. Horizontal survey control is Washington State Plane North Zone, NAD 83 US Feet.

1.2 SUBMITTALS

A. Submit in accordance with Section 01300 – Contractor Submittals.

B. The CONTRACTOR shall submit an electronic copy of all surveyors' notes on a quarterly basis. Surveyor's notes shall be scanned and submitted in Adobe Acrobat PDF format

C. **As-Built Drawings and Survey Data Submittals**

1. Drawings and Survey Data from quarterly and annual as-built surveys conducted in accordance with Paragraph 3.4 of this Section shall be submitted within 30 days of completion of survey. Each As-Built submittal package shall include a CD, DVD or USB drive with the following electronic files:

a. All raw survey data.

b. ACAD Drawings of topographic surfaces (AutoCad 2010 Format)

c. Scanned Adobe Acrobat PDF files of all field/survey notes

d. Photographs, or other field data collected by the survey crew.

D. Unacceptable Drawings

1. As-Built survey shall be reviewed by the ENGINEER and incomplete As-Built Drawings will not be accepted.

2. The CONTRACTOR shall revise rejected drawings and resubmit within 10 Days.

PART 2 -- PRODUCTS (NOT USED)

PART 3 -- EXECUTION

3.1 ACCURACY OF SURVEYS

A. Points for cross sections and topographic surveys shall be located to the nearest 0.1 ft horizontally and vertically.

B. Vertical elevation surveys shall close within 0.01 ft times the square root of the length of the circuit in miles.

C. All grade stakes shall be set to 0.1 ft.

D. Alignment of tangents and curves shall be within 0.1 ft.

E. Points for structures shall be set to the nearest 0.1 ft, except where operational function of special features require closer tolerances.

F. Tolerances for all other Work shall be as shown or specified in the Contract Documents.

G. Survey instruments shall be accurate and shall be subject to inspection by ENGINEER for proper operation.

1. Electronic distance measuring (EDM) instruments used by CONTRACTOR on the Site shall be checked for calibration a minimum of once per month on an established base line approved by ENGINEER. Calibration results shall be kept in a log book, available for ENGINEER's review, showing the date and distances measured on the base line. An EDM shall not be used if it does not meet the minimum advertised accuracy published by the manufacturer of the EDM.

2. Defective instruments shall be promptly replaced, repaired, or adjusted to operate within the tolerances of the instrument manufacturer.

H. All work not performed with the methods and equipment as submitted by CONTRACTOR and accepted by ENGINEER shall be removed and replaced by CONTRACTOR at his own expense.

I~~G~~. The ENGINEER may randomly spot-check the CONTRACTOR'S surveys, staking and computations at the ENGINEER'S discretion. After the survey or staking has been

completed, the CONTRACTOR shall provide the ENGINEER with a minimum of 24 hours notice prior to performing any WORK, and shall furnish the appropriate data as required, to allow for such random spot-checking; however, the COMPANY assumes no responsibility for the accuracy of the WORK.

3.2 SURVEY CONTROL

A. All surveying involving property lines or monuments shall be done by, or under the direction of, a Registered Land Surveyor licensed in the State of Washington.

B. The CONTRACTOR shall use competent, qualified personnel and suitable equipment for the layout work required and shall furnish all stakes, templates, straightedges and other devices necessary for establishing, checking and maintaining the required points, lines and grades.

C. The COMPANY shall supply information relative to the approximate locations of monuments and corners, but final responsibility for locations, referencing, and restoration shall rest with the CONTRACTOR.

D. The CONTRACTOR shall not destroy, remove, or otherwise disturb any existing survey markers or other existing street or roadway markers without proper authorization. No excavation or other work shall be started until all survey or other permanent marker points that will be disturbed by the excavation or work have been properly referenced. Survey markers or points disturbed by the CONTRACTOR shall be accurately restored after the work has been completed.

E. In the event the CONTRACTOR does not replace the survey monuments and property corners disturbed by the CONTRACTOR'S operations, the COMPANY may, after first notifying the CONTRACTOR, replace the monuments in question. The cost of such replacements shall be deducted from payments to the CONTRACTOR.

F. The CONTRACTOR shall obtain all information necessary for as-built plan production, from actual measurements and observations made by its own personnel, including Subcontractors.

3.3 CONSTRUCTION STAKING

A. The CONTRACTOR shall perform all staking necessary to delineate clearing and/or grubbing limits; all cross sections necessary for determination of excavation and embankment quantities, including intermediate and/or remeasure cross sections as may be required; all slope staking; all staking of culverts and drainage structures, including the necessary checking to establish the proper location and grade to best fit the conditions on site; the setting of such finishing stakes as may be required; the staking of right-of-way; the taking, reference and other actions as may be required to preserve or restore land monuments and property corners; and all other staking necessary to complete the project.

3.4 ANNUAL AERIAL PHOTOGRAPHY

A. The COMPANY shall perform annual site aerial photography.

3.5 AS-BUILT SURVEYS

A. The CONTRACTOR shall perform and provide annual topographic surveys of all disturbed areas during the WORK. Annual topographic surveys shall be conducted on

or about the anniversary of the date of commencement as stated on the Notice-To-Proceed.

B. The CONTRACTOR shall perform and provide topographic surveys of all completed excavations, including stockpiles (all types), overburden piles, pits, mine waste excavation areas, contaminated soil and sediment excavation areas.

C. **Pit 3 and Pit 4 Waste Containment Area (WCAs) and Mine Waste Excavation As-Built Surveys**

1. The CONTRACTOR shall perform and provide as-built surveys of the final excavated surface of the Pit 3 and Pit 4 Waste Containment Areas (WCAs), prior to placement of the underdrain drain gravel. As-builts surveys of excavated WCAs shall include:

   a. Topographic survey of the entire excavated surface;

   b. Detailed survey of underdrain sumps.

2. The CONTRACTOR shall perform an as-built survey of the completed sub-waste liner systems of the Pit 3 and Pit 4 WCAs, before placement of the overliner protection layer. As-builts surveys of the sub-waste liner systems shall include:

   a. Topographic survey of the entire liner system surface;

   b. Detailed survey of dewatering sumps.

3. The CONTRACTOR shall perform quarterly as-built topographic surveys of the Pit 3 and Pit 4 WCAs during placement of mine waste and the associated excavation areas. Quarterly as-built surveys of excavation and disposal shall include:

   a. Topographic surveys of the WCAs.

   b. Topographic surveys of all active excavation areas during the quarterly period between surveys.

   c. Delineation of pit slope drains.

   d. Location and elevation of dewatering riser pipes.

4. The CONTRACTOR shall perform as-built topographic surveys of the geomembrane cover of the WCAs for each phase of construction. Geomembrane cover surveys shall be conducted prior to placement of cover soils.

   a. Topographic surveys of the completed liner surface shall be of sufficient detail to use for GPS guided equipment placement of the soil cover and final cover grading.

5. The CONTRACTOR shall perform as-built topographic surveys of the completed soil cover of the WCAs for each phase of construction.

3.6 QUANTITY SURVEYS

A. As-built surveys required by Paragraph 3.4 shall be used as the basis for verifying final quantities of excavations and fills for the WORK in the subject areas. Calculations and quantities shall be provided to the ENGINEER for review.

B. The CONTRACTOR shall conduct additional quantity surveys as needed of all borrow areas and fill areas not subject to the as-built surveys required by Paragraph 3.4. Quantity surveys shall include topographical surveys of these areas before the WORK commences and upon completion of the construction phase or completion of the WORK in the subject area. Calculations and quantities shall be provided to the ENGINEER for review.

~~THIS PARAGRAPH REQUIRES COORDINATION WITH SECTION 01050 – MEASUREMENT AND PAYMENT AT 100% DESIGN SUBMITTAL~~

3.7 SURVEY NOTES

A. Field notes shall be kept in standard bound notebooks in a clear, orderly and neat manner, consistent with standard engineering and surveying practices. The CONTRACTOR'S field books shall be available for inspection by the ENGINEER at any time.

B. All field survey notes, including those which become source documentations for which quantities for payment are computed, shall be recorded by a notekeeper furnished by the CONTRACTOR. The notekeeper shall be thoroughly familiar with generally accepted standards of good survey notekeeping practice.

C. The CONTRACTOR shall make all field survey notes available for inspection if requested by the ENGINEER.

D. The CONTRACTOR shall submit copies of all field survey notes on a quarterly basis during the WORK in accordance with Paragraph1.3 of this Section.

- END OF SECTION -

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SECTION 01300 - CONTRACTOR SUBMITTALS

PART 1 -- GENERAL

1.1 SUMMARY

A. Wherever submittals are required by the Contract Documents, submit them to the ENGINEER in accordance with the requirements of this Section. The requirements of this Section apply to all Submittals unless specifically noted on the Drawings or in individual specification sections.

B. Several specific work and safety plans are required by the Contract Documents and shall be submitted in accordance with the requirements of this section. These include, but may not be limited to, the following:

1. Construction Storm Water Pollution Prevention Plan (CSWPPP). Refer to Section 01570.

2. Construction Spill Prevention, Control, and Countermeasures Plan. Refer to Section 01575 – Spill Prevention Control and Countermeasures Plan

3. Submittals required by Section 01585 – Green and Sustainable Practices. Refer to Section 01585, Part 1.3.

~~3.~~4. Marine Installation Plan. Refer to Section 01500 – Marine Installation Requirements.

5. Construction Dewatering Plan. Refer to Section 02140 – Dewatering and Control of Water

~~4.~~6. Shoring Plan. Refer to Section 02200 - Earthwork.

~~5.~~7. Rock Fall Protection Plan. Refer to section 02205 – Mine Waste Excavation and Disposal

~~6.~~8. Blasting Plan. Refer to Section 02210 – Blasting.

C. Within 14 days after the date of commencement as stated in the Notice to Proceed, submit the following items for review:

1. Submittal Schedule

a. Submit a preliminary schedule of Shop Drawings, Samples, and proposed Substitutes ("or equal") submittals listed in the Bid. Where multiple Submittals are expected under a particular specification section each package should be identified in the Submittal Schedule.

b. Base the schedule of submittals on CONTRACTOR's priority, planned construction sequence and schedule, long-lead items, and size of submittal package.

c. Allow time for resubmittals.

2. Submit a list of permits and licenses the CONTRACTOR shall obtain, indicating the agency required to grant the permit and the expected date of submittal for the permit and required date for receipt of the permit.

1.2 PRECONSTRUCTION CONFERENCE SUBMITTALS

A. At the preconstruction conference of Section 01200 Project Meetings, submit the following items to the ENGINEER for review:

1. Revised schedule of Shop Drawings, Samples, and proposed Substitution ("or-equal") submittals listed in the Bid;

2. List of permits and licenses the CONTRACTOR shall obtain, indicating the agency required to grant the permit, the expected date of submittal for the permit, and required date for receipt of the permit (Refer to Specification Section 01060 - Permits;

3. Preliminary Schedule of Values in accordance with Section 01301 – Schedule of Values;

4. a 120-day bar chart plan of operation schedule in accordance with Section 01310 – Construction Schedule~~ or Section 01311 – CPM Schedule~~; and,

5. a project overview bar chart in accordance with Section 01310 – Construction Schedule; ~~or Section 01311 – CPM Schedule;~~

6. Submittal Register

1.3 SHOP DRAWINGS AND GENERAL SUBMITTALS

A. Wherever called for in the Contract Documents or where required by the ENGINEER, furnish an email electronic copy of each Submittal. Electronic submittals shall be in Adobe Acrobat portable document format (pdf) and shall be printed directly from the software generating the information. Illegible pdf documents made by scanning of hard copies, and which are not easily readable, shall be rejected.

B. Shop Drawings include detail design calculations, shop-prepared drawings, fabrication and installation drawings, erection drawings, lists, graphs, catalog sheets, data sheets, and similar items.

C. CONTRACTOR shall provide at least one full size, hard copy of each final, approved, reinforcing steel submittal to the ENGINEER.

D. Whenever the CONTRACTOR is required to submit design calculations as part of a submittal, such calculations shall bear the signature and seal of an engineer registered in the appropriate branch and in the State of Washington, unless otherwise indicated.

E. Transmittal Form

1. Shop drawing submittals shall be accompanied by the ENGINEER's standard submittal transmittal form, a reproducible copy of which is available from the ENGINEER.

2. A submittal without the form, or where applicable items on the form have not been completed, will be returned for resubmittal.

F. Organization

1. Use a single submittal transmittal form for each technical specification Section or item or class of material or equipment for which a submittal is required.

2. A single submittal covering multiple Sections will not be accepted, unless the primary specification references other Sections for components: For example, if a pump Section references other Sections for the motor, shop-applied protective coating, anchor bolts, local control panel, and variable frequency drive, a single submittal would be accepted, whereas a single submittal covering vertical turbine pumps and horizontal split-case pumps would not be accepted.

3. On the transmittal form, index the components of the submittal and insert tabs in the submittal to match the components.

4. Relate the submittal components to specification paragraph and subparagraph, Drawing number, detail number, schedule title, room number, or building name, as applicable.

5. Unless otherwise indicated, match terminology and equipment names and numbers used in the submittals with those used in the Contract Documents.

G. Format

1. Minimum sheet size shall be 8-1/2 inches by 11 inches, and maximum sheet size shall be 24 inches by 36 inches.

2. Number every page in a submittal in sequence.

3. Collate and staple or bind, as appropriate, each copy of a submittal; the ENGINEER will not collate sheets or copies.

4. Where product data from a manufacturer is submitted, clearly mark which model is proposed, with complete pertinent data capacities, dimensions, clearances, diagrams, controls, connections, anchorage, and supports.

5. Present a sufficient level of detail for assessment of compliance with the Contract Documents.

6. Numbering

   a. Assign to each Submittal a unique number as follows:

      1) five-digit number corresponding to the Specification Section to which the Submittal is responding,

      2) followed by a two-digit submittal number in sequential order,

      3) followed by a two-digit submittal number in sequential order to distinguish between the original Submittal and each resubmittal.

   b. For example, 03300-03.01 indicates that the Submittal responds to the requirements of Section 03300 – Cast-In-Place Concrete (03300), is the third (03) Submittal under that section and is the first (01) resubmittal of the product(s) of the unique Submittal.

c. Number the Submittals sequentially for each Specification section, with the submittal numbers clearly noted on the transmittal.

H. Disorganized submittals that do not meet the requirements of the Contract Documents will be returned without review.

I. ENGINEER's Review

1. Except as otherwise indicated, the ENGINEER will return prints of each submittal to the CONTRACTOR with comments noted thereon, within 21 Days following receipt by the ENGINEER.

2. It is considered reasonable that the CONTRACTOR shall make a complete and acceptable submittal to the ENGINEER by the first resubmittal on an item.

3. The COMPANY reserves the right to withhold monies due to the CONTRACTOR to cover additional costs of the ENGINEER's review beyond the first resubmittal.

4. The ENGINEER'S maximum review period for each submittal or resubmittal will be 21 Days; thus, for a submittal that requires 2 resubmittals before it is complete, the maximum review period could be 63 Days.

J. If a submittal is returned to the CONTRACTOR marked "NO EXCEPTIONS TAKEN," formal revision and resubmission will not be required.

K. If a submittal is returned marked "MAKE CORRECTIONS NOTED," the CONTRACTOR shall make the corrections on the submittal, but formal revision and resubmission will not be required.

L. Resubmittals

1. If a submittal is returned marked "AMEND-RESUBMIT," the CONTRACTOR shall revise the submittal and resubmit the required number of copies.

2. Resubmittal of portions of multi-page or multi-drawing submittals will not be accepted: For example, if a Shop Drawing submittal consisting of 10 drawings contains one drawing noted as "AMEND-RESUBMIT," the submittal as a whole is deemed "AMEND-RESUBMIT," and 10 drawings are required to be resubmitted.

3. Every change from a submittal to a resubmittal or from a resubmittal to a subsequent resubmittal shall be identified and flagged on the resubmittal.

M. Rejected Submittals

1. If a submittal is returned marked "REJECTED-RESUBMIT," it shall mean either that the proposed material or product:

   a. does not satisfy the Specification,

   b. the Submittal is so incomplete that it cannot be reviewed,

   c. is disorganized,

   d. is illegible, or

   e. is a substitution request not submitted in accordance with Section 01600 – Products, Materials, Equipment, and Substitutions.

2. In the first four cases, the CONTRACTOR shall prepare a new submittal and shall submit the required number of copies.

3. In the latter case, the CONTRACTOR shall submit the substitution request according to the requirements of Section 01600 – Products, Materials, Equipment, and Substitutions.

4. The resubmittal of rejected portions of a previous submittal will not be accepted.

N. Construction, fabrication or procurement of an item may commence only after the ENGINEER has reviewed the pertinent Submittals and returned the Submittal to the CONTRACTOR marked either "NO EXCEPTIONS TAKEN" or "MAKE CORRECTIONS NOTED." Starting construction, fabrication or procurement of an item marked as "MAKE CORRECTIONS NOTED" may commence only if the CONTRACTOR accepts all corrections noted, otherwise further discussion and resubmittal is required. Commencing construction, fabrication or procurement of items of Submittals marked as "MAKE CORRECTIONS NOTED" and not accepted by the CONTRACTOR, "AMEND-RESUBMIT" or "REJECTED-RESUBMIT" shall be at the sole risk of the CONTRACTOR.

O. Corrections indicated on submittals shall be considered as changes necessary to meet the requirements of the Contract Documents and shall not be taken as changes to the contract requirements.

P. Review by CONTRACTOR

1. Submittals shall be carefully reviewed by an authorized representative of the CONTRACTOR prior to submission to the ENGINEER.

2. Each submittal shall be dated and signed by the CONTRACTOR as being correct and in strict conformance with the Contract Documents.

3. In the case of Shop Drawings, each sheet shall be so dated and signed.

4. Any deviations from the Contract Documents shall be noted on the transmittal sheet.

5. The ENGINEER will only review submittals that have been so verified by the CONTRACTOR.

6. Non-verified submittals will be returned to the CONTRACTOR without action taken by the ENGINEER, and any delays caused thereby shall be the total responsibility of the CONTRACTOR.

Q. Conformance

1. Corrections or comments made on the CONTRACTOR's Shop Drawings during review shall not relieve the CONTRACTOR from compliance with Contract Drawings and Specifications.

2. Review is for conformance to the design concept and general compliance with the Contract Documents only.

3. The CONTRACTOR shall be responsible for confirming and correlating quantities and dimensions, fabrication processes and techniques, coordinating WORK with the trades, and satisfactory and safe performance of the WORK.

1.4 SAMPLES

A. Quantity

1. The CONTRACTOR shall submit the number of samples indicated by the Specifications.

2. If the number is not indicated, submit not less than 3 samples.

3. Where the quantity of each sample is not indicated, submit such quantity as necessary for proper examination and testing by the methods indicated.

B. Identification and Distribution

1. Individually and indelibly label or tag each sample, indicating the salient physical characteristics and the manufacturer's name.

2. Upon acceptance by the ENGINEER, one set of the samples will be stamped and dated by the ENGINEER and returned to the CONTRACTOR, one set of samples will be retained by the ENGINEER, and one set shall remain at the Site in the ENGINEER's field office until completion of the WORK.

C. Selection

1. Unless otherwise indicated, the ENGINEER will select colors and textures from the manufacturer's standard colors and standard materials, products, or equipment lines.

2. If certain samples represent non-standard colors, materials, products, or equipment lines that will require an increase in Contract Times or Price, the CONTRACTOR shall clearly state so on the transmittal page of the submittal.

D. The CONTRACTOR shall schedule sample submittals such that:

1. Sample submittals for color and texture selection are complete so the ENGINEER has 30-Days to assemble color panels and select color- and texture-dependent products and materials without delay to the construction schedule; and,

2. After the ENGINEER selects colors and textures, the CONTRACTOR has sufficient time to provide the products or materials without delay to the construction schedule.

3. The Contract Times will not be extended for the CONTRACTOR's failure to allow enough review and approval or selection time, failure to submit complete samples requiring color or texture selection, or failure to submit complete or approvable samples.

1.5 TECHNICAL MANUAL

A. The CONTRACTOR shall submit technical operation and maintenance information for each item of mechanical, electrical, and instrumentation equipment in an organized manner in the Technical Manual.

B. The manual shall be written such that it can be used and understood by the COMPANY's operation and maintenance staff.

C. Technical Manual(s) shall contain all information which may be needed or useful for operation, maintenance, repair, dismantling or assembling, and for identification of parts for ordering replacements. The manual will be subject to ENGINEER's approval.

D. Categories

1. The Technical Manual shall be subdivided first by Specification Section number; second, by equipment item; and last, by "Category." The following "Categories" shall be addressed (as applicable):

a. Category 1 - Equipment Summary

1) Summary: A table shall indicate the equipment name, equipment number, and process area in which the equipment is installed.

2) Form: The ENGINEER will supply an Equipment Summary Form for each item of mechanical, electrical, and instrumentation equipment in the WORK. The CONTRACTOR shall fill in the relevant information on the form and include it in Part 1.

b. Category 2 - Operational Procedures

1) Procedures: Manufacturer-recommended procedures on the following shall be included in Part 2:

Installation
Adjustment
Startup
Location of controls, special tools, equipment required, or related instrumentation needed for operation
Operation procedures
Load changes
Calibration
Shutdown
Troubleshooting
Disassembly
Reassembly
Realignment
Testing to determine performance efficiency
Tabulation of proper settings for pressure relief valves, low and high pressure switches, and other protection devices
List of all electrical relay settings including alarm and contact settings

c. Category 3 - Preventive Maintenance Procedures

1) Procedures: Preventive maintenance procedures shall include manufacturer-recommended procedures to be performed on a periodic basis, both by removing and replacing the equipment or component, and by maintaining the equipment in place.

2) Schedules: Recommended frequency of preventive maintenance procedures shall be included. Lubrication schedules, including lubricant SAE grade, type, and temperature ranges, shall be covered.

d. Category 4 - Parts List

1) Parts List: A complete parts list shall be furnished, including a generic description and manufacturer's identification number for each part. Addresses and telephone numbers of the nearest supplier and parts warehouse shall be included.

2) Drawings: Cross-sectional or exploded view drawings shall accompany the parts list. Part numbers shall appear on the drawings with arrows to the corresponding part.

e. Category 5 - Wiring Diagrams

1) Diagrams: Category 5 shall include complete internal and connection wiring diagrams for electrical equipment items.

f. Category 6 - Shop Drawings

1) Drawings: This category includes approved shop or fabrication drawings with ENGINEER comments and corrections incorporated, complete with dimensions.

g. Category 7 - Safety

1) Procedures: This category describes the safety precautions to be taken when operating and maintaining the equipment or working near it.

h. Category 8 - Documentation:

1) Equipment warranties, affidavits, certifications, calibrations, laboratory test results, etc. required by the Technical Specifications shall be placed in this category.

E. Format

1. Bind each Technical Manual in standard size 3-ring hardcover binders, labeled on the spine and cover with Project name, COMPANY's project number, Specification Section number, equipment name, and equipment identification number

2. Each Binder shall contain its own detailed table of contents at the front, plus a summary level table of contents information for the other binders in a multi-binder set.

3. Documents in binders shall be 3-hole punched, with no text punched out, and pages larger than 8-1/2 by 11 shall be folded to 8-1/2 by 11 size.

4. Provide a CD with electronic files with each part of the O&M Manual in clearly legible Adobe Acrobat pdf format.

F. Review Process

1. Furnish 3 draft Technical Manuals for each Specification Section that requires a manual.

2. The ENGINEER will retain one copy, will forward one copy to the COMPANY, and will return one copy to the CONTRACTOR with review comments.

3. Incorporate comments and submit six identical hard copies of the final manual plus one electronic copy in Adobe Acrobat pdf format for acceptance. The pdf copy shall be provided in unprotected mode so it can be modified and added to as may become necessary.

G. Submittal and Corrections

1. Except as otherwise indicated, submit the manuals in final form to the ENGINEER not later than the 75 percent of construction completion time.

2. Discrepancies found by the ENGINEER shall be corrected within 30 Days from the Date of written notification by the ENGINEER.

H. Manuals that are incomplete or unacceptable at the schedule criterion above will constitute sufficient justification for the COMPANY to retain the amount in Paragraph "Technical Manual Submittals" of Section 01700 – Project Closeout, from any monies due the CONTRACTOR.

1.6 SPARE PARTS LIST

A. General

1. Furnish to the ENGINEER 5 identical sets of spare parts information for mechanical, electrical, and instrumentation equipment.

2. The spare parts list shall include those spare parts that each manufacturer recommends to be maintained by the COMPANY in inventory.

B. Sources and Pricing

1. The spare parts list shall include a current list price of each spare part.

2. Each manufacturer or supplier shall indicate the name, address, and telephone number of its nearest outlet of spare parts, to assist the COMPANY in ordering.

C. Format

1. Cross-reference the spare parts lists to the equipment numbers designated in the Contract Documents.

2. The spare parts lists shall be bound in standard-size, 3-ring, loose-leaf, vinyl plastic, hard-cover binders suitable for bookshelf storage.

3. The binder ring size shall not exceed 2-1/2 inches.

4. Each copy of the spare parts lists shall be accompanied by a CD containing the lists in electronic format, in files created under Microsoft Office 2010.

1.7 CONTRACTOR RED-LINE DRAWINGS

A. Maintain one set of full-size Contract Drawings at the Site for the preparation of Redline Drawings.

1. On this set, mark changes to location, configuration, material, dimension, and any other change or deviation to the drawing details, cross-sections and plan views which may differ from the Contract Drawings at the time of award except as noted below.

    a. Grading changes do not require recording on Redline Drawings.

    b. Contaminated soil and sediment excavation limits do not require recording on Redline Drawings.

    c. Give special attention to recording the horizontal and vertical location of the following:

        1) Buried utilities that differ from the locations indicated, or that were not indicated on the Contract Drawings.

        2) Depths and locations of sumps.

        3) Pipelines and pipe appurtenances.

2. Supplement the Redline Drawings with any detailed sketches as necessary or as directed, in order to fully indicate the WORK as actually constructed.

3. Use red ink or pencil for alterations and notes.

4. Notes shall identify relevant Change Orders, Substitutions, and RFI's by number and date.

B. The Redline Drawings are the CONTRACTOR's representation of as-built conditions, shall include revisions made by addenda and change orders, and shall be maintained up-to-date during the progress of the WORK.

C. On-site Redline Drawings shall be accessible to the ENGINEER during the construction period for review.

D. Information submitted by the CONTRACTOR will be assumed to be correct, and the CONTRACTOR shall be responsible for the accuracy of such information.

E. Final Payment

1. Final payment will not be acted upon until the Redline Drawings and supplemental information has been completed, verified and submitted to the ENGINEER.

2. Redline Drawings are subject to review by the ENGINEER. CONTRACTOR shall revise and resubmit Redline Drawings based upon the ENGINEER'S review.

1.8 AS-BUILT SURVEYS

A. As-Built Surveys shall be conducted and submitted in accordance with Specification Section 01018 – Construction Survey and Staking.

1.9 QUALITY CONTROL (QC) SUBMITTALS

A. Quality control submittals are defined as those required by the Specifications to present documentary evidence to the ENGINEER that the CONTRACTOR has satisfied certain requirements of the Contract Documents.

B. Unless otherwise indicated, QC submittals shall be submitted:

1. Before delivery and unloading, for the following types of submittals:

a. Manufacturers' installation instructions

b. Manufacturers' and Installers' experience qualifications

c. Ready mix concrete delivery tickets

d. Design calculations

e. Affidavits and manufacturers' certification of compliance with indicated product requirements

f. Laboratory analysis results

g. Factory test reports

2. Within 30 Days of the event documented for the following types of submittals:

a. Manufacturers' field representative certification of proper installation

b. Field measurement

c. Field test reports

d. Receipt of permit

e. Receipt of regulatory approval

C. The ENGINEER will record the date that a QC submittal was received and review it for compliance with submittal requirements, but the review procedures above for Shop Drawings and samples will not apply.

PART 2 -- PRODUCTS (NOT USED)

PART 3 -- EXECUTION (NOT USED)

- END OF SECTION -

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SECTION 01301 - SCHEDULE OF VALUES

PART 1 -- GENERAL

1.1 SUMMARY

~~A.~~ This Section defines the process whereby the Schedule of Values (lump sum price breakdown) shall be developed. ~~and incorporated into the cost loading function of the CPM Schedule in accordance with the requirements of Section 01311 – CPM Construction Schedule.~~

~~B.~~A. Monthly progress payment amounts will be determined from the monthly progress updates of the CPM Schedule activities.

~~C.~~B. Develop the Schedule of Values independent of, but simultaneous with, the development of the CPM Schedule activities and logic.

1.2 DETAILED SCHEDULE OF VALUES

A. Prepare and submit a detailed Schedule of Values for every lump sum bid item to the ENGINEER within 30 Days from the date of Notice to Proceed.

B. Because the ultimate requirement is to develop a detailed Schedule of Values sufficient to determine appropriate monthly progress payment amounts through cost loading of the CPM Schedule activities, furnish a sufficiently detailed breakdown in order to meet this requirement.

C. The ENGINEER will be the sole judge of acceptable numbers, details and description of values established.

D. If, in the opinion of the ENGINEER, a greater number of Schedule of Values items than proposed is necessary, add the additional items so identified by the ENGINEER.

E. Adjustments and Acceptance

1. The CONTRACTOR and ENGINEER shall meet and jointly review the detailed Schedule of Values within 7 Days from the receipt of the Schedule of Values by the ENGINEER, at which time the value allocations and extent of detail shall be reviewed in order to determine if necessary adjustments to the values are required, and to determine if sufficient detail has been proposed in order to allow acceptable cost loading of the CPM Schedule activities.

2. Make necessary adjustments to the value allocation or level of detail, and submit a revised detailed Schedule of Values within 7 Days from the date of meeting with the ENGINEER to discuss the initial submittal of the Schedule of Values.

3. Following acceptance of the detailed Schedule of Values, incorporate the values into the cost loading portion of the CPM Schedule.

4. Concurrently develop the CPM activities and logic with the development of the detailed Schedule of Values; however, it shall be necessary to adjust the detailed Schedule of Values to correlate to individual Schedule activities.

5. It is anticipated that instances will occur, due to the independent but simultaneous development of the Schedule of Values and the CPM Schedule activities, where interfacing these two documents will require changes to each document.

6. Schedule activities may need to be added to accommodate the detail of the Schedule of Values, and Schedule of Value items may need to be added to accommodate the detail of the CPM Schedule activities.

7. Where such instances arise, propose changes to the Schedule of Values and to the CPM Schedule activities in order to satisfy the CPM Schedule cost loading requirements.

1.3 CROSS-REFERENCE LISTING

A. To assist in the correlation of the Schedule of Values and the CPM Schedule, provide a cross-reference listing to be furnished in 2 parts:

1. In the first part, list each scheduled activity with the breakdown of the respective valued items making up the total cost of the activity; and,

2. In the second part, list the valued item with the respective schedule activity or activities that make up the total indicated cost.

B. In the case where a number of schedule items make up the total cost for a valued item (shown in the Schedule of Values), indicate the total cost for each Schedule of Value item.

C. Update and submit these listings in conjunction with the CPM monthly submittals. ~~as indicated in Section 01311 – CPM Construction Schedule.~~

D. Incorporate approved Change Orders reflected in the CPM Schedule into the Schedule of Values as a single unit identified by the Change Order number.

1.4 CHANGES TO SCHEDULE OF VALUES

A. Changes to the CPM Schedule which additional activities not included in the original schedule but included in the original WORK (schedule omissions) shall have values assigned as approved by the ENGINEER.

B. Reduce other activity values in order to provide equal value adjustment increases for added activities, as approved by the ENGINEER.

C. In the event that the CONTRACTOR and ENGINEER agree to make adjustments to the original Schedule of Values because of inequities discovered in the original accepted detailed Schedule of Values, increases and equal decreases to values for activities may be made.

PART 2 -- PRODUCTS (NOT USED)

PART 3 -- EXECUTION (NOT USED)

- END OF SECTION -

SECTION 01510 - TEMPORARY UTILITIES

PART 1 -- GENERAL

1.1 GENERAL

The types of utility services required for general temporary use at the Site include the following:

1. Water service (potable and non-potable)
2. Electric power service
3. Communications service

1.2 JOB CONDITIONS

Scheduled Uses: The CONTRACTOR, in conjunction with establishing the progress schedule, shall establish a schedule for implementation and termination of service for each temporary utility at the earliest feasible time, and when acceptable to the COMPANY, change over from temporary utility service to permanent service.

PART 2 -- PRODUCTS

2.1 MATERIALS

The CONTRACTOR shall provide either new or used materials and equipment, that are in substantially undamaged condition and without significant deterioration and which are recognized in the construction industry by compliance with appropriate standards, as being suitable for intended use in each case. Where a portion of temporary utility is provided by utility company, the CONTRACTOR shall provide the remaining portion with matching and compatible materials and equipment and shall comply with recommendations and requirements of the utility company.

PART 3 -- EXECUTION

3.1 INSTALLATION OF TEMPORARY UTILITY SERVICES

General: Wherever feasible, the CONTRACTOR shall engage the utility company to install temporary service to the Site, or as a minimum, to make connection to existing utility service; locate services where they will not interfere with WORK, including installation of permanent utility services; and maintain temporary services as installed for required period of use; and relocate, modify or extend as necessary from time to time during that period as required to accommodate WORK in progress.

Approval of Electrical Connections: Temporary connections for electricity shall be subject to approval of the power company representative, and shall be removed in like manner at the CONTRACTOR's expense prior to final acceptance of the WORK.

Separation of Circuits: Circuits used for power purposes shall be separate from lighting circuits.

Construction Wiring: Wiring for temporary electric light and power shall be properly installed and maintained and shall be securely fastened in place. Electrical facilities shall conform to the requirements of Electrical Safety Standards, Administration, and Installation WAC 296-46B, Washington State Department of Labor and Industries; and Subpart K of the OSHA Safety and Health Standards for Construction.

3.2 INSTALLATION OF POWER DISTRIBUTION SYSTEM

Power: The CONTRACTOR shall provide power required for its operations under the Contract and shall provide and maintain temporary power lines required to perform the WORK in a safe and satisfactory manner.

Temporary Power Distribution: Temporary power distribution shall be in accordance with Specification Section 01515 – Temporary Distribution Line.

Generators: Generators shall be model year 2011 or newer and shall be compliant with 40 CFR Part 1039 - CONTROL OF EMISSIONS FROM NEW AND IN-USE NONROAD COMPRESSION-IGNITION ENGINES. Generators shall comply with the applicable portions of Specification Section 01585 – Green and Sustainable Practices.

3.3 INSTALLATION OF LIGHTING

Construction Lighting: WORK conducted at night or under conditions of deficient daylight shall be suitably lighted to insure proper performance and to afford adequate facilities for inspection and safe working conditions.

Temporary Lighting: The CONTRACTOR shall provide a general, weatherproof, grounded temporary lighting system in every area of construction as soon as overhead floor/roof deck structure has been installed to provide sufficient illumination for safe working and traffic conditions. Run circuit wiring generally overhead, and rise vertically in locations where it will be least exposed to possible damage from construction operations on grade, floors, decks, or other areas of possible damage or abuse.

3.4 WATER SUPPLY

General: The CONTRACTOR shall provide an adequate supply of water of a quality suitable for all domestic and construction purposes.

The CONTRACTOR shall provide and operate pumping facilities, pipelines, valves, hydrants, storage tanks, and other equipment necessary for the adequate development and operation of the water supply system. Water used for domestic purposes shall be free of contamination and shall conform to the requirements of the State and local authorities for potable water. The CONTRACTOR shall be solely responsible for the adequate functioning of its water supply system and shall be solely liable for any claims arising from the use of same, including discharge or waste of water therefrom.

Water Connections: The CONTRACTOR shall not make connection to or draw water from on-site wells~~,~~ or any other water supply source without gaining permission from the COMPANY.

3.5 INSTALLATION OF SANITARY FACILITIES

Toilet Facilities: Fixed or portable chemical toilets shall be provided wherever needed for the use of CONTRACTOR's employees. Toilets at construction sites shall conform to the requirements of Subpart D, Section 1926.51 of the OSHA Standards for

Construction. Provide separate field office and Construction Support Zone facilities in conformance with Section 01525 – Construction Support Zone Temporary Facilities.

Sanitary and Other Organic Wastes: The CONTRACTOR shall establish a regular collection of sanitary and organic wastes. Wastes and refuse from sanitary facilities provided by the CONTRACTOR or organic material wastes from any other source related to the CONTRACTOR's operations shall be disposed of away from the Site in accordance with laws and regulations pertaining thereto.

3.6 INSTALLATION OF FIRE PROTECTION

Fire Protection: The construction plant and the WORK shall be connected with the CONTRACTOR's temporary water supply system and shall be adequately protected against damage by fire. Hose connections and hose, water casks, chemical equipment, or other sufficient means shall be provided for fighting fires in the temporary structures and other portions of the WORK, and responsible persons shall be designated and instructed in the operation of such fire apparatus so as to prevent or minimize the hazard of fire. The CONTRACTOR's Fire Suppression and Mitigation Plan~~fire protection program~~ shall conform to the requirements of Fire Suppression Equipment WAC 296-24 Part G-3, Washington State Department of Labor and Industries, and Subpart F of the OSHA Standards for Construction.

CONTRACTOR shall furnish, install and maintain a minimum of 10,000 gallons of temporary water storage, and appropriate distribution equipment, for fire suppression water storage. Fire suppression water storage shall be in a temporary tank or water tower or other storage method as approved by the ENGINEER and shall be placed in a location designated by the ENGINEER.

The water storage facility for fire suppression shall not be used for construction water unless a minimum volume of 10,000 gallons is maintained at all times.

3.7 INSTALLATION OF COMMUNICATIONS

Cellular Telephone Services: The CONTRACTOR shall provide and maintain during the progress of the WORK cellular booster equipment and services for primary off-site communications~~not less than one telephone in good working order at its own field construction office at or near the Site. Each such telephone shall be connected to an established exchange for toll service and with other telephones utilized by the CONTRACTOR~~.

Internet Services: The CONTRACTOR shall provide and maintain during the progress of the WORK internet service with not less than 10 mbps download speed and not less than 2 mbps upload speed, and not less than 60 MB monthly data usage allowance. The CONTRACTOR shall provide and maintain a wireless network for use by the COMPANY to access internet services. ~~**Telephone Use:** The CONTRACTOR shall permit the ENGINEER, the COMPANY, or their authorized representatives or employees free and unlimited use of said telephone facilities for calls that do not involve published toll charges. Calls originated by the ENGINEER, the COMPANY, their authorized representatives or employees which involve toll or message unit charges shall be billed to the COMPANY by the CONTRACTOR at the rates charged by the telephone company.~~

~~**Internet Services:** TO BE INCLUDED AT 100% DESIGN~~

3.8 OPERATIONS AND TERMINATIONS

Inspections: Prior to placing temporary utility services into use, the CONTRACTOR shall inspect and test each service and arrange for governing authorities' required inspection and tests, and obtain required certifications and permits for use thereof.

Protection: The CONTRACTOR shall maintain distinct markers for underground lines, and protect from damage during excavating operations.

Termination and Removal: When need for a temporary utility service or a substantial portion thereof has ended, or when its service has been replaced by use of permanent services, or not later than time of substantial completion, the CONTRACTOR shall promptly remove installation unless requested by ENGINEER to retain it for a longer period. The CONTRACTOR shall complete and restore WORK which may have been delayed or affected by installation and use of temporary utility, including repairs to construction and grades and restoration and cleaning of exposed surfaces.

Removal of Water Connections: Before final acceptance of the WORK on the project, temporary connections and piping installed by the CONTRACTOR shall be entirely removed, and affected improvements shall be restored to original condition or better, to the satisfaction of the ENGINEER and to the agency owning the affected utility.

- END OF SECTION –

SECTION 01515 – TEMPORARY DISTRIBUTION LINE

PART 1 -- GENERAL

1.1 INTRODUCTION

A. Temporary power lines shall be constructed at the Midnite Mine Site to provide electricity to the existing WTP and outbuildings where needed, associated dewatering pumps and controls, and the construction support zone throughout all phases until the permanent power system is available. Temporary power line shall be used instead of generators wherever feasible. The capacity of the existing power lines shall be verified by CONTRACTOR to be sufficient to meet the demand of the temporary power line powered equipment prior to use.

~~A.~~B. This specification contains references to standards, codes, best practices and industry specific requirements which shall be applied in conjunction with the project specific details and requirements described in this specification.

~~B.~~C. **Attachment A - Temporary Power Line Performance Specification, appended hereto, contains the specific CONTRACTOR performance requirements for the temporary power lines.**

~~C.~~D. These specifications shall form the technical basis for the design, material procurement and construction of the temporary power distribution lines.

1.2 REFERENCES

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

AEIC CS8	(2007) Specifications for Extruded Dielectric Shielded Power Cable Rated 5 kV through 46 kV
ATIS ANSI O5.1	(2008) Wood Poles -- Specifications & Dimensions

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI C135.14	(1979) Staples with Rolled or Slash Points for Overhead Line Construction
ANSI C29.1	(2002) Test Methods for Electric Power Insulators

AMERICAN WOOD PROTECTION ASSOCIATION (AWPA)

AWPA A3	(2005) Standard Method for Determining Penetration of Preservatives and Fire Retardants
AWPA C1	(2003) All Timber Products - Preservative Treatment by Pressure Processes
AWPA C4	(2003) Poles - Preservative Treatment by Pressure Processes
AWPA T1	(2009) Use Category System: Processing and Treatment Standard

ASTM A123	(2009) Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
ASTM A153	(2009) Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware
ASTM A36/A36M	(2008) Standard Specification for Carbon Structural Steel
ASTM A475	(2003; R 2009e1) Standard Specification for Zinc-Coated Steel Wire Strand
ASTM B1	(2001; R 2007) Standard Specification for Hard-Drawn Copper Wire
ASTM B2	(2008) Standard Specification for Medium-Hard-Drawn Copper Wire
ASTM B231	(2012) Standard Specification for Concentric-Lay-Stranded Aluminum 1350 Conductors
ASTM B232/B232M	(2009) Standard Specification for Concentric-Lay-Stranded Aluminum Conductors, Coated-Steel Reinforced (ACSR)
ASTM B3	(2001; R 2007) Standard Specification for Soft or Annealed Copper Wire
ASTM B8	(2011) Standard Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft
ASTM D 117	(2010) Standard Guide for Sampling, Test Methods, Specifications and Guide for Electrical Insulating Oils of Petroleum Origin
ASTM D 1654	(2008) Evaluation of Painted or Coated Specimens Subjected to Corrosive Environments
ASTM D 2275	(2008) Standard Test Method for Voltage Endurance of Solid Electrical Insulating Materials Subjected to Partial Discharges (Corona) on the Surface
ASTM D 3487	(2009) Standard Specification for Mineral Insulating Oil Used in Electrical Apparatus
ASTM D 877	(2002; R 2007) Standard Test Method for Dielectric Breakdown Voltage of Insulating Liquids Using Disk Electrodes
ASTM D 92	(2005a; R 2010) Standard Test Method for Flash and Fire Points by Cleveland Open Cup Tester
ASTM D 97	(2011) Pour Point of Petroleum Products

ASTM B609	(2012) Standard Specification for Aluminum 1350 Round Wire, Annealed and Intermediate Tempers, for Electrical Purposes

AMERICAN SOCIETY OF CIVIL ENGINEERS (ASCE)

ASCE Manual No. 104	(2003) Recommended Practice for Fiber-Reinforced Polymer Products for Overhead Utility Services
FM APP GUIDE	http://www.approvalguide.com/

INTERNATIONAL CABLE ENGINEERS ASSOCIATION (ICEA)

ICEA-S-94-649	(2013) Concentric Neutral Cables Rated 5 kV through 46 kV
ICEA-T-31-610	(2007) Water Penetration Resistance Test, Sealed Conductor

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE 8	(2002) Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Ground System
IEEE 48	(2011) Test Procedures and Requirements for Alternating-Current Cable Terminations Used on Shielded Cables Having Laminated Insulation Rated 2.5 kV through 765 kV or Extruded Insulation Rated 2.5 kV through 500 kV
IEEE 141	(2002) IEEE Recommended Practice for Electrical Power Distribution for Industrial Plants
IEEE 386	(2002) Standard for Separable Insulated Connector Systems for Power Distribution Systems above 600V
IEEE 400.2	(2005) Guide for Field Testing of Shielded Power cable Systems Using Very Low Frequency (VLF)
IEEE 1235	(2002) IEEE Guide for the Properties of Identifiable Jackets for Underground Power Cables and Jackets
IEEE C37.42	(2009) Standard Specifications for High-Voltage (> 1000 V) Expulsion-Type Distribution-Class Fuses, Fuse and Disconnecting Cutouts, Fuse Disconnecting Switches, and Fuse Links, and Accessories Used with These Devices
IEEE C62.11	(2005; Amd 1 2008) Standard for Metal-Oxide Surge Arresters for Alternating Current Power Circuits (>1kV)
IEEE C135.1	(1999) Standard for Zinc-Coated Steel Bolts and Nuts for Overhead Line Construction
IEEE C135.2	(1999) Threaded Zinc-Coated Ferrous Strand-Eye Anchor Rods and Nuts for Overhead Line Construction

IEEE C135.22	(1988) Standard for Zinc-Coated Ferrous Pole-Top Insulator Pins with Lead Threads for Overhead Line Construction
IEEE C135.30	(1988) Standard for Zinc-Coated Ferrous Ground Rods for Overhead or Underground Line Construction
IEEE C2	(2012) National Electrical Safety Code
IEEE C37.41	(2008; Errata 2009) Standard Design Tests for High-Voltage (>1000 V) Fuses, Fuse and Disconnecting Cutouts, Distribution Enclosed Single-Pole Air Switches, Fuse Disconnecting Switches, and Accessories Used with These Devices
IEEE C37.42	(2009) Standard Specifications for High-Voltage (> 1000 V) Expulsion-Type Distribution-Class Fuses, Fuse and Disconnecting Cutouts, Fuse Disconnecting Switches, and Fuse Links, and Accessories Used with These Devices
IEEE C57.12.20	(2005; INT 1-3 2008) Standard for Overhead Type Distribution Transformers, 500 KVA and Smaller: High Voltage 34 500 Volts and Below: Low Voltage, 7970/13,800 Y Volts and Below
IEEE C57.12.28	(2005) Standard for Pad-Mounted Equipment - Enclosure Integrity
IEEE C62.11	(2005; Amd 1 2008) Standard for Metal-Oxide Surge Arresters for Alternating Current Power Circuits (>1kV)
IEEE Std. Dictionary 100	(2009) IEEE Standards Dictionary: Glossary of Terms & Definitions

INTERNATIONAL ELECTRICAL TESTING ASSOCIATION (NETA)

NETA ATS	(2009) Standard for Acceptance Testing Specifications for Electrical Power Equipment and Systems

INTERNATIONAL ELECTROTECHNICAL COMMISSION (IEC)

IEC 62271-111	(2005) High Voltage Switchgear and Control gear - Part 111: Overhead, Pad-Mounted, Dry Vault, and Submersible Automatic Circuit Reclosers and Fault Interrupters for Alternating Current Systems Up To 38 kV; Ed 1.0

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA FB1	(2012) Standard for Fittings, Cast, Metal Boxes and Conduit bodies for Conduit, Electrical Metal Tubing and Cable
NEMA C135.4	(1987) Zinc-Coated Ferrous Eyebolts and Nuts for Overhead Line Construction

NEMA ICS 6	(1993; R 2006) Enclosures
NEMA TC 2	(2003) Electrical Polyvinyl Chloride (PVC) Conduit
NEMA TC 3	(2004) Polyvinyl Chloride (PVC) Fittings for Use with Rigid PVC Conduit and Tubing
NEMA WC 74/ICEA S-93-639	(2006) 5-46 kV Shielded Power Cable for Use in the Transmission and Distribution of Electric Energy
NEMA WC26	(2008) Binational Wire and Cable Packaging Standard

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2011; TIA 11-1; Errata 2011) National Electrical Code

ORGANISATION FOR ECONOMIC CO-OPERATION AND DEVELOPMENT (OECD)

OECD Test 203	(1992) Fish Acute Toxicity Test

OCCUPATIONAL SAFETY AND HEALTH STANDARDS (OSHA)

OSHA Std 1910.333	Electrical

U.S. DEPARTMENT OF AGRICULTURE (USDA)

RUS 202-1	(2004) List of Materials Acceptable for Use on Systems of RUS Electrification Borrowers
RUS 1728F-806	(2000) Specifications and Drawings for Underground Electrical Distribution

UNDERWRITERS LABORATORIES (UL)

UL 467	(2007) Grounding and Bonding Equipment
UL 486A-486B	(2003; Reprint Feb 2010) Wire Connectors
UL 510	(2005; Reprint Apr 2008) Polyvinyl Chloride, Polyethylene and Rubber Insulating Tape
UL 651	(2005) Schedule 40 and 80 Rigid PVC Conduit and Fittings

1.3 SUBMITTALS

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

B. CONTRACTOR shall prepare and submit a power distribution plan and schedule package (Construction Package) in accordance with Attachment A - Temporary Power Line Performance Specification, Paragraph 3.1 A of this specification.

C. Overhead Power:

1. Pole-mounted equipment information (surge arrester, cable termination, fuse cut-off switch):

a) A certification from the manufacturer, that the technical requirements of this specification are met.

b) Field test reports

2. Product Data:

a) Conductors

b) Insulators

c) Wood poles

d) Cutouts

e) Surge arresters

f) Guy strand

g) Anchors

h) Line hardware

i) Transformers

3. Ground Resistance Test Reports:

a) Submit the measured ground resistance of grounding system. When testing grounding electrodes and grounding systems, identify each grounding electrode and each grounding system for testing. Include the test method and test setup (i.e. pin location) used to determine ground resistance and soil conditions at the time the measurements were made.

4. Certificates:

a) Wood poles

D. Underground Power:

1. Shop Drawings:

a) CONTRACTOR shall submit detailed termination diagrams, documents and shop drawings. Documents shall include detailed descriptions, step-by-step procedures, and pictures describing the method of termination at the structure and method of underground installation.

b) A complete set of physical outline shop drawings detailing all installation procedures, termination components and accessories for the termination shall be submitted to the ENGINEER for review and approval. Upon “Approval” by the ENGINEER, these shop drawings will be utilized as “For Construction” drawings by the CONTRACTOR to complete all terminations and install the 15 kV cable.

2. Product Data: Product data on all components utilized for the terminations shall be submitted to the ENGINEER for review and approval. Product data shall include

but are not limited to items such as cables, cable terminations, bushings, cable supports, method of shield connections or earthling methods, conduits and etc.

3. Certified Test Reports: CONTRACTOR shall provide certified copies of all the test reports.

4. Test Data and Calculations: CONTRACTOR shall supply test data and calculations supporting the cable system design and reliability requirements as supplied by the cable manufacturer.

5. Pulling Plan: CONTRACTOR shall provide pulling plan for the direct buried cable.

6. Earthwork Plan: CONTRACTOR shall submit excavation method plan and fill method plan.

1.4 REGULATORY REQUIREMENTS

A. In each of the publications referred to herein, consider the advisory provisions to be mandatory. Interpret references in these publications to the "authority having jurisdiction," or words of similar meaning, to mean the COMPANY/ ENGINEER. Provide equipment, materials, installation, and workmanship in accordance with the mandatory and advisory provisions of NFPA 70 and IEEE C2 unless more stringent requirements are specified or indicated.

1.5 DELIVERY, STORAGE AND HANDLING

A. Visually inspect devices and equipment when received and prior to acceptance from conveyance. Protect stored items from the environment in accordance with the manufacturer's published instructions. Replace damaged items. Store surge arrester, cable terminations and fused cut-off switches in accordance with the manufacturer's requirements. Handle and store wood poles in accordance with the manufacturer's instructions.

PART 2 -- PRODUCTS

2.1 GENERAL

A. Standard Products

1. Provide materials and equipment that are products of manufacturers regularly engaged in the production of such products which are of equal material, design and workmanship. Provide products that have been in satisfactory commercial or industrial use for 2 years prior to bid opening. The 2-year period includes applications of equipment and materials under similar circumstances and of similar size. Provide a product that has been on sale on the commercial market through advertisements, manufacturers' catalogs, or brochures during the 2-year period. Where two or more items of the same class of equipment are required, provide items that are products of a single manufacturer; however, the component parts of the item need not be the products of the same manufacturer unless stated in this section.

B. Alternative Qualifications

1. Products having less than a 2-year field service record are acceptable if a certified record of satisfactory field operation for not less than 6000 hours, exclusive of the manufacturers' factory or laboratory tests, is furnished.

C. Material and Equipment Manufacturing Date

1. Do not use products manufactured more than 3 years prior to date of delivery to site, unless specified otherwise.

2.2 OVERHEAD PRODUCTS

A. MATERIALS

1. Consider materials specified herein which are identical to materials listed in RUS 202-1 as conforming to requirements.

B. POLES

1. Wood Poles

a) Wood poles machine trimmed by turning, [Douglas Fir] conforming to ATIS ANSI O5.1 and RUS Bulletin 1728E-700. Wood poles shall not be gained. Ensure the quality of each pole with "WQC" (wood quality control) brand on each piece, or by an approved inspection agency report.

2. Storage

a) For poles stored for any reason more than 2 weeks, stack them on decay-resistant skids of such dimensions and so arranged as to support the poles without producing noticeable distortion. Stack poles in a manner that permits free circulation of air; with the bottom poles of the stacks at least 1-foot above ground level or any vegetation growing thereon. No decayed or decaying wood is permitted to remain underneath stored poles. Store the poles in accordance with manufacturer’s instructions.

3. Preservative

a) Treat wood poles with waterborne preservatives conforming to AWPA T1. The preservative shall be EPA approved and meets FIFRA.

4. Treatment

a) Poles shall be full-length pressure treated. All poles in the treating vessel shall be exclusively Douglas fir and have similar pole volume (size). All poles not conforming to the specified minimum treatment requirements shall be rejected or retreated. Only one retreat is permitted. Any pole not passing, after a second treatment, is unacceptable.

5. Penetration

a) Compliance, regardless of actual pole size, shall be verified in accordance with AWPA C4 for Group B poles. Minimum depth of penetration shall be as follows, determined by vision examination, enhanced with dye, or the Bill Stein flame method as necessary or as required by AWPA.

Location	Penetration
Near the pole brand	0.75" and 100% of the sapwood (Whichever is greater)
Groundline (deep incised zone)	100% entire cross-section*

* Skips in penetration are allowed in three (3) or less consecutive annual rings as long as the skips are located in the innermost 1/3 of the core sample.

6. Butt Treatment

   a) Poles shall be butt treated according to AWPA Standards U1, T1, M1 and M4.

7. Preservative Treatment for Field-Drilled Holes

   a) All field-drilled holes shall be treated with a preservative compound. Unused holes shall be plugged with treated wood dowel pins 3 inch in length.

8. Handling

   a) Do not drag treated poles along the ground. Do not use pole tongs, cant hooks, and other pointed tools capable of producing indentations more than 1 inch in depth, in handling the poles. Poles shall be lifted and supported as per manufacturer's instructions. Do not apply tools to the groundline section of any pole. Groundline section is that portion between 1 foot above and 2 feet below the ground line.

C. CROSSARMS AND BRACKETS

1. Fiberglass Crossarms

   a) Provide cross-sectional area dimensions of 4-5/8 inches in height by 3-5/8 inches in depth in accordance with IEEE C2. Provide crossarms that are 10 feet in length. Provide required climbing space and wire clearances by drilling.

2. Armless Construction

   a) Provide brackets either integrally as part of an insulator or attached to an insulator with a suitable stud. Provide bracket mounting surface suitable for the shape of the pole. Provide pole top brackets that conform to IEEE C135.22. Provide brackets that have a strength exceeding that of the required insulator strength, but in no case less than a 2800 pound cantilever strength.

D. HARDWARE

1. Provide hot-dip galvanized hardware in accordance with ASTM A153 and ASTM A123. Provide zinc-coated hardware that complies with IEEE C135.1, IEEE C135.2, NEMA C135.4, ANSI C135.14 IEEE C135.22. Provide steel hardware that complies with ASTM A575 and ASTM A576. Install washers under bolt heads and nuts as required. Make the diameter of holes in washers the correct standard size for the bolt on which a washer is used. Provide washers for use under heads of carriage-bolts, of the proper size to fit over square shanks of bolts. Use eye bolts, bolt eyes, eye nuts, strain-load plates, lag screws, guy clamps, fasteners, hooks, shims, and clevises wherever required to support and to protect poles, brackets, crossarms, guy wires, and insulators.

E. TRANSFORMERS – POLE-MOUNTED AND PAD-MOUNTED

1. CONTRACTOR shall properly size and specify the pole-mounted and pad-mounted transformers per the relevant requirements contained in the following documents: ANSI 70, ANSI/IEEE C57.12.00, ANSI C57.12.26, ANSI C57.12.70-1978, ANSI C57.12.00-1987, ANSI C62.11-1987, ANSI C57.12.90-1987, ANSI C57.12.20-1988, ANSI C57.12.28-1988, ANSI C57.12.25-1990, ANSI C57.12.26-1992, ANSI C57.12.00-1993, ANSI C57.12.90-1993, ANSI C57.12.90-1999, ANSI C57.12.35-2007, ANSI C26.11-Draft 1, ASTM D2161-1987, ASTM D877-1987, ASTM D445-1988, ASTM D92-1990, IEEE 386-1985, IEEE 386-1995, NEMA 260-1982, FMERC P7825, AIM X5-2, and AIM X5-4.

2. CONTRACTOR also shall coordinate with the utility company to ensure compliance with their transformer specifications and associated requirements.

3. The transformer selection criteria and transformer cut sheets shall be reviewed by ENGINEER prior to procurement.

F. INSULATOR

1. Provide polymer insulators which are radio interference free.

b) Suspension insulators: ANSI Class DS-15

c) Spool insulators: ANSI C29.3

d) Guy strain insulators: ANSI C29.4

e) Pin insulators: ANSI C29.5

G. OVERHEAD CONDUCTORS, CONNECTORS AND SPLICES

1. Use conductors of aluminum conductor steel reinforced (ACSR). Where aluminum conductors are connected to dissimilar metal, use fittings conforming to UL 486A-486B.

a) Solid Copper

i. ASTM B1, ASTM B2, and ASTM B3, hard-drawn, medium-hard-drawn, and soft-drawn, respectively. ASTM B8, stranded.

2. Aluminum Conductor Steel Reinforced (ACSR)

a) The conductor shall be Class AA concentric-lay-stranded H-19 (hard-drawn) alloy 1350. The outer layer of strands of the conductor shall have a right-hand lay.

b) Aluminum – The electrical resistivity of selected samples shall conform to the latest revision of ASTM Specification B230 and shall not exceed 17.002 ohms–circular-mil/foot at 20°C for distribution conductors. (Standard Conductivity - equivalent to 61.2% material with a 61.0% minimum conductivity.)

c) Steel – The coated steel core wires shall conform to the latest revision of ASTM Specification B498 (Class A, Galvanized) or B802 (Aluminum-Mischmetal Alloy).

d) Zinc – The zinc or zinc-alloy coating shall conform to the latest revision of ASTM Specification B498 or B802, respectively.

e) The conductor as received shall be clean and free of imperfections not consistent with good commercial practice per ASTM B232. In addition, the following visual imperfections observed as the conductor is wound onto or off from the shipping reel, shall be cause for rejection:

i. Splaying that exceeds the following limits: (Splaying is defined as the spreading of the peripheral strands of the conductor that potentially weakens the conductor.

- Gaps between outer strands of more than 1/2 the strand diameter,
- Any raised strands that cannot be pressed back into its position with the normal force of one finger

ii. Crossovers: Any strand that is popped out of position and lying over another stand

iii. Excessive scuffing: This is characterized as multiple scrapes on the surface and along the length of the conductor with associated burrs of aluminum protruding from the strand. Characterized as more than just a dent or dimple. It is recognized that, in the manufacturing of twisted pair conductor, there is rubbing between the sub-conductors that would not be detrimental to the performance of the conductor.

3. Connectors and Splices

a) Provide connectors and splices of copper alloys for copper conductors and copper-to-copper that complies with UL 486A-486B.

H. GUY STRAND

1. ASTM A475, extra high-strength, Class A, galvanized strand steel cable. Provide guy terminations designed for use with the particular strand and developing at least the ultimate breaking strength of the strand.

I. ANCHOR AND ANCHOR RODS

1. Site Conditions

a) Local variations in the characteristics of the subsurface materials shall be anticipated and are not justification for contract changes. The CONTRACTOR is responsible for verifying the location of all utilities that may be affected by construction of the installation of the anchors. Any difficulties encountered in the installation of the specified anchor, due to changed or unforeseen conditions in the field, shall be referred to COMPANY/ ENGINEER for analysis and recommendation.

J. GROUNDING AND BONDING

1. Driven Ground Rods

a) Provide copper-clad steel ground rods conforming to UL 467 not less than 5/8 inch in diameter by 8 feet in length.

2. Grounding Conductors

a) ASTM B8. Provide soft drawn copper wire ground conductors a minimum No. 4 AWG.

3. Grounding Connections

a) UL 467. Compression and bolted connectors.

K. SURGE ARRESTERS

1. IEEE C62.11, metal oxide, polymeric-housed, surge arresters arranged for crossarm mounting. Provide 9 kV RMS voltage rating. Provide Distribution class arresters. The surge arrester shall be Hubbell Power Systems or equal #213715-7324.

L. FUSED CUTOUTS

1. Type K fuses conforming to IEEE C37.42 with ampere ratings equal to 150 percent of the transformer full load rating. Open link type fuse cutouts are not acceptable. Fuse cutouts shall be Hubbell Power Systems or equal # C7101142.14

M. CALKING COMPOUND

1. Provide compound for sealing of conduit risers that is of a puttylike consistency workable with hands at temperatures as low as 35 degrees F, that does not slump at a temperature of 300 degrees F, and that does not harden materially when exposed to air. Provide compound that readily caulks or adheres to clean surfaces of the materials with which it is designed to be used. Provide compound that has no injurious effects upon the workmen or upon the materials.

N. NAMEPLATES

1. Manufacturer's Nameplate

a) Provide each item of equipment with a nameplate bearing the manufacturer's name, address, model number, and serial number securely affixed in a conspicuous place; the nameplate of the distributing agent is not acceptable. Provide equipment containing liquid-dielectrics with the type of dielectric on the nameplate.

2. Field Fabricated Nameplates

a) ASTM D 709. Provide laminated plastic nameplates for each equipment enclosure, relay, switch, and device. Identify the function and, when applicable, the position with each nameplate inscription. Provide melamine plastic, 0.125 inch thick nameplates, white with black center~~blackcenter~~ core. Provide matte finish surface. Provide square corners. Accurately align lettering and engrave

into the core. Minimum size of nameplates is one by 2.5 inches. Minimum size of lettering is 0.25 inch high normal block style.

2.3 UNDERGROUND PRODUCTS

A. ACCEPTABLE SUPPLIER

1. The supplier of the 15 kV cables, the pad-mounted transformer terminations, and outdoor terminations shall be Southwire cables, or equal. Conduits, as needed, shall be supplied by CONTRACTOR as approved by COMPANY's ENGINEER.

B. MATERIALS

1. The CONTRACTOR shall furnish all material required for the completion of the work as shown on the drawings and/or listed in the specifications.

   a) 15 kV Cable

      i. 15kV medium voltage cables shall have the following characteristics

System line voltage	13.2 kV
Rated cable voltage	15 kV
Phase to ground rated voltage (Vg)	9 kV
BIL	110 kV
Max. conductor temp. under normal operation	90°C

      ii. The cable shall be polymer insulated moisture blocked concentrically stranded-dielectric cable rated for service at 15 kV. The conductor shall be aluminum 1/0 with 19 strands rated at 100% insulation level, with semi-conducting cross-linked polyethylene strand shield, a tree-retardant cross-linked polyethylene primary insulation, and a semi-conducting cross-linked polyethylene insulation shield. A concentric neutral of bare copper wires and semi-conducting polyethylene jacket applied over the insulation shield shall be supplied.

      iii. The cable shall conform to the following requirements:

- Length: Cable shall be furnished in reels containing cable lengths such that all individual cable runs can be made without splices. No splices shall be allowed in the cable runs.

- Conductor: Conductor shall be aluminum alloy 1350 concentric-lay stranded, Class B conductors with circular cross-section and free from any metallic or foreign particles that may contaminate the insulation. The conductor shall have smooth interface with no intermediate joint and well compacted.

- Semi-Conducting XLPE Strand Shield: Cable shall have semi-conducting XLPE strand shield.

- Tree-Retardant XLPE Insulation: Main insulation shall be tree-retardant cross linked polyethylene insulation, at least 30 mils

thickness, and as described in ICEA-S-93-639 and NEC. It shall be free from void and contaminants. The minimum thickness at any point shall not be less than 90% of the specified thickness. The void, contaminant and amber limits for XLPE insulated cables shall be as described in the relevant standard. The insulation thickness shall comply with the ICEA S-96-659.

- XLPE Insulation Shield: A semi-conducting shield shall be provided. Triple head extrusion process shall be used to firmly bond the conductor, insulation and insulation shield together. The three layers shall be cross-linked in a dry curing process.

- Neutral: Concentric neutral conductors shall be copper suitable for use in the three phase circuit. The concentric neutral shall consist of #14AWG, uncoated bare annealed copper wires per ICEA Standards. The concentric neutral strands shall be smooth and free from corrosion, oil.

- Jacket: Cable shall have an overall semi-conducting polyethylene jacket suitable for the direct burial.

iv. Each cable length shall be furnished with a watertight pulling socket eye which shall be fitted to the pulling end. Pulling socket eye shall be able to withstand the pulling force.

v. The cable system shall be suitable for installation in direct burial, conduits, and in open air.

vi. The cable system shall withstand all mechanical and thermal stresses under steady state and transient operating conditions.

vii. A distinctive marking including the following details shall be identified continuously on the jacket. The semi-conducting layer marking and method of marking shall comply with the standard. The following marking shall be subjected to the ENGINEER's approval.

- Rated Voltage (15 kV)

- Type of main insulation (XLPE)

- Conductor material and size

- Supplier's Name

- Year of manufacture

- Sequential marking of length of cable

viii. The jacket shall be marked with three red stripes.

ix. Packing: The finished cable shall be wound on steel or wooden reels. It shall be suitably packed and protected against water so that it shall not be damaged during transportation. The CONTRACTOR shall be responsible for the disposal of empty reels from the Site.

b) Terminations

i. All terminations to be rated for 15kV, 60 Hz, suitable for pad-mounted transformer cables. The terminations shall comply with IEEE 48, Class 1 and shall be suitable for use with the type of the cable supplied.

ii. Each termination shall be packaged as a self-sufficient kit including: skirts, stress control terminator, ground clamp, connectors, and lugs. It shall contain packing kits, instructions as required for the installation and testing.

iii. Terminations, where required, shall be provided with mounting brackets suitable for the intended installation and with grounding provisions for the cable shielding, metallic sheath, or armor.

iv. Terminations shall be the product of one manufacturer, suitable for the type, diameter, insulation class and level, and materials of the cable terminated. Do not use separate parts of copper or copper alloy in contact with aluminum alloy parts in the construction or installation of the terminator.

v. Cold-Shrink Type: Terminator shall be a one-piece design, utilizing the manufacturer's latest technology, where high-dielectric constant (capacitive) stress control is integrated within a skirted insulator made of silicone rubber. Termination shall not require heat or flame for installation. Termination kit shall contain all necessary materials (except for the lugs). Termination shall be designed for installation in low or highly contaminated indoor and outdoor locations and shall resist ultraviolet rays and oxidative decomposition.

vi. Termination mounted on the structure shall be Tyco Electronics #TF-151E, or equal. Brackets/ supports to support the bushings and facilitate cable entrance to the bushings from the bottom shall be provided by the CONTRACTOR.

vii. 200 Ampere loadbreak connector with optional jacket seal ratings: Voltage: 15 kV, 95 kV BIL. Short time rating: 10,000 rms symmetrical amperes. The connector shall be Cooper Power Systems or equal, #LEJ215CCACC2CT. Two load break bushing inserts – one –with latch indicator ring and one without latch indicator ring -Cooper Power Systems or equal, # LBI215 shall be provided. An insulated bushing well plugs Cooper Power Systems or equal, #IBWP225 shall also be provided.

viii. All clamps, ground sheaths, supporting brackets and insulators, cable guides, etc. as required to furnish an integral MV cable system which runs from the deadend riser pole to the pad-mounted transformer shall be furnished and installed by the CONTRACTOR. All tools and equipment required for terminating of 15 kV cables shall be supplied by the CONTRACTOR. The termination and jointing kits shall be suitable for the cable and complete with all the accessories including crimping type cable lugs, jointing materials and consumables.

ix. Tests shall be carried out on the cable termination components of each type and rating being furnished in accordance with IEEE 48. Cable test shall be in accordance with AEIC CS8.

c) Load-Break Elbows

i. The cable/elbow interface is sealed by pulling the integral jacket seal over the joint.

ii. Elbows should be installed with enough slack for hot-stick operations including switching and grounding.

iii. The load current carrying rating of an elbow is effected by load and internal cabinet temperature. For areas that experience high temperature and excessive loads, the area ENGINEER must be contacted for derating of elbows in order to reduce failures.

d) Cable Testing Capabilities

i. The cable end unit design for each termination shall include the capability for high voltage testing of the connected power cable on site.

e) Buried Warning and Identification Tape

i. CONTRACTOR shall provide detectable tape from Grainger or equal.

f) Grounding Systems

i. CONTRACTOR shall provide grounding system as indicated on the project drawing

C. SPECIFIED SPARE PARTS

1. The following spare parts shall be furnished with the cable and three-phase terminations:

a) One (1) complete cable termination for the three-phase pad-mounted transformer.

b) One (1) complete outdoor cable to air termination.

D. FACTORY TESTS

1. The tests shall be in accordance with AEIC CS8. A certified test report showing test results shall be submitted for ENGINEER's review and approval.

2. The production tests shall include partial discharge, high voltage DC withstand test, jacket test and neutral indent test on jacket in accordance with AEIC CS8.

3. Terminations, including bushings and component parts, shall be tested in accordance with IEEE 48.

PART 3 -- EXECUTION

3.1 GENERAL

A. In accordance with the specifications contained in this section and/ or as directed, the CONTRACTOR shall furnish all labor, materials, and equipment required to procure (including factory test), deliver to site, route and install, field test and commission the overhead power lines and/ or underground cables. The CONTRACTOR shall also be responsible for material and labor required for trenching, excavation and backfill. The CONTRACTOR shall be solely responsible for procuring any applicable permits and for all construction means, methods, techniques, sequences, procedures, and safety and compliance programs in connection with the performance of the work. The CONTRACTOR shall determine the locations of all existing power, communication and pipeline facilities that might interfere with the overhead power line and underground cable in accordance with the applicable rules and regulations.

3.2 OVERHEAD EXECUTION

A. Provide overhead pole line installation conforming to requirements of IEEE C2 overhead lines in heavy loading districts and NFPA 70 for overhead services.

B. TREE TRIMMING

1. Where lines pass through trees, trim trees at least 15 feet clear on both sides horizontally and below for medium-voltage lines, and 5 feet clear on both sides horizontally and below for other lines. Do not allow a branch to overhang horizontal clearances.

C. WOOD POLE INSTALLATION

1. Provide pole holes at least as large at the top as at the bottom and large enough to provide 4 inch clearance between the pole and side of the hole. Provide a 6 inch band of soil around and down to the base of the pole treated with 2 to 3 gallons of a one percent dursban TC termiticide solution.

2. Setting

a) Pole holes must be a minimum of 8 inches wider than the butt diameter of the pole. When pole bearing plates are used, pole holes must be the minimum diameter necessary for installation of the pole. The excavated hole must be at least as large at the bottom as at the top.

b) Accumulated water must be removed from the hole prior to setting the pole. Any soil added to level the bottom of the holes must be tamped before the pole is set in the hole.

3. Bedrock Excavation

a) When shallow bedrock is encountered, the CONTRACTOR shall provide special drilling equipment, including but not limited to: rock core barrels, rock tools, air tools, and other equipment as necessary to construct the excavation to the size and depth required.

4. Backfill

a) If Engineered backfill becomes required, the ideal mix shall be free of organic material and conform to the requirements for Type I, Gradation C, surface-course materials, ANSI/ASTM D1241, except that one hundred percent (100%) shall pass the one and one half (1-1/2) inch screen and that a minimum of eight percent (8%) shall pass the No. 200 screen in lieu of the minimum percentage shown in Table I for Gradation C.

b) Percentages by sieve size for the engineered backfill are as follows:

GRADATION REQUIREMENTS FOR ENGINEERED BACKFILL	
SIEVE SIZE (SQUARE OPENINGS)	**PERCENT PASSING SIEVE (BY WEIGHT)**
1-1/2”	100
3/8”	50 - 85
NO. 4	35 - 65
NO. 10	25 - 50
NO. 40	15 - 30
NO. 200	8 - 15

c) If material conforming to this gradation is costly to provide and/or difficult to locate, the ENGINEER will review samples of road mix which may be locally available and inform the CONTRACTOR of suitability of proposed material. For bid purposes, the CONTRACTOR shall assume that local material can be used without screening for an acceptable gradation, provided that the materials consistency allows compaction to act as a firm base and that it contains no aggregate larger than two (2) inches.

d) Backfill must be placed around the pole in layers not exceeding 6 inches in depth, with each layer mechanically tamped before the next layer is added. The backfill must be compacted to a density equal to or greater than that of the surrounding undisturbed soil. Backfill shall be free of large rocks, organic material or other low density, unsuitable soils and shall be banked and tamped twelve inches above the natural ground surface. If satisfactory backfill material is not available from the excavation or within the immediate vicinity of the structure, the CONTRACTOR would import any additional material required for setting of structures, as approved by the Project ENGINEER. All additional backfill shall be provided by the CONTRACTOR.

e) Upon completion of stringing operations, the CONTRACTOR shall inspect structure compaction at each location for settlement. The CONTRACTOR shall re-tamp poles where necessary due to settlement, mounding up engineered backfill around poles to an elevation of twelve inches above the natural grade, and must be sloped away from pole.

5. Setting Poles

   a) Set poles so that alternate crossarm gains face in opposite directions, except at terminals and dead ends where gains of last two poles are on side facing terminal or dead end. On unusually long spans, set poles so that crossarm comes on side of pole away from long span. Where pole top pins are used, place on opposite side of pole from gain, with flat side against pole.

6. Alignment of Poles

   a) Poles shall be raked, as required so that they shall remain plumb at the corner, angle and terminal structures after conductors are installed to required tension.

7. Marking

   a) Mark each pole in accordance with the requirements of ATIS ANSI O5.1. Mark each pole with height, class, etc. 5 ft above groundline. Mark on the face of the pole at other locations standard with the pole manufacturer, where approved by the COMPANY/ ENGINEER.

D. ANCHOR AND GUY INSTALLATION

1. Place anchors in line with strain. Provide indicated length of the guy lead (distance from base of pole to the top of the anchor rod). Anchors shall be placed in the proper depth excavation to allow a minimum of six inches of rod extension after the guy tension has been applied. Native soils obtained from the excavation should be used to backfill and compact the anchor as necessary.

   a) Setting Anchors

      i. Set anchors in place with anchor rod aligned with, and pointing directly at, guy attachment on the pole with the anchor rod projecting 6 to 9 inches out of ground to prevent burial of rod eye.

   b) Backfilling Near [Plate] Anchors

      i. Backfill plate, expanding, concrete, or cone type anchors with tightly tamped coarse rock 2 feet immediately above anchor and then with tightly tamped earth filling remainder of hole. Backfill plate anchors with tightly tamped earth for full depth of hole.

   c) Screw Anchors

      i. Power installed screw anchors must be installed with the appropriate size and type of equipment in accordance with the ENGINEER's requirements and manufacturer's recommendations. Screw anchors must not be reversed to meet the requirements of project of the rods above the ground. All installations must be witnessed by the COMPANY's representative.

   d) Guy Installation

      i. Securely clamp plastic guy marker to the guy or anchor at the bottom and top of marker. Complete anchor and guy installation, dead end to dead end, and tighten guy before wire stringing and sagging is begun on that

line section. Provide strain insulators at a point on guy strand 8 feet minimum from the ground and 6 feet minimum from the surface of pole. Effectively ground and bond guys to the system neutral.

ii. Each guy must be pretensioned to remove any slack in the guy. Guys must be retensioned after the conductors and overhead ground wires are installed to plumb the poles and to equalize tensions in the guys. If slack guys are found, they must be readjusted so that all guys in any structure have approximately equal tension. The final tension in the guys and the plumb of the poles must meet the approval of the ENGINEER.

e) Proof Tests

i. All anchors are to be proof-tested by the application of a 20,000 lb. load for the duration of three minutes.

E. HARDWARE

1. Provide hardware with washer against wood and with nuts and lock nuts applied wrench tight. Provide locknuts on threaded hardware connections. Provide M-F style locknuts and not palnut style.

F. GROUNDING

1. Unless otherwise indicated, provide grounding that conforms to IEEE C2 and NFPA 70. Provide pole grounding electrodes with a resistance to ground not exceeding 25 ohms.

a) Ground Rod Installation

i. Step 1: Install eight (8) feet of ground rod and measure the ground resistance using a~~an~~ COMPANY-approved testing procedure and instrument(s). If the structure footing resistance is twenty-five (25) ohms or less, record the structure number and structure footing resistance. If the structure footing resistance is greater than twenty-five (25) ohms go to Step 2.

ii. Step 2: Install additional eight (8) foot rod sections until a footing resistance of twenty-five (25) ohms or less is achieved or until the rod has either been driven thirty-two (32) feet or can be driven no further. If the structure footing resistance is twenty-five (25) ohms or less, record the structure number, structure footing resistance and number of ground rods driven. If the structure footing resistance is greater than twenty-five (25) ohms go to Step 3.

iii. Step 3: Install a second ground rod at a new location and repeat Step 2. If the structure footing resistance is still greater than twenty-five (25) ohms after a maximum of four (4) ground rods have been driven at four (4) separate locations then record the structure number, structure footing resistance, number of ground rods driven and contact the ENGINEER of COMPANY's representative so that alternative grounding procedures can be issued if required.

b) If ground rod cannot be installed properly due to presence of bedrock, contact the ENGINEER or COMPANY's representative so that alternative grounding procedures can be issued.

2. Grounding Electrode Conductors

a) On multi-grounded circuits, as defined in IEEE C2, provide a single continuous vertical grounding electrode conductor. Bond neutrals, surge arresters, and equipment grounding conductors to this conductor. For single-grounded or ungrounded systems, provide a grounding electrode conductor for the surge arrester and equipment grounding conductors and a separate grounding electrode conductor for the secondary neutrals. Staple grounding electrode conductors to wood poles at intervals not exceeding 2 feet. Size grounding electrode conductors as indicated. Connect secondary system neutral conductors directly to the transformer neutral bushings, then connect with a neutral bonding jumper between the transformer neutral bushing and the vertical grounding electrode conductor as indicated. Bends greater than 45 degrees in grounding electrode conductor are not permitted.

3. Grounding Electrode Connections

a) Make above grade grounding connections on pole lines by exothermic weld or by using a compression connector. Make exothermic welds strictly in accordance with manufacturer's written recommendations. Welds which have puffed up or which show convex surfaces indicating improper cleaning, are not acceptable. No mechanical connectors are required at exothermic weldments. Provide compression connectors that are the type that uses a hydraulic compression tool to provide correct pressure. Provide tools and dies recommended by compression connector manufacturer. Provide an embossing die code or similar method as visible indication that a connector has been fully compressed on ground wire.

4. Grounding and Grounded Connections

a) Where no primary or common neutral exists, bond together surge arresters and frames of equipment operating at over 750 volts and connect to a dedicated primary grounding electrode.

b) Where no primary or common neutral exists, transformer secondary neutral bushing, secondary neutral conductor, and bond together frames of equipment operating at under 750 volts and connect to a dedicated secondary grounding electrode.

c) When a primary or common neutral exists, connect all grounding and grounded conductors to a common grounding electrode.

G. CONDUCTOR INSTALLATION

1. Line Conductors

a) Handle conductors with care necessary to prevent nicking, kinking, gouging, abrasions, sharp bends, cuts, flattening, or otherwise deforming or weakening conductor or any damage to insulation or impairing its conductivity. Remove damaged sections of conductor and splice conductor. Provide conductors that are paid out with the free end of conductors fixed and cable reels portable, except where terrain or obstructions make this method unfeasible. Make the bend radius for any insulated conductor not less than the applicable NEMA specification recommendation. Do not draw conductors over rough or rocky ground or around sharp bends. When installed by machine power, provide conductors that are drawn from a mounted reel through stringing sheaves in straight lines clear of obstructions. Check the initial sag and tension, in accordance with the manufacturer's approved sag and tension charts, within an elapsed time after installation as recommended by the manufacturer.

2. Connectors and Splices

a) Provide conductor splices, as installed, that exceed ultimate rated strength of conductor and are of the type recommended by conductor manufacturer. No splices are permitted within 25 feet of a support. Provide connectors and splices that are mechanically and electrically secure under tension and are of the non-bolted compression type. Make splices have a tensile strength of not less than the rated breaking strength of the conductor. Provide splice materials, sleeves, fittings, and connectors that are noncorrosive and that do not adversely affect conductors. Wire brush and apply an oxide inhibitor to aluminum-composition conductors before making a compression connection. Connectors which are factory-filled with an inhibitor are acceptable. Provide types of inhibitors and compression tools recommended by the connector manufacturer. Provide solderless pressure type low-voltage connectors for copper conductors. Smoothly tape noninsulated connectors to provide a waterproof insulation equivalent to the original insulation, when installed on insulated conductors. On overhead connections of aluminum and copper, install the aluminum above the copper.

3. Ties

a) Provide ties on pin insulators tight against conductor and insulator and ends turned down flat against conductor so that no wire ends project.

4. Guard Structures

a) Guard structures must be furnished and installed by the CONTRACTOR, where required, to prevent the conductor or overhead ground wires which are being pulled from coming into contact with existing overhead electric supply lines, communication lines, roads, highways, and railroads crossed by the line. All labor and materials required must be furnished by the CONTRACTOR and included in the cost for conductor.

b) After completion of all wire work, the CONTRACTOR shall remove the guard structures, fill and tamp all pole holes, and restore the right-of-way and access to its original condition.

5. Reinstalling Conductors

a) When splicing wire into existing spans the existing wire tension shall be determined prior to cutting into existing wire. After splicing in new wire the span wires shall be re-sagged to the same condition as existing.

6. New Conductor Installation

a) The CONTRACTOR shall perform stringing in accordance with IEEE Publication 524, "Guide to the Installation of Overhead Transmission Line Conductors", subject to the conductor manufacturer's concurrence.

b) The precise stringing procedures which include equipment to be used, number of crews, composition, and responsibilities of each crew, proposed equipment set-up, locations of all splices, and locations and descriptions of temporary snubs and anchors shall be submitted to the ENGINEER or COMPANY's representative for review and approval prior to any stringing operations.

c) The CONTRACTOR shall take extreme care during the conductor stringing operation to avoid damage to conductor or overhead ground wire strands. This damage can be defined as any deformity on the wire which can be detected by sight or touch. Kinked, twisted, abraded, "bird-caged", or flattened wire will not be allowed to remain on the line. If damage is found, the stringing operation shall be halted. Any conductor found to be damaged as described above shall be replaced or repaired by the CONTRACTOR at his own expense, and to the satisfaction of the ENGINEER or the COMPANY's representative.

d) The stringing tension shall be high enough to ensure that the conductor does not drag across the ground, trees, underbrush, fences, guard structures, towers, or any other surface other than the stringing sheaves. The CONTRACTOR shall continuously inspect the conductor as it leaves the reels. If the conductor has an accumulation of grease, oil, dirt or any other foreign substance, such substance shall be removed as the wire leaves the reels by a method approved by the ENGINEER or the COMPANY's representative.

e) No more than one splice shall be allowed in each phase of a tension section consisting of more than one span. No splices are allowed in single span tension sections.

f) Not more than two (2) reels of conductor per phase may be pulled at one time. Full tension compression splices shall not be pulled through the stringing blocks.

g) During stringing operations, the CONTRACTOR shall ensure that the conductor will not be dragged on the ground, driven over with vehicles, or allowed to come into contact with any fences or other structures. Fences and small structures should be removed or well covered during the stringing operation. The CONTRACTOR shall not begin stringing operations unless weather reports indicate that wind and weather will allow adequate time to sag and clip in all structures.

h) All conductors shall be sagged to the proper tensions in accordance with the initial stringing sag and tension data charts provided by the ENGINEER. All sagging shall be checked by dynamometer or by sighting with a target and transit as indicated in the IEEE Publication 524. CONTRACTOR shall ensure that all sags shall be within a tolerance of +3 and -0 inches of the specified values in the stringing charts.

i) The CONTRACTOR shall select the length of each sag and the sag-checking spans subject to the review and approval of the ENGINEER. Regardless of the CONTRACTOR's sagging method, the CONTRACTOR shall ensure that uniform tensions are realized throughout the sag and that the allowable sag and tolerances are not exceeded.

j) The CONTRACTOR shall make any and all necessary adjustments in the conductor or hardware at any time during the construction period to ensure that the conductor is at the proper tension, sags are within tolerance, and suspension insulators and overhead ground wire assemblies hang plumb. These ongoing adjustments will be furnished by the CONTRACTOR at no additional cost to the COMPANY.

k) The CONTRACTOR shall ensure that each reel of wire is sagged within seventy-two (72) hours after the start of the stringing operation.

7. Fittings

a) Provide dead end fittings [clamp or compression type] that conform to written recommendations of ENGINEER of record and that develop full ultimate strength of conductor.

8. Aluminum Connections

a) Make aluminum connections to copper or other material using only splices, connectors, lugs, or fittings designed for that specific purpose. Keep a copy of manufacturer's instructions for applying these fittings at job site for use of the inspector.

H. JUMPERS

1. All jumpers must be installed in accordance with the manufacturer's recommendations. Jumper wire loops must be of sufficient length to present a smooth, uniformly curving appearance, and which do not put the jumper string of insulators in compression. Excess length of conductor from the wire stringing operation may be used to make up the jumper loops.

I. REELS AND EXCESS CONDUCTOR

1. CONTRACTORs shall be responsible for salvaging the wire reels and all excess conductor and overhead ground wire. All such wire must be inventoried, placed on reels, and returned to the client or disposed of as directed by the ENGINEER. Returnable reels must be shipped back to the wire fabricators in accordance with the ENGINEER's instruction. Nonreturnable wood reels must be disposed of in a manner meeting the approval of the ENGINEER. All costs associated with the receiving, handling, shipping, or disposal of excess wire and reels must be in the labor costs for installation of wire units.

J. RISER

1. Secure galvanized steel conduits on riser pole by galvanized steel pipe straps spaced no more than four feet as indicated and within 3 feet of any outlet or termination. Ground metallic conduits. Secure steel riser shields on poles as indicated.

K. CROSSARM MOUNTING

1. Extend bolts not less than 1/8 inch or more than 2 inches beyond nuts. On single crossarm construction, install the bolt head on the crossarm side of the pole. Provide fiberglass crossarm braces on crossarms.

2. Line Arms and Buck Arms

   a) Provide line arms and buck arms that are set at right angles to lines for straight runs and for angles 45 degrees and greater; and line arms that bisect angles of turns of less than 45 degrees. Use dead-end assemblies for turns where shown. Install buck arms, as shown, at corners and junction poles. Provide double crossarms at ends of joint use or conflict sections, at dead-ends, and at angles and corners to provide adequate vertical and longitudinal strength. Provide double crossarms at each line-crossing structure and where lines not attached to the same pole cross each other.

3. Equipment Arms

   a) Set equipment arms parallel or at right angles to lines as required to provide climbing space. Locate equipment arms below line construction to provide necessary wire and equipment clearances.

L. FIELD QUALITY CONTROL

1. Perform field testing in the presence of the COMPANY/ ENGINEER. Notify the COMPANY/ ENGINEER prior to conducting tests. Furnish materials, labor, and equipment necessary to conduct field tests. Perform tests and inspections recommended by the manufacturer unless specifically waived by the COMPANY/ ENGINEER. Maintain a written record of tests which includes date, test performed, personnel involved, devices tested, serial number and name of test equipment, and test results. Sign and date field reports.

   a) Safety

      i. Provide and use safety devices such as rubber gloves, protective barriers, and danger signs to protect and warn personnel in the test

vicinity. Replace any devices or equipment which are damaged due to improper test procedures or handling.

b) Sag and Tension Test

i. Give the COMPANY/ ENGINEER prior notice of the time schedule for stringing conductors or cables serving overhead medium-voltage circuits. The COMPANY/ ENGINEER reserves the right to witness the procedures used for ascertaining that initial stringing sags and tensions are in compliance with requirements for the applicable loading district and cable weight.

c) Pre-Energization Services

i. Perform the following services on the equipment listed below. Perform these services subsequent to testing but prior to the initial energization. Inspect the equipment to insure that installation is in compliance with the recommendations of the manufacturer. Inspect terminations of conductors at major equipment to ensure the adequacy of connections. Inspect bare and insulated conductors between such terminations to detect possible damage during installation. If factory tests were not performed on completed assemblies, perform tests after the installation of completed assemblies. Inspect components for damage caused during installation or shipment and to ensure that packaging materials have been removed.

d) Performance of Acceptance Checks and Tests

i. Perform in accordance with the manufacturer's recommendations and include the following visual and mechanical inspections and electrical tests, performed in accordance with NETA ATS.

- Grounding System
  - Visual and mechanical inspection: Inspect ground system for compliance with contract plans and specifications.
- Electrical tests
  - Perform ground-impedance measurements utilizing the fall-of-potential method. On systems consisting of interconnected ground rods, perform tests after interconnections are complete. On systems consisting of a single ground rod perform tests before any wire is connected. Take measurements in normally dry weather, not less than 48 hours after rainfall. Use a portable ground testing megger in accordance with manufacturer's instructions to test each ground or group of grounds. Provide an instrument that is equipped with a meter reading directly in ohms or fractions thereof to indicate the ground value of the ground rod or grounding systems under test.

ii. Devices Subject to Manual Operation

- Operate each device subject to manual operation at least three times, demonstrating satisfactory operation each time.

e) Follow-Up Verification

i. Upon completion of acceptance checks and tests, show by demonstration in service that circuits and devices are in good operating condition and properly performing the intended function. As an exception to requirements stated elsewhere in the contract, give the COMPANY/ ENGINEER 5 working days advance notice of the dates and times of checking and testing.

3.3 UNDERGROUND EXECUTION

A. GENERAL

1. SHIPPING

a) In general, dusty conditions will exist at the site and hence wherever possible, the cable ends, bushings, and terminating materials shall be well protected during transport. Cable ends shall be kept sealed by heat shrinkable PVC or polyethylene caps to prevent damage and ingress of moisture.

B. CONTRACTOR'S RESPONSIBILITY

1. CONTRACTOR shall install all materials, connected, erected, cleaned and conditioned in accordance with the manufacturer's instructions, except as otherwise provided in the specifications.

2. CONTRACTOR shall determine the locations of all existing power, communication and pipeline facilities within the project areas in accordance with applicable laws and regulations. CONTRACTOR shall bring to COMPANY and ENGINEER any interference and make provisions subject to ENGINEER approval to avoid interference with the operation and maintenance of such facilities.

3. CONTRACTOR shall provide indoor weather proof storage suitable for storing cable splicing and terminating materials and other weather sensitive equipment. The storage shall be adequately sized to contain and allow the inspection of the material and equipment.

4. CONTRACTOR shall provide all tools and equipment required for the complete installation.

5. CONTRACTOR shall do all grubbing, soil and rock excavation, drilling, forming, sheathing, pumping and draining required for proper installation of the work.

6. The CONTRACTOR shall interface and coordinate terminations and the methods of terminations with the transformer supplier to ensure no major problems occur during installation.

C. TRENCHING

1. Trenches for direct-burial cables shall be excavated to depths required to provide the minimum necessary cable cover. When rock is encountered, remove to a depth of at least 3 inches below the cable and fill the space with sand.

2. Bottoms of trenches shall be smooth and free of stones and sharp objects. Where materials in bottoms of trenches are other than sand, a 3 inch layer of sand shall be laid first and compacted to approximate densities of surrounding firm soil.

3. Trenches shall be not less than 15 inches wide, and shall be in straight lines between cable markers. Cable plows shall not be used.

4. Bends in trenches shall have a radius consistent with the cable manufacturer's published minimum cable bending radius for the cable installed.

5. Cables shall be directly buried in earth below the frost line per IEEE C2 and NEC. Minimum depth of burial shall not be less than 36 inches.

D. CABLE INSPECTION

1. Prior to installation, each cable reel shall be inspected for correct storage positions, signs of physical damage, and broken end seals. If end seal is broken, moisture shall be removed from cable prior to installation in accordance with the cable manufacturer's recommendations.

E. CABLE INSTALLATION PLAN AND PROCEDURE FROM MANUFACTURER

1. The CONTRACTOR shall obtain from the manufacturer an installation manual or set of instructions that address such aspects as cable construction, insulation type, cable diameter, bending radius, cable temperature limits for installation, lubricants, coefficient of friction, conduit cleaning, storage procedures, moisture seals, testing for and purging moisture, maximum allowable pulling tension, and maximum allowable sidewall bearing pressure. CONTRACTOR shall then prepare a checklist of significant requirements, perform pulling calculations and prepare a pulling plan which shall be submitted along with the manufacturer’s instructions in accordance with submittals. Cable shall be installed strictly in accordance with the cable manufacturer's recommendations and the approved installation plan.

2. Calculations and pulling plan shall include:

   a) Site layout drawing with cable pulls identified in numeric order of expected pulling sequence and direction of cable pull.

   b) List of cable installation equipment.

   c) Lubricant manufacturer's application instructions.

   d) Procedure for resealing cable ends to prevent moisture from entering cable.

   e) Cable pulling tension calculations of all cable pulls.

   f) Cable sidewall bearing pressure.

   g) Cable minimum bend radius and minimum diameter of pulling wheels used.

   h) Cable jam ratio.

   i) Maximum allowable pulling tension on each different type and size of conductor.

j) Maximum allowable pulling tension on pulling device.

F. CABLE INSTALLATION

1. The cables shall be unreeled along the sides of or in trenches and carefully placed on sand or earth bottoms. Pulling cables into direct-burial trenches from a fixed reel position will not be permitted, except as required to pull cables through conduits under paving or railroad tracks and through conduits at overhead line structure and pad mounted transformer.

2. Cable placement shall be done under constant ENGINEER's supervision.

3. Where two or more cables are laid parallel in the same trench, space cables laterally at not less than 3 inches apart.

4. Where direct burial cable transitions to duct-enclosed cable, direct-burial cables shall be centered in duct entrances, and a waterproof nonhardening mastic compound shall be used to facilitate such centering.

5. Sufficient slack, and in no case less than 24 inches, must be left at riser structure and transformer pads so that movements of the cable after backfilling will not damage or strain the cable. Riser conduit shall extend at least 18 inches below grade at riser poles.

6. Bends in cables shall have an inner radius not less than those specified per manufacturer's recommendation. Cable bends must not be made within 6 inches of the cable terminal base.

G. BACKFILL AND COMPACTING

1. The first six inches of trench backfill shall be free from rock, gravel or other material which will damage the cable jacket.

2. The CONTRACTOR shall place a 2 inch bed of clean sand under the cable and 4 inches of clean sand above the cable. This soil layer shall be carefully compacted so that the cable is not damaged. The remainder of trench backfill shall be compacted to a density not less than the natural in-place dry density of the surrounding earth. Backfill shall be free of large rocks (>0.75''), organic material or other low density, unsuitable soils.

3. Backfilling shall be completed in such a manner that voids will be minimized. Excess soil shall be piled on top and must be well tamped.

4. Restore to their original elevation and condition unpaved surfaces disturbed during installation of direct burial cable.

5. Preserve sod and topsoil removed during excavation and reinstall after backfilling is completed. Replace sod that is damaged by sod of quality equal to that removed.

H. ALUMINUM CONDUCTOR TERMINATION

1. Use particular care in making up joints and terminations. Remove surface oxides by cleaning with a wire brush or emery cloth. Apply joint compound to conductors, and use UL-listed solid aluminum connectors for connecting aluminum conductors.

When connecting aluminum to copper conductors, use connectors specifically designed for this purpose.

2. Terminate aluminum conductors at cable terminators on the riser structure by using all-aluminum nuts, bolts, washers, and lugs, or as directed by cable terminator manufacturer.

3. Connect the load-break elbow connector, bushing well to pad-mounted transformer.

I. GROUNDING

1. Ground concentric neutral wires of each phase conductor and bond with a ground wire at each termination at the riser structure and pad-mounted transformer.

J. SEALING AND FIELD TESTS

1. When the installation is complete, CONTRACTOR shall seal all conduit and other entries into the equipment enclosure with an approved sealing compound. Seals shall be of sufficient strength and durability to protect all energized live parts of the equipment from rodents, insects, or other foreign matter.

2. After installation of the 15 kV cable and all terminations are complete, field acceptance tests as identified below shall be performed. The Supplier's site representative and the ENGINEER shall sign-off on the individual certified test forms.

3. Visual and mechanical inspections include the following:

   a) Inspect exposed cable sections for physical damage.

   b) Verify that cable is supplied and connected in accordance with contract plans and specifications

   c) Inspect for proper shield grounding, cable support, and cable termination

   d) Verify that cable bends are not less than ICEA or manufacturer's minimum allowable bending radius

   e) Visually inspect jacket and insulation condition

   f) Inspect for proper phase identification and arrangement

4. Measurement of electrical resistance shall be conducted between ends of each complete conductor and termination.

5. The following electrical tests shall be conducted:

   a) Perform a shield continuity test on each power cable by ohmmeter method. Record Ohmic value, resistance values in excess of 1 ohms per 100 feet of cable shall be investigated and justified.

   b) Perform high potential test on cable.

6. Commissioning: After all tests have been completed, commissioning of the complete system shall be performed.

- END OF SECTION -

ATTACHMENT A

TEMPORARY POWER LINE PERFORMANCE SPECIFICATION

PART 1 – GENERAL

1.1 INTRODUCTION

A. Temporary power lines shall be constructed at the Midnite Mine Site to provide electricity to the existing WTP and outbuildings where needed, associated dewatering pumps and controls, and the construction support zone throughout all phases until the permanent power system is available. Temporary power line shall be used instead of generators wherever feasible. The capacity of the existing power lines shall be verified by CONTRACTOR to be sufficient to meet the demand of the temporary power line powered equipment prior to use.

B. It is intended that this attachment contain the specific requirements for the temporary power lines. The Temporary Distribution Line specification contains references to standards, codes, best practices and industry specific requirements which shall be applied in conjunction with the project specific details and requirements described in this specification. The specifications shall form the technical basis for the design, material procurement and construction of the temporary power lines.

C. CONTRACTOR is responsible for coordination, design and installation of an electrical distribution system at the site. System changes needed to accommodate CONTRACTOR's remediation Work will be performed by the CONTRACTOR to meet the CONTRACTOR's schedule and the project's powered equipment needs.

1.2 POWER LINE ENGINEERING AND DESIGN

A. LOAD AND WEATHER CASES

1. The required load and weather cases are described in the following tables, which the CONTRACTOR shall use to design the power line and the supporting structures.

Table 1. Loads Cases

Description	Weather case	Cable condition	Wire Vert. Load Factor	Wire and Struct. Wind Load Factor	Wire Tension Load Factor	Struct. Weight Load Factor	Strength Factor Steel Poles Tubular-Arms	Strength Factor Wood Poles	Strength Factor Concrete Poles Ultimate	Strength Factor Guys	Strength Factor Non- Tubular Arms	Strength Factor Braces	Strength Factor Insulators	Strength Factor Foundation
RULE 250B	NESC Heavy District Loading (250B)	Initial RS	1.5	2.5	1.65	1.5	1	0.65	1	0.9	0.65	0.65	1	1
RULE 250B Uplift	NESC Heavy District Loading (250B)	Initial RS	1	2.5	1.65	1	1	0.65	1	0.9	0.65	0.65	1	1
RULE 250C	NESC Extreme Wind (250C)	Initial RS	1	1	1	1	1	0.75	1	0.9	0.75	0.75	1	1
RULE 250D	NESC Concurrent Ice and Wind (250D)	Initial RS	1	1	1	1	1	0.75	1	0.9	0.75	0.75	1	1
RULE 277 Insulators	NESC Heavy District Loading (250B)	Initial RS	1	1	1	1							1	1
Extreme Ice	Extreme Ice	Initial RS	1	1	1	1	1	1	1	1	1	1	1	1
Uplift	Cold Uplift	Initial RS	1	1	1	1	1	1	1	1	1	1	1	1
RULE 261A	NESC Extreme Wind (250C)	Initial RS	1	1	1	1	1	0.75	1	0.9	0.75	0.75	1	1
RULE 250B (Broken Wire)	NESC Heavy District Loading (250B)	Initial RS	1.5	2.5	1.65	1.5	1	0.65	1	0.9	0.65	0.65	1	1
RULE 250C (Broken Wire)	NESC Extreme Wind (250C)	Initial RS	1	1	1	1	1	0.75	1	0.9	0.75	0.75	1	1
RULE 250D (Broken Wire)	NESC Concurrent Ice and Wind (250D)	Initial RS	1	1	1	1	1	0.75	1	0.9	0.75	0.75	1	1
Extreme Ice (Broken Wire)	Extreme Ice	Initial RS	1	1	1	1	1	1	1	1	1	1	1	1

Table 2. Weather Cases

Description	Air Density Factor (Q) (psf/mph^2)	Wind Velocity (mph)	Wind Pressure (psf)	Wire Ice Thickness (in)	Wire Ice Density (lbs/ft^3)	Wire Temp. (deg F)	Weather Load Factor	NESC Constant (lbs/ft)	Wire Wind Height Adjust Model	Wire Gust Response Factor
NESC Heavy District Loading (250B)	0.00256	39.5	4	0.5	57	0	1	0.3	None	1
NESC Extreme Wind (250C)	0.00256	90	20.7	0	0	60	1	0	NESC 2012	NESC 2012
NESC Concurrent Ice and Wind (250D)	0.00256	40	4.1	0.5	57	15	1	0	None	1
Extreme Ice	0.00256	0	0	0.5	57	30	1	0	None	1
Cold Uplift	0.00256	0	0	0	0	-20	1	0	None	1
Maximum Operating	0.00256	0	0	0	0	212	1	0	None	1
NESC Tension Limit (261H1b)	0.00256	0	0	0	0	0	1	0	None	1
NESC Blowout 6PSF	0.00256	48.4	6	0	0	60	1	0	None	1
No Wind (SWING 1)	0.00256	0	0	0	0	60	1	0	None	1
Moderate Wind (SWING 2)	0.00256	48.4	6	0	0	32	1	0	None	1
Moderate Wind (SWING 3)	0.00256	48.4	6	0	0	60	1	0	None	1
High Wind (SWING 4)	0.00256	90	20.7	0	0	60	1	0	None	1
GALLOPING (SWING)	0.00256	28.0	2	0.5	57	32	1	0	None	1
GALLOPING (SAG)	0.00256	0	0	0.5	57	32	1	0	None	1
-20 Deg F	0.00256	0	0	0	0	-20	1	0	None	1
0 Deg F	0.00256	0	0	0	0	0	1	0	None	1
30 Deg F	0.00256	0	0	0	0	30	1	0	None	1
32 Deg F & 1/2 Inch Ice	0.00256	0	0	0.5	57	32	1	0	None	1
60 Deg F	0.00256	0	0	0	0	60	1	0	None	1
90 Deg F	0.00256	0	0	0	0	90	1	0	None	1
120 Deg F	0.00256	0	0	0	0	120	1	0	None	1
167 Deg F	0.00256	0	0	0	0	167	1	0	None	1
212 Deg F	0.00256	0	0	0	0	212	1	0	None	1

B. WIRE TENSION LIMITS

1. Power line design shall be in conformity with the wire tension limits requirements shown in the table below.

Table 3. Wire Tension Limits

Weather case	Cable condition	% of Ultimate
NESC Heavy District Loading (250B)	Initial RS	60
NESC Extreme Wind (250C)	Initial RS	80
NESC Concurrent Ice and Wind (250D)	Initial RS	80
NESC Tension Limit (261H1b)	Initial RS	35
NESC Tension Limit (261H1b)	Creep RS	25
0 Deg F	Creep RS	14

C. PERMANENT STRETCH DUE TO CREEP AND LOAD

1. Weather cases are listed in the following table for calculating the permanent stretches due to creep and short term exposure to extreme loads.

Table 4. Weather Cases for Final after Creep and Load

Weather Case for Final after Creep
60 Deg F

Weather Cases for Final after Load
NESC Heavy District Loading (250B)
NESC Extreme Wind (250C)
NESC Concurrent Ice and Wind (250D)
Extreme Ice

D. CLEARANCES

1. CONTRACTOR shall be responsible for designing and constructing the power lines to the NESC minimum clearance requirements including but not limited to the vertical clearances above ground and other obstacles, horizontal clearances from line conductors to objects, clearances between conductors and between conductors and overhead ground wire, and clearances of conductors from supporting structures.

E. STRUCTURE TYPES AND CONFIGURATIONS

1. CONTRACTOR shall be responsible for establishing the detailed configuration, design, and detailing of all structures in the structure family following the general configuration guidelines as described in the Midnite Temporary Power Line Technical Specification.

2. CONTRACTOR shall submit structure design calculations and drawings, fabrication details, alignment drawing and fabrication drawings for review by ENGINEER.

F. FOUNDATION

1. Wood pole structures may be direct embedded using native backfill where applicable. CONTRACTOR shall determine the required embedment depth using accepted design and analysis methods. When the required depth becomes greater than ten percent (10%) plus four (4) feet using the average embedded diameter of the pole only, a combination of increased hole diameter and engineered backfill shall be used to determine an appropriate embedment.

2. CONTRACTOR shall coordinate with COMPANY/ Supervising CONTRACTOR to conduct Geotechnical field investigation to assist in the foundation design.

G. SPOTTING

1. Structures shall be spotted to maintain the NESC minimum clearance requirements. In addition, spotting shall be compliant with clearances to edge of established right-of-way.

H. POWER LINE INTERFACE

1. CONTRACTOR shall be responsible for coordinating with COMPANY to assure integrated construction schedules and design compatibility between newly constructed and existing power lines.

I. RE-USE OF POLES

1. In order to re-use some of the existing poles installed during the previous construction phase(s), the third party pole inspection company like Osmose Utilities Services, Inc. or equal shall be involved to perform the inspection and/ or testing of the strength and conditions of the poles. CONTRACTOR shall also ensure the reused poles meet the design criteria and requirements contained in the power line specifications.

PART 2 – PRODUCTS (NOT USED)

PART 3 – EXECUTION

3.1 POWER LINE CONSTRUCTION

A. GENERAL REQUIREMENTS

1. CONTRACTOR shall prepare a complete power distribution plan and schedule package (Construction Package) to be submitted no later than thirty (60) days prior to construction mobilization. Unless otherwise specified, CONTRACTOR shall provide three (3) paper copies and two (2) digital copies of the Construction Package. The Construction Package shall be bookmarked, on ANSI "B" paper (11"x17"), as applicable in three-ring binders with sections labeled and ordered, including, but not limited to the following:

- Location Map
- Plan & Profile Drawings
- Outage Constraints with Complete Schedule
- Right-of-Way Constraints
- Geotechnical Reports
- Staking Sheets
- Structure Drawings
- Structure Foundation Drawings
- Structure Erection Drawings
- Conductor Installation and Handling
- Insulator and Hardware Assembly Drawings
- Initial and Final Sag Charts

B. CONTRACTOR'S SAFETY ASSURANCE PROGRAM

1. CONTRACTOR shall establish and document as a plan a project-specific electrical power system safety assurance program, which is owned by CONTRACTOR and is project-wide in scope and has jurisdiction over all activities of the CONTRACTOR and all sub-CONTRACTORs. The safety assurance program shall include the identification of a safety assurance officer who shall have authority over the entire project for health and safety issues consistent with the safety assurance program. The safety assurance program will be submitted with CONTRACTOR's bid and be incorporated into the Contract.

C. CONTRACTOR'S QUALITY ASSURANCE PROGRAM

1. CONTRACTOR shall prepare and submit a project-specific quality assurance program. The quality assurance program will be submitted with CONTRACTOR's bid carrying the expectation that the CONTRACTOR will eventually establish a project-specific quality assurance program which will be incorporated into the Contract.

D. TEMPORARY WORK AND OUTAGES

1. To enable the installation of the foundations and/or structures setting or to avoid extended outages, temporary electrical connections may have to be installed so the existing circuits can be returned to service. CONTRACTOR shall comply with the COMPANY's general requirements for outages for energized facilities and equipment and for working in the vicinity of energized facilities and equipment. CONTRACTOR shall be responsible for damages and downtime as a result of downtime in excess of requirements. CONTRACTOR shall prepare a detailed work plan for each location where temporary Work is required or requested. The work plan shall detail the labor, equipment and material required, a detailed description and sequence of construction activities, outage procedures and safety procedures. The extent of all temporary line Work shall be determined by CONTRACTOR and reviewed by ENGINEER fourteen (14) days before Work is to be performed.

E. LINE CROSSINGS

1. CONTRACTOR shall be responsible for ensuring that all potential power line crossings are identified through engineering~~ENGINEERing~~ analysis and field survey. CONTRACTOR shall be responsible for all work associated with any line crossings.

2. CONTRACTOR shall install guard structures as determined by engineering~~ENGINEERing~~ and field analysis for power line crossings to assure required clearance can be maintained during construction and after final completion of temporary power lines.

3. Where proper clearance cannot be maintained either during construction, or after final completion of temporary power lines, and modifications to COMPANY or other facilities is required, CONTRACTOR shall be responsible for the costs to relocate such facilities including the coordination and costs associated with other third party facility COMPANYs.

4. CONTRACTOR shall be responsible for ensuring all necessary permits are obtained for the work described in this section.

F. ACCEPTANCE REQUIREMENTS

1. Upon completion of temporary construction activities, CONTRACTOR shall undertake, perform to satisfactory completion, and document all to COMPANY's satisfaction the following Acceptance Requirements:

2. Third-Party Inspection Report. CONTRACTOR shall employ an independent third-party inspector to perform an inspection focusing on (i) compliance with specifications and codes; (ii) insulator assemblies installed on each structure;(iii) shield wire/OPGW hardware assemblies; and (iv) rights of way conditions. Inspection shall be completed at the request of the ENGINEER not to exceed 2

times per year. The inspection report shall contain a summary analysis of the actual findings, as compared to the Contract requirements and Specifications for each of the aforementioned items. Additionally, the inspection report shall contain the inspector's observation report. Non-conformances identified by the visual inspections shall be included in the Punchlist and shall be repaired. COMPANY shall have fifteen (15) Business Days after receipt of the completed inspection report to review and provide any comment, as appropriate.

3. Power Line Clearance Verification. CONTRACTOR shall verify that all clearances for the power line are in accordance with the design drawings and the NESC minimum clearance requirements.

- END OF SECTION -

SECTION 01525 – CONSTRUCTION SUPPORT ZONE TEMPORARY FACILITIES

PART 1 -- GENERAL

1.1 THE REQUIREMENT

A. The CONTRACTOR shall provide labor, equipment, and materials to construct the temporary facilities in the Construction Support Zone as shown on the Drawings.

B. The CONTRACTOR shall furnish, install and service the ENGINEER'S field office at the Site, including connection to the CONTRACTOR's temporary power system as indicated in Section 01510 – Temporary Utilities. The ENGINEERS's office shall be located in a location designated by the ENGINEER.

1.2 REFERENCE REMEDIAL ACTION WORK PLANS

A. The work under this section shall be conducted in substantial compliance with the following work plans included as part of the Contract Documents in accordance with Section 01015 – Remedial Action Work Plans:

1. Remedial Action Work Plan, Appendix B, Construction Support Facilities and Early Works

   a. Special consideration shall be given to the Performance Standards listed in the above referenced work plan. CONTRACTOR provided facilities shall comply with these standards.

1.3 CSZ REQUIREMENTS

~~C.~~A. A general layout and grading plan for the CSZ is shown on the Drawings. The CONTRACTOR may elect to configure the facilities differently to suit its operations. Any reconfiguration or deviation from that shown on the plans shall meet the requirements of this specification, and shall be submitted to the ENGINEER for review and approval. Expansion of the CSZ beyond the limits shown on the Drawings requires AGENCY approval in addition to ENGINEER approval.~~CONTRACTOR shall furnish and maintain a temporary 10,000-gallon water tank for fire suppression.~~

~~D.~~B. A list of Construction Support Zone areas and uses are provided in the table below for the CONTRACTOR'S reference.

Area Designation	Function/Use
Construction Management Area and Site Sign-In	Construction offices, parking, -visitor control.
Safety/Emergency Services Area	Medical/safety office, carport for on-site ambulance, 80' x 80' helipad.
Contractor Lay-Down and Storage Area	Clean material laydown area.
Fuel Farm Area	Bulk fuel storage. Located within the CSZ to facilitate deliveries without decontamination of delivery trucks.
Crew Drop-Off/Pick up and Lunch Area	Area for: (1) Construction crew to be dropped off and picked up by shuttle vehicles, (2) Contractor trailers for crew lunches, safety meetings, etc. , and (3) Portable restrooms.

Area Designation	Function/Use
Construction Personnel Decontamination Area	Decontamination trailers and laundry facilities. Construction crew sign in/sign out.
Vehicle and Equipment Decontamination Area	Area for scanning and decontamination of vehicles and equipment leaving the MA. Will include area for vehicle/equipment decontamination activities, a geomembrane lined sump for collecting impacted water, a sediment trap to separate the sediment from impacted water, heated building for housing decontamination equipment.
MA Vehicle Parking Area	Within the MA, adjacent to the Personnel Decontamination Area to promote efficient flow of Site Contractor personnel to and from on-site vehicles in the MA.
Contractor Maintenance/ Electrical Area	Area within the MA for the Contractor's use.
On-Site Mobile Laboratory Area	Within the MA. To be used for the On-Site Mobile Laboratory and associated storage and parking.

1.4 SUBMITTALS

A. CONTRACTOR shall submit the following for ENGINEER review and approval in accordance with Section 01300 - Contractor Submittals:

1. Plan layout and grading of proposed CSZ facilities

2. Description of facilities and list of all equipment to be provided for each area listed in the table in Part 1.3 of this Section.

3. List of proposed deviations or modifications from the Drawings and Specifications.

4. Any other information required to demonstrate compliance with applicable performance standards (see Part 1.2 of this Section).

B. To the extent practical, the submittal listed above shall be compiled in a single comprehensive submittal.

~~1.2~~1.5 ENGINEER'S FIELD OFFICE SCHEDULE

A. The ENGINEER's field office shall be for exclusive use by the ENGINEER and the COMPANY's representative and staff and shall be furnished and setup by the CONTRACTOR within 14 Days after the commencement date stated in the Notice-to-Proceed or other time as mutually agreed with the ENGINEER.

B. The CONTRACTOR's attention is directed to the condition that no payment for that portion of the Contract Price designated for mobilization, or any part thereof, will be approved for payment until the field office facilities indicated herein have been set up. Separate payment will be made for set up and servicing of the ENGINEER's field office.

C. Unless released earlier by the ENGINEER in writing, the field office shall be maintained in full operation at the Site with all utilities connected and operable until the Notice of Completion has been executed or recorded. Upon execution or recordation of the Notice of Completion, or upon early release of the field office by the ENGINEER, the

CONTRACTOR shall disconnect and remove the office, and the CONTRACTOR shall restore the Site occupied by the field office according to the requirements of the Contract Documents.

PART 2 -- PRODUCTS

2.1 OFFICE FACILITIES

A. **General:** The CONTRACTOR shall provide necessary electrical wiring, plumbing, toilet and lavatory fixtures, air conditioning and heating equipment, and shelving, and shall furnish light, heat, water, and daily janitorial services in connection with the field office.

B. **Primary Field Office:** The office shall be one separate, well lighted, air conditioned, electrically-heated field office with a toilet room containing a water closet and lavatory partitioned off from the working area. The water closet may be of the chemical type provided that it is a flush type with an approved holding tank. The toilet room door shall be provided with a latch set. Water efficient fixtures shall be provided. The office shall have an outside door lock. Area of the field office shall not be less than 896 square feet, excluding toilet room area. Office shall be of the portable trailer type unless otherwise specifically authorized by the ENGINEER in writing and shall be a separate unit, not attached or connected to any other structures. The office shall have as minimum 3 private offices, one conference room, and one common area that can accommodate at least 2 desks, 4 filing cabinets, 1 plan table, and 2 bookcases.

2.2 FIELD OFFICE FURNISHINGS

A. The CONTRACTOR shall furnish the following items in good condition in the primary field office:

[[[ ]]] each	Standard 30- by 60-inch desks with not less than 3 drawers each
[[[ ]]] each	Plan table 36- by 72-inch top; 36-inches tall
[[[ ]]] each	Plan rack (all metal plan-hold type) capable of holding 6 sets of plans, complete with 6 standard all metal plan-hold clamps
[[[ ]]] each	File cabinet, legal size, 4 or 5 drawer with lock and 3 keys, double suspension, complete.
[[[ ]]] each	Office chairs, standard armrest type, adjustable, swivel, tilt-back with casters
[[[ ]]] each	Office chairs, stiff-leg type, no armrest
[[[ ]]] each	Waste baskets
[[[ ]]] each	White Board, 36- by 42-inches
[[[ ]]] each	[[[4]]] [[[5]]] shelf bookshelves
[[[ ]]] each	Bottled water dispenser unit (supplying both hot and cold water) and bottled water service and supply of paper cups

[illegible] [illegible] each	Recycling receptacles; including individual receptacles for aluminum, plastic, paper & cardboard.
	Energy efficient fluorescent or LED lighting fixtures and bulbs
	Thermal window coverings

2.3 FIELD OFFICE SERVICES

A. Each field office shall be provided with sufficient lighting to produce not less than 50 foot-candles at desktop height at each desk location. Exterior lighting shall be provided over the entrance door. Lighting fixtures and bulbs shall be energy-efficient fluorescent or LED.

B. A minimum of four 110 VAC duplex grounded electric convenience outlets shall be provided in each office and in the conference room and common area. At least one such outlet shall be located on each wall. The electric distribution panel shall service not less than two 110 VAC circuits.

C. Where inside toilet facilities are not connected to outside plumbing, a flush-type chemical toilet with a holding tank shall be provided. Sanitary waste material shall be regularly pumped out and the chemicals recharged. Toilet paper and paper towels shall be furnished for each toilet facility.

D. Regular daily janitorial services shall be furnished during working hours each Day. Offices shall be swept, dusted, and waste receptacles and recycling receptacles emptied. Toilet facilities shall be sanitized and cleaned daily, and paper supplies shall be replenished.

2.4 COMMUNICATIONS

A. Communications shall be provided in accordance with Specification Section 01510 - Temporary Utilities.

2.5 DECONTAMINATION FACILITIES

A. The Decontamination Facilities shall contain (1) a vehicle decontamination area, and (2) a personnel decontamination area. As shown on the Drawings, these decontamination areas will be adjacent to one another, but separate to isolate personnel traffic from vehicular traffic and to minimize the potential for accidents.

B. **Vehicle Decontamination Area:** Vehicle decontamination facilities shall be located in the northwest corner of the fenced-in support corridor as shown on the Drawings. The vehicle decontamination area shall be paved with concrete and shall drain to a geomembrane-lined sump. The collection sump will collect impacted water from the vehicle decontamination procedures, and stormwater runoff from a portion of the Site Access Road and other nearby areas within the CSZ. Impacted water collected in the sump will pass by gravity to the existing seep collection system in the Western Drainage, where it will be pumped to the Water Treatment system. A heated structure shall be provided for screening equipment storage.

C. **Personnel Decontamination Area:** Personnel decontamination facilities shall be located as depicted on the Drawings. The facilities in this area shall include: scanning equipment, showers, lockers (for changing from civilian clothes into work clothes and vice versa), restroom, and laundry facilities.

~~A. INCLUDED WITH 100% DESIGN SUBMITTAL~~

2.6 FIRE SUPPRESSION

A. CONTRACTOR shall furnish, install and maintain a temporary 10,000 gallon water storage tank for fire suppression water storage in accordance with Section 01510 – Temporary Utilities.~~01530 – Protection of Existing Facilities.~~

PART 3 -- EXECUTION

3.1 GENERAL

A. Clearing, grubbing, or grading in the CSZ performed by the CONTRACTOR for setting up and maintaining this area shall be approved by the ENGINEER, and shall be performed in accordance with and Section 02100 – Site Preparation.

B. Fill placement, gravel surfacing, drainage work shall be performed in accordance with Section 02200 – Earthwork.

C. Asphalt paving shall be performed in accordance with Section 02460 – Hot Mix Asphalt and Base~~AC Pavement~~

D. Concrete pavement shall be performed in accordance with Section 03300 – Cast-In-Place Concrete.

E. Geomembranes shall be installed in accordance with Section 02272 – Geomembranes.

- END OF SECTION –

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SECTION 01560 - TEMPORARY ENVIRONMENTAL CONTROLS

PART 1 -- GENERAL

1.1 SUMMARY

A. This section covers environmental controls and procedures required to be put in place and followed by the CONTRACTOR including hauling requirements, dust abatement, storm water pollution prevention, water pollution prevention, use of herbicides and pesticides, control of rubbish, noise abatement, and procedures for dealing with cultural resources if such are discovered in the course of the WORK.

1.2 REFERENCES

A. Code of Federal Regulations 40 CFR 49.126(d)

B. Washington Administrative Code WAC 173-400-040(9)

~~1.2~~1.3 ABATEMENT OF AIR POLLUTION

A. The CONTRACTOR shall comply with the COMPANY'S Air Quality Control and Monitoring Plan provided with the Contract Documents.

B. The CONTRACTOR shall comply with all ARARs and substantive requirements of permits that would otherwise be required absent CERCLA. These shall include all applicable National and local laws and ordinances and regulations concerning the prevention and control of air pollution.

C. In conducting construction activities and operation of equipment, the CONTRACTOR shall utilize such practicable methods and devices as are reasonably available to control, prevent, and otherwise minimize atmospheric emissions or discharges of air contaminants.

D. The CONTRACTOR shall avoid engine idling and use machinery with automatic idle-shutdown devices. Additional requirements for the reduction of air emissions shall be in accordance with Section 01585 – Green and Sustainable Practices.

~~1.3~~1.4 DUST ABATEMENT

A. The emission of dust into the atmosphere shall be minimized during hauling, processing, handling and storage of construction materials, and the CONTRACTOR shall use such methods and equipment as are necessary to minimize or prevent dust during these operations to levels consistent with project permit requirements.

B. **Storage Piles**: Enclose, cover, water (as needed), or apply non-toxic soil binders according to manufacturer's specifications on material piles (i.e. gravel, sand, dirt) with a silt content of 5 percent or greater.

C. **Active Areas of Site**: Water active construction areas and unpaved roads as needed and as requested by ENGINEER.

D. **Inactive Areas of Site**: Apply non-toxic soil stabilizers according to manufacturer's specifications to inactive construction areas, or water as needed to maintain adequate dust control.

E. **Vehicle Loads**: Vehicles carrying materials on, to, or from the site shall be secured and covered in compliance with 40 CFR 49.126(d) and WAC 173-400-040(9).

~~E. **Vehicle Loads**: Cover or maintain at least two feet of freeboard vertical distance between the top of the load and the top of the trailer sides on trucks hauling dirt, sand, soil, or other loose materials off of the Site.~~

F. **Roads**: When there is visible track-out onto a paved public road, install wheel washers where the vehicles exit and enter onto the paved roads and wash the undercarriage of trucks and any equipment leaving the Site on each trip. Sweep the paved road at the end of each shift with a **Mobil Athey** or similar water spray pick-up broom-type street sweeper as necessary or as directed by ENGINEER.

1. Haul Road speed limits shall be 20 mph or as otherwise required by the ENGINEER to effectively abate dust.

G. **Dust Suppression Water**: Utilize treated effluent water from the on-site water treatment plant for on-site areas. Dust suppression water for use at off-site areas, including off-site borrow areas and haul roads, shall meet National Primary Drinking Water Standards.

~~1.4~~1.5 STORMWATER POLLUTION PREVENTION

A. CONTRACTOR shall prepare, implement and maintain a Storm Water Pollution Prevention Plan (SWPPP) in accordance with Section 01570 – Storm Water Pollution Prevention Plan.

B. BMP installation shall be in compliance with the CSWPPP and Specification Section 02270 – Temporary Erosion Control.

C. If storm water discharges threaten water quality, take immediate suitable action to preclude erosion and pollution.

D. BMPs that have been damaged or undercut shall be repaired or replaced. If maintenance or modifications to existing BMPs are necessary following a storm or inspection, complete implementation as soon as possible and before the next storm event whenever practicable.

E. Maintain BMPs in accordance with the CSWPPP and Specification Section 02270 – Temporary Erosion Control. Maintain temporary and permanent erosion and sediment control measures in effective operating condition. Coordinate BMPs with subcontractors and utility companies doing Work in the Project area.

~~1.5~~1.6 PREVENTION OF WATER POLLUTION

A. The CONTRACTOR shall prepare, implement, and comply with a Spill Prevention Control and Counter Measure Plan (SPCCP) in compliance with Specification Section 01575 - Spill Prevention Control and Counter Measure Plan.

B. The CONTRACTOR's construction activities shall be performed by methods that shall prevent entrance or accidental spillage of solid matter, contaminants, debris, and other pollutants and wastes into streams, flowing or dry water courses, lakes, and underground water sources.

C. Such pollutants and wastes include, but are not restricted to, refuse, garbage, sediment from erosion of construction areas, sanitary waste, industrial waste, radioactive substances,

oil and other petroleum products, aggregate processing tailings, mineral salts, and thermal pollution.

D. Wastewater from construction operations shall not enter streams or water courses, without passing through suitable sedimentation removal structures or treatment facilities approved by the ENGINEER. Sediment removal structures shall reduce sediment loads to no more than 5 NTU above background at the point where wastewater is discharged from sedimentation removal structures.

E. The CONTRACTOR shall comply with all project permit requirements, and all other applicable National and local laws, orders, regulations, permits, and water quality standards concerning the control and abatement of water pollution.

~~1.6~~1.7 RUBBISH CONTROL

A. During the progress of the WORK, the CONTRACTOR shall keep the Site and other areas for which it is responsible in a neat and clean condition and free from any accumulation of rubbish. The CONTRACTOR shall dispose of rubbish and waste materials in accordance with Paragraph 1.7.

~~1.7~~1.8 WASTE DISPOSAL

A. **Contractor Generated Waste:**

1. The CONTRACTOR is responsible for proper disposal of all construction waste generated by the CONTRACTOR'S operations.

2. **Clean (uncontaminated) Areas of the Construction Support Zone ("Outside the Fence")**:

a. All CONTRACTOR generated waste shall be disposed of in a proper manner via the use of onsite dumpsters supplied by the CONTRACTOR. The CONTRACTOR shall provide removal services by a licensed solid waste management firm.

b. Dumpsters shall be emptied a minimum of once per week and more often if necessary, unless otherwise approved by the ENGINEER. CONTRACTOR generated waste materials shall be disposed of in an approved solid-waste facility or other approved facility.

c. It shall be the responsibility of the CONTRACTOR to make any necessary arrangements with private parties and with local officials pertinent to locations and regulations of area landfills in the vicinity of the project. Any fees or charges required to be paid for disposal of materials shall be paid by the CONTRACTOR. In the event that certain materials cannot be disposed of in the area waste disposal facility, the CONTRACTOR shall identify a suitable alternative approved waste disposal facility and shall dispose of the material at such facility at no additional cost to the COMPANY.

3. **Areas Within the Contaminated Area of the Construction Support Zone or Within the Mine Affected Area ("Inside the Fence")**:

a. Large items of construction generated waste such as haul truck tires shall be decontaminated to the extent practicable.

b. Waste that cannot be decontaminated shall be disposed of in the WCA in areas and with methods approved by the ENGINEER.

c. Waste that can be successfully decontaminated shall be disposed of in accordance with Paragraph 1.7 A 2.

B. **Non-Mine Hazardous Wastes:** All hazardous materials used for the construction shall be stored, handled, and applied per the manufacturer's printed instructions and per all applicable Federal, State, and local codes. The CONTRACTOR shall ensure that the CONTRACTOR'S onsite work crews and subcontractors are trained and knowledgeable in the proper manner of disposal for hazardous wastes. The disposal of hazardous wastes from the construction site shall be the responsibility of the CONTRACTOR and be performed by a licensed hazardous waste management firm.

C. **Record Keeping**: The CONTRACTOR shall maintain records of the type and quantity of waste materials disposed from the site, the disposal firm, and other information required by Federal, State, and local regulations. These records shall be maintained in the CONTRACTOR'S construction trailer during the entire construction period and available for inspection. A copy of the records shall be transferred to the COMPANY at the end of the construction period.

~~1.8~~1.9 SANITATION

A. **Sanitary facilities shall be provided in accordance with Section 01510 – Temporary Utilities.**

~~A. **Toilet Facilities:** Fixed or portable chemical toilets shall be provided wherever needed for the use of employees. Toilets shall conform to the requirements of Part 1926 of the OSHA Standards for Construction. At the COMPANY's discretion an on-site vault may be utilized to collect sanitary waste.~~

~~B. **Sanitary and Other Organic Wastes:** The CONTRACTOR shall establish a regular daily collection of sanitary and organic wastes. Wastes and refuse from sanitary facilities provided by the CONTRACTOR or organic material wastes from any other source related to the CONTRACTOR's operations shall be disposed of in a manner satisfactory to the ENGINEER and in accordance with Laws and Regulations pertaining thereto.~~

~~1.9~~1.10 CHEMICALS

A. Chemicals used on the WORK or furnished for facility operation, whether defoliant, soil sterilant, herbicide, pesticide, disinfectant, polymer, reactant, or of other classification, shall show approval of either the U.S. Environmental Protection Agency or the U.S. Department of Agriculture. Use of such chemicals and disposal of residues shall be in strict accordance with the printed instructions of the manufacturer.

~~1.10~~1.11 ABATEMENT OF NOISE

A. The CONTRACTOR shall comply with all ARARs and substantive requirements of permits that would otherwise be required absent CERCLA. These shall include Tribal regulations, applicable National and local laws and ordinances, orders, and regulations concerning the prevention, control, and abatement of excessive noise.

B. Construction activities shall be performed only during COMPANY approved working hours.

~~1.11~~1.12 CULTURAL RESOURCES

A. Identification and protection of cultural resources at the Site shall comply with the National Historic Preservation Act of 1966 (16 U.S.C. 470) and 36 CFR 800, which provides for the preservation of potential historical architectural, archaeological, or cultural resources (hereinafter called "cultural resources").

B. In the event potential cultural resources are discovered during subsurface excavations at the Site, the following procedures shall be instituted:

1. The COMPANY shall issue a temporary Notice to Suspend Work directing the CONTRACTOR to cease construction operations at the location of identified potential cultural resources.

2. The suspension Notice shall contain the following:

   a. A clear description of the WORK to be suspended.

   b. Instructions regarding issuance of further orders by the CONTRACTOR for material services.

   c. Guidance as to the action to be taken on subcontracts.

   d. Suggestions to the CONTRACTOR to minimize incurred costs.

   e. Estimated duration of the temporary suspension.

3. Such suspension shall be effective until such time as a qualified archeologist can assess the value of the potential cultural resources and make recommendations to Washington State Cultural Resources Officials and the Spokane Tribe of Indians.

4. The COMPANY shall implement appropriate actions as directed by the Washington State Cultural Resources Officials and the Spokane Tribe of Indians. The CONTRACTOR shall cease WORK in the area of a discovery until appropriate actions have been determined in accordance with this paragraph.

5. If human remains are discovered, WORK in the immediate vicinity of the find shall stop. The County Coroner and Spokane Tribe of Indians shall be notified.

C. If the archeologist determines that the potential find is a bonafide cultural resource, at the direction of the Washington State Cultural Resources Officials and the Spokane Tribe of Indians, the COMPANY shall extend the duration of the suspension.

D. Changes to the Contract Price and Contract Times for suspension due to discovery of a potential cultural resource shall be made in the following manner:

1. Contract Times

   a. If the WORK temporarily suspended is on the “critical path”, the total number of Days for which the suspension is in effect shall be added to the Contract Times.

   b. If a portion of WORK at the time of such suspension is not on the “critical path”, but subsequently becomes WORK on the critical path, the Contract Times shall be computed from the date such WORK is classified as on the critical path.

2. Contract Price

   a. If, as a result of a cultural resources suspension, the CONTRACTOR sustains a loss that could not have been avoided by judicious handling of forces and equipment or redirection of forces or equipment to perform other WORK on the contract, there shall be paid an amount based on time and materials for the loss in accordance with the following:

      1) Idle Time of Equipment: Compensation for equipment idle time shall be determined in accordance with the General Conditions for equipment time and equipment rental time.

      2) Idle Time of Labor: Compensation for idle time of workers shall be determined in accordance with the General Conditions for labor.

   b. Costs of labor shall be compensated only to the extent such cost was in fact caused by the suspension.

   c. Compensation for loss due to idle time of either equipment or labor shall not include markup for profit.

   d. The hours for which compensation shall be paid shall be the actual normal working time during which such suspension lasts, but shall in no case exceed eight hours in any single day.

   e. The days for which compensation shall be paid exclude Saturdays, Sundays, and legal holidays during the suspension.

PART 2 -- PRODUCTS (NOT USED)

PART 3 -- EXECUTION (NOT USED)

- END OF SECTION -

SECTION 01585 – GREEN AND SUSTAINABLE PRACTICES

PART 1 -- GENERAL

1.1 GENERAL DESCRIPTION

A. Furnish all labor, materials, equipment and supplies required to implement the green and sustainable practices outlined in this specification.

B. Required green and sustainable practices include elements of Materials Management, Water Management, and Emissions Reduction are tabulated below. These efforts shall be conducted throughout RA activities at the site.

Materials Management	Paper reduction Recycling Equipment Reuse
Water Management	Water treatment plant effluent for site water uses, as appropriate
Air Emissions Reduction	Ultra-low sulfur diesel fuel for vehicles and equipment Vehicle and equipment “no-idling” policy Vehicle speed limit Worker Transportation (carpool/rideshare) Emissions reduction measures for temporary generators Nonroad diesel equipment fleet requirements

1.2 REFERENCES AND STANDARDS

A. Comply with all Federal and State laws or ordinances, as well as applicable codes, standards, regulations and/or regulatory agency requirements including the partial list below:

A. Occupational Safety and Health Administration (OSHA) 29 CFR Part 1926 Safety and Health Regulations for construction.

B. WSDOT Traffic Manual M 51-02.05 Page 2-1 (for signage).

C. National Primary Drinking Water Standards 40 CFR Part 141.61-.63

D. Green Remediation Best Management Practices - Pump and Treat Technologies, EPA 542-F-09-005, December 2009.

E. Green Remediation Best Management Practices for Excavation and Surface Restoration, EPA 542-F-08-012, December 2008.

1.3 SUBMITTALS

A. The following plans are required to be prepared and submitted by the CONTRACTOR for ENGINEER review and approval.

A. 1. Comply with Section 01300 – Contractor Submittals.

2~~B~~. **Materials Management Plan**: Include plans to maximize use of electronic format for communications and submittals, and to minimize paper uses (i.e., provide double-sided prints). Include recycling plans for collection of plastics, paper, cardboard, and aluminum.

3~~C~~. **Emissions Reduction Plan:** Verify the existence of and contract with a local low-sulfur diesel supplier for all vehicles and equipment used; provide worker transportation plan, include carpool or rideshare parking area(s) in centralized location(s) (i.e., Wellpinit or Reardon); and no-idle and speed limit policies. Outline an emissions reduction education plan for workers, include benefits of not idling (e.g., reduction in emissions). Include a section titled "Emission Reduction Plan for Temporary Generators" outlining policies to minimize power uses from temporary fuel-powered generators that will be needed before power drops are available at the construction support facilities. The plan shall include procedures and guidelines for optimizing the use of temporary generator sets for heating, lighting, tools, and equipment. (Include guidelines for reducing idling time, following manufacturer's recommended maintenance and engine warm-up and cool-down times, and optimize generator size given anticipated needs.)

4~~D~~. **Water Management Plan:** To the extent possible, optimize water use through construction practices. Plans for the use of effluent water (uses, schedule for use, estimated volume, location of water truck filling stations, effluent/pipeline diversion details, treatment details for off-site water use as appropriate, deviation criteria [e.g., criteria when treatment plant effluent will not be used], etc.) shall be submitted in accordance with Section 01300 Contractor Submittals. Include coordination efforts with COMPANY and plant operators.

5. ~~E.~~ **Signs**:~~.~~ Submit plans for speed limit and no-idling policy signs.

6. **Nonroad Diesel Equipment List**: A list of all nonroad diesel engine powered construction equipment to be used on the project shall be submitted at the beginning of each project phase (Phases are defined in Specification Section 01010 – Summary of Work). All the project-specific Nonroad Construction Equipment shall be reviewed by the Construction Contractor every 12 months to ensure compliance with the fleet requirements tabulated in section **3.2 F** of this specification.

1.4 SCHEDULING

A. Install required signage before or at the onset of construction mobilization.

B. Temporary heating and lighting use plan approved before or at the onset of construction mobilization.

C. Utilize treated effluent from the existing water treatment plant (WTP) for construction uses until the new WTP is constructed and operational.

1.5 COORDINATION

A. Coordinate with the COMPANY and plant operators concerning access to treated water effluent.

B. Coordinate with officials of centralized carpooling and bus pickup locations (e.g., cities of Wellpinit, Ford and/or Reardon) concerning selection and approval of carpool and rideshare parking areas in their respective municipalities.

PART 2 -- PRODUCTS

2.1 SIGNS

A. On Site and haul roads speed limits~~limit (30 miles per hour)~~ and no-idle zone signs shall comply with WSDOT requirements, including but not limited to sign size, letter size, and posts. Size of lettering shall comply with the appropriate comprehension rate given the speed limit (refer to WSDOT Traffic Manual).

PART 3 -- EXECUTION

3.1 MATERIALS MANAGEMENT

A. Reduce paper use:

1. Minimize hardcopy submittals. Utilize electronic communications and submit required submittals in electronic format.

2. Develop electronic file sharing system for submittals and communication.

3. Set printers to default double-sided print. When hardcopy printouts are necessary, utilize double-sided printing.

B. Equipment reuse. Dismantle specified existing equipment in the existing water treatment plant for use in the new water treatment plant (refer to Demolition specification, Section 11563 Recessed Plate Filter Press, and engineering drawings for list of equipment to be dismantled and reused).

3.2 EMISSIONS REDUCTION

A. Fuel for Vehicles and Equipment. Ultra-low sulfur diesel fuel shall be used for all on and off-road operation of vehicles and construction equipment if available locally and is cost competitive.

B. On-Site Vehicle Speed Limits. On-Site vehicle speeds will be restricted to accommodate safe roadway conditions based on roadway grade, roadway soil conditions, roadway congestion, and the need to limit air emissions caused by roadway fugitive dust. These dust emission shall be controlled on-site through use of chemical dust suppressant and/or water applications to roadways.

~~B.~~C. No-idling Policy

1. No work vehicles or work equipment is allowed to idle longer than 5 minutes unless:

a) The vehicle/equipment is undergoing testing, servicing, repair, or diagnostic
b) The vehicle/equipment is in queue
c) The vehicle/equipment is accomplishing work for which it was designed
d) There is a safety issue.

2. Follow manufacturer-recommended warm-up and cool-down periods.

~~C.~~D. Worker Transportation. Identify carpooling and/or rideshare parking areas in centralized area(s) for workers to use to get to the site (i.e., Reardon and/or Wellpinit). Encourage worker participation.

~~D.~~E. Conduct Worker Training. Cover specific idle-reduction operating practices, environmental benefits, and safety.

~~E.~~F. Minimize Emissions from Temporary Generators. Follow protocol outlined in the approved 'Emissions Reduction Plan for Temporary Generators' section of the approved Emissions Reduction Plan. Implement measures to minimize use of temporary generators for lighting, heat, tools, and equipment. (To include, but not necessarily be limited to: minimizing generator idling time, following manufacturer's recommended maintenance and motor warm-up~~warmup~~/cool-down, and optimizing generator sizing and selection based on anticipated loads.)

G. Nonroad Diesel Powered Construction Equipment Fleet Requirements. All nonroad diesel engines for construction equipment shall meet federal standards (40 CFR 1039 in a phased approach as outlined in the table below:

Project Construction Phase	**Maximum Percentage of Tier 2 Equipment**	**Required Percentage of Tier 3 or newer Equipment**	**Required Percentage of Tier 4 (or better) Equipment**
Early Works and Phase I	50% max	50% min	20% min
Phase II	20% max	80% min	40% min
Phase III	None	30% max	70% min
Post Phase III	None	None	100%

3.3 CLEAN WATER MANAGEMENT

A. Follow ENGINEER approved Water Management Plan, and coordinate with COMPANY and plant operators.

A. 1. Dust Suppression Water. Utilize treated effluent water from the on-site water treatment plant for on-site areas. Dust suppression water for use at off-site areas, including off-site borrow areas and haul roads, shall meet National Primary Drinking Water Standards.

B. 2. Decontamination Water. Utilize treated effluent water from the treatment plant for decontamination activities as much as practicable.

- END OF SECTION -

SECTION 02017 – MONITORING WELLS

PART 1 -- GENERAL

1.1 THE REQUIREMENT

General: The CONTRACTOR shall provide groundwater monitoring wells and appurtenant WORK, in accordance with the Contract Documents.

The Redundant BPA Dewatering Well shall be constructed in accordance with this section.

The ENGINEER will be responsible for identifying and marking the final well locations prior to drilling.

1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

ASTM F480	Thermoplastic Well Casing Pipe and Couplings Made in Standard Dimension Ratios (SDR) SCH 40 and SCH 80

1.3 CONTRACTOR SUBMITTALS

Furnish submittals in accordance with Section 01300 - Contractor Submittals.

Submit product data for all monitoring well materials.

Submit a list of drilling equipment.

Submit procedures~~details~~ for development water collection and disposal.

PART 2 -- PRODUCTS

2.1 CASING, SCREENS, AND APPURTENANCES

Well Casing: Each well casing shall be 6-inch nominal Schedule 80 PVC pipe, 5-inch nominal Schedule 80 PVC, 4-inch nominal diameter Schedule 40 PVC pipe, as indicated, with ASTM threads according to ASTM F 480. The blank PVC shall be factory-assembled in 20-foot lengths. Smaller lengths of 5- to 10-feet shall also be furnished to accommodate the final well design. The blank PVC casing surface shall be free of solvents, oils, grease, paint, and dirt and shall be certified clean from factory or be steam cleaned at the Site. Sections of casing shall be received from the supplier wrapped in polyethylene protective wrappers with sealed ends to limit exposure to potential contaminants. Casing shall not be removed from the wrapping until immediately before placing it in the borehole. Bottom caps shall be flush- threaded and top caps shall be of the oversize slip cap type.

Casing Joints: Casing joints shall be ASTM thread and shall be attached in accordance with the requirements of ASTM F 480. The CONTRACTOR shall not utilize glued joints.

Well Screen: The screen slot size shall be 20 slot (0.020 inch) or 40 slot (0.040 inch) as indicated. Screen openings shall widen inward so as to be non-clogging. Final screen length and positioning will be approved by the ENGINEER and is subject to change based on observed field conditions. The well screen shall be sufficient size and design to hold back and support the filter pack and in-situ soils surrounding the screen. The

well screen surface shall be free of solvents, oils, grease, paint, and dirt and shall be certified clean from the factory or be steam-cleaned on Site. The well screen shall have smooth, sharp-edged openings free of burrs, chipped edges, or broken pieces on the interior and exterior surface of the pipe. Sections of screen shall be received from the supplier wrapped in polyethlyene protective wrappers with sealed ends for limiting exposure to potential contaminants. Wrapping shall not be removed until screen is to be used.

Centralizers: Centralizers shall be PVC or stainless steel.

Above-Ground Completion/Well Heads: Wellheads shall be constructed as indicated.

2.2 SEALING MATERIAL

A. **Cement:** The cement/bentonite grout mixture shall consist of 95 to 97 percent Type V or Type II-V Portland Cement and 3 to 5 percent bentonite powder by weight (equivalent to one 94-pound bag of cement and between 2.8 and 4.7 pounds of bentonite).

2.3 FILTER PACK MATERIAL

Filter Pack material: The filter pack shall consist of 8 x 12 (40 slot screen) or 10 x 20 (20 slot screen) Colorado Silica Sand (or equivalent).

Filter pack material shall be protected from contaminants prior to placement by either sorting it in plastic-lined paper bags or in a location protected from the weather and contamination on plastic sheeting. Filter pack materials shall be transported to the well in a manner preventing contamination by other soils, oils and grease, and other chemicals.

The filter pack material shall be compatible with the well screen slot size. A sample and sieve analysis of filter packing materials shall be submitted for review and acceptance prior to anticipated placement of the material in the well annulus. Failure to match gradation of approved sample shall be grounds for rejection of the material. The filter pack material, if stockpiled at the Site, shall be kept free of foreign matter.

PART 3 -- EXECUTION

3.1 DRILLING

Each well shall be installed in a single work shift, or continuous work shifts without shutdown.

Wells~~All wells~~ shall be drilled using air-rotary drilling methods. Drilling shall be performed using Barber (dual-rotary), odex, or other temporary casing methods. Air will be the primary drilling fluid used. If other fluids are needed for borehole stability, cuttings removal, or restoring circulation, they will be used in the following sequence: (1) air/water mist, (2) foam, (3) polymer, and (4) bentonite mud. The discharge from the borehole will be directed to a cyclone so that ground water discharge rates can be measured.

1. Hollow-stem auger drilling methods may be proposed by the CONTRACTOR for monitoring wells. Hollow-stem auger drilling methods shall be approved by the ENGINEER.

The diameter of the boreholes shall be sufficient to provide a minimum 2-inch annulus between the well casing and the borehole. The borehole diameter is anticipated to be 14 inches at the surface to allow for 10-inch steel surface casing. The borehole below the steel casing is anticipated to be 10 inches nominal.

Sequence

Wells shall be constructed as follows:

Set up drill rig.

Drill borehole.

Collect and deliver lithologic samples from each borehole to ENGINEER.

Provide well casing and screen assembly.

Develop the well by approved methods.

Construct the final above ground surface well completions.

3.2 DATA COLLECTION

General Notes

The borehole shall be airlifted to dryness (or until clean ground water is produced) at the end of a shift. This may require airlifting 15 to 30 minutes, letting the borehole sit undisturbed for 15 to 30 minutes, and then airlifting again.

First Occurrence of Water

The depth at which water is first encountered shall be noted. There is no minimum amount of water required to count as first water (i.e., any water encountered regardless of quantity qualifies as first water).

If drilling dry, the zones that produce moist/damp cuttings but no free water shall be noted. It shall be noted if damp/wet zones are encountered and if deeper zones are dry. In zones that produce moist/damp cuttings, stop drilling, let the borehole sit undisturbed for 10 to 15 minutes, and then airlift to determine if free water is present.

Alluvial Bedrock Contact

Stop drilling at the alluvial/bedrock contact and let the borehole sit undisturbed for 10 to 15 minutes and then airlift to determine if free water is present. Record in the field logbook whether or not water is present.

Water Production Measurement During Drilling

Measure water production during drilling as follows:

Airlift until water production stabilizes or diminishes to less than 0.5 gallons per minute (gpm), as specified in item 2 below. The procedure will be performed 1) every 10 feet of drill advancement, 2) after each drill rod is fully advanced, 3) after cleaning

cuttings from the borehole, 4) after discontinuing drilling fluid injection, and 5) at the end of each shift.

Airlift, without injecting drilling fluid, a minimum of 5 minutes. Continue airlifting until water production stabilizes or is less than 0.5 gpm. Stabilization of water production usually takes between 5 and 15 minutes depending on borehole conditions (e.g., depth, degree of fracturing, drill fluid additives, and the amount of ground water).

After airlifting a minimum of 5 minutes, consider water production to be stable when two consecutive discharge measurements are nearly the same.

Measure discharge to the nearest 0.25 gpm using a calibrated 1- or 5-gallon bucket and a stopwatch.

Record the stable water production rate in the field logbook.

Ground water may not be present in sufficient quantities to sustain water production during airlifting. Note if a slug of water is observed after the new drilling rod is added or at the start of a shift.

Record other hydrogeologic information when possible. Note fracture zones, zones where flow increases/decreases, lost circulation zones, voids, and water blowing out of other boreholes.

~~Water Level Measurement~~

~~Measure water levels in boreholes at the start of every shift according to the following procedures:~~

~~Prepare the borehole and drill rig for water level measurement at the end of the previous shift by airlifting the borehole to remove injected drilling fluids and cuttings and by leaving the drill rods in the borehole so that the water level can be measured at the start of the next shift without raising or lowering the drill rods.~~

~~At the start of every shift, measure the water level inside the drill rod with a water level probe as follows. Measure the water level before disturbing the borehole in any way (e.g., do not raise or lower the drill rods, or turn on the air).~~

~~Test the water level probe before use by dipping it in water.~~

~~Add weight to the water level probe as necessary.~~

~~Note the depth of the exchange or any other obstacle in the drill rod and do not lower the water level probe beyond that depth.~~

~~Determine depth to water from the ground surface. If the borehole is dry, record the maximum depth obtained during the measurement (e.g., dry to 200 feet below ground surface [bgs]) to the nearest foot.~~

~~Note the reliability of the measurement. Some measurements may be questionable and shall be noted as such.~~

~~Record the date, time, depth to water below ground level, and borehole depth~~

Collection and Description of Samples

Borehole stratigraphy shall be logged by examination of the sample cuttings or split barrel samples. Monitoring wells shall be drilled using air-rotary drilling methods. Air will be the primary drilling fluid. The return fluid will consist of air, drill cuttings, and ground water, which will be routed through a cyclone to separate the air and allow measurement of ground water production. Representative samples of cuttings shall be collected by routing a portion of the cuttings/ground water discharge stream from the cyclone into a sample bag. The sample bag shall be replaced at 10-foot intervals. The sample bag shall be labeled with the borehole number, depth interval, date, and time of collection. A split of the sample shall be placed in a chip tray. The chip tray shall be labeled with the same information as the sample bag.

3.3 MONITORING WELL DESIGN AND COMPLETION

Well Design For Four-Inch or Five-Inch Casing and Screen

All groundwater monitoring wells shall be completed with new 5-inch schedule-80 PVC riser or 4-inch, schedule-40 PVC riser. Joints shall be flush threaded. The screen shall be factory slotted and approximately 20 feet in length. Screen lengths may be increased or decreased depending on hydrogeologic conditions. The screen slot size shall be 20 slot (0.020 inch). Bottom caps shall be flush- threaded and top caps shall be of the oversize slip cap type.

Well Design For Six-Inch Casing and Screen

All groundwater production wells ~~will~~ shall be completed with new 6-inch schedule-80 PVC riser. Joints shall be flush threaded. The screen shall be 6- inch schedule-80 PVC and shall be either wire-wrapped, high-flow factory slotted, or regular-flow factory slotted, depending on ground water flow rates encountered during drilling. The screen length is anticipated to be 20 feet, but it may be increased or decreased depending on hydrogeologic conditions. The screen slot size shall be 20 slot (0.020 inch) or 40 slot (0.040 inch) depending on subsurface material sizes and ground water flow rates encountered during drilling. Bottom caps shall be flush-threaded and top caps shall be the oversize slip cap type.

Centralizers

Stainless steel or PVC centralizers shall be used at the top and bottom of the screen.

Filter Pack

The filter pack shall consist of 8 x 12 (40 slot screen) or 10 x 20 (20 slot screen) Colorado Silica Sand (or equivalent). The filter pack shall extend from the bottom of the screen to a point between 3 and 5 feet above the top of the screen. The filter pack shall be placed by pumping with water through a tremmie pipe.

Bentonite Seal

A bentonite seal that is a minimum of 5 feet thick shall be placed above the filter pack. The bentonite seal shall consist of coated pellets, pellets, chips, or slurry, depending on borehole conditions. Slurry seals shall be used only when pellets or chips cannot be placed in the annulus, and shall be mixed 20 to 30 percent solids by weight and be a minimum of 10 feet thick. Slurry seals shall be pumped through tremmie pipe and positively displaced upward.

Cement/Bentonite Grout

The annular space between the well casing and the borehole shall be grouted from the top of the bentonite seal to the surface. If the grout seal is placed on top of a bentonite slurry seal, the bentonite slurry seal shall be allowed to set before placement of the grout seal. If the grout seal is placed on top of a bentonite chip or pellet seal, the chip or pellet seal shall be allowed to hydrate a minimum of 1 hour before placement of the grout seal. The cement/bentonite grout mixture shall consist of 95 to 97 percent Type V or Type II-V Portland Cement and 3 to 5 percent bentonite powder by weight (equivalent to one 94-pound bag of cement and between 2.8 and 4.7 pounds of bentonite). Approximately 8.5 gallons of water shall be used for each cement/bentonite batch. The grout mixture shall be prepared by thoroughly mixing the bentonite powder with water first and then mixing in the cement.

Grout shall be placed in the well annulus with a tremmie pipe located within approximately 10 feet of the top of the bentonite seal. For wells less than 60 feet in depth, the grout shall be pumped through the tremmie pipe and positively displaced upward until undiluted grout flows from the annular space at ground surface. For wells deeper than 60 feet, the grout shall be pumped through the tremmie and positively displaced upward until approximately one-half the calculated volume has been pumped. The tremmie pipe shall then be pulled up to a depth approximately one-half the distance between the bentonite seal and the surface, and the remaining annular space shall be grouted by positively displacing the grout upward until undiluted grout flows from the annular space at ground surface.

No single lift of grout shall exceed 100 feet. If the depth of the annular space is greater than 100 feet, the annular space shall be grouted in two or more lifts, each lift being less than 100 feet. Each lift shall be allowed to set before the next lift is placed. Grout accelerants shall not be used.

Surface Completion

Steel protective casings with locking caps shall be installed at the surface around the monitoring wells. The steel casings shall be cemented in place and shall extend a minimum of 5 feet below ground surface and 3 feet above ground surface. The protective casings shall be a minimum of 4 inches larger in diameter than the PVC monitoring wells.

Grout shall be placed within the protective casing annulus from ground surface to one-half foot above ground surface. A weep hole shall be drilled in the protective casing at the top of the grout.

The monitoring well number shall be written on the top of the PVC monitoring well cap. A permanent mark shall be placed on the north side of the PVC monitoring well casing to indicate the water level measurement point.

Tremmie Pipe

Tremmie pipe used for the placement of the filter pack, bentonite slurry seals, and grout shall comprise flush-threaded steel or schedule-80 PVC. The tremmie pipe shall have a minimum inner diameter (ID) of 1.25 inches.

3.4 MONITORING WELL INSTALLATION

Perform the following procedures when drilling and installing wells using casing advance systems:

All drilling equipment shall be decontaminated. Record the decontamination procedure and personnel present in the field logbook.

Count and measure the lengths and sizes of all drilling rods, temporary drilling casing, and bits and record this information in the field logbook. This information may be useful in verifying borehole depths and diameters. Record the type of drill rig and the names of the drillers and helpers on the borehole log and in the field logbook.

Advance the borehole to total depth. During drilling, perform ground water airlift testing as specified in Paragraph 3.1 D and record the results on the borehole logs and/or in the field logbook.

~~Perform overnight water level measurements as specified in Paragraph 3.1 D.~~

Collect cuttings samples over 10 foot intervals and log and label them as specified in Section Paragraph 3.1 E.

After the borehole has been drilled to total depth, record the depth on the borehole log and in the field logbook. Trip out the drill string and measure the total depth of the open hole using a weighted fiberglass tape or by tagging with the well casing when installing. Record the total open hole depth on the borehole log and in the field logbook.

Measure and record each joint of blank riser, screen, and the endcap to the nearest 0.1 foot.

Assemble the endcap, screen, and riser as it is lowered into the borehole and attach centralizers as specified in Paragraph 3.1 F. Record the locations of the centralizers on the borehole log and/or in the field logbook.

For monitoring wells that do not use wire-wrapped screen, lower the screen and casing until the endcap rests on the bottom of the borehole and then raise the casing string until it is held in tension. For monitoring wells that use wire wrapped screen, lower the screen and casing until the endcap is approximately 1 foot off the bottom, based on measurements of the casing string and the open borehole depth.

Measure the stickup of the top of the casing above ground surface and calculate the screened interval. Adjust the screened interval by raising the casing assembly to desired interval, if necessary, and add bentonite pellets or sand to fill the bottom of the borehole to the bottom of the endcap. Record the total depth of the casing on the borehole log and in the field book.

Calculate and record the volume of the filter pack, bentonite seal, and grout required to fill the annular space based on the borehole size and casing size. The volume is calculated by subtracting the volume of the casing (based on the outer diameter) from the volume of the borehole using the equation:

$V=\pi(rb2 - rc2)h$

where: V =volume (in feet3); rb = radius of borehole (in feet); rc = radius of casing (in feet); h =height (in feet) between the top and bottom of the material (filter pack, bentonite, or grout).

As the temporary casing is pulled back, begin adding the filter pack into the annular space as described in Section 5.5.4. Repeated depth soundings to monitor the filter pack level shall be taken using either measured tremmie pipe or a weighted tape. The filter pack should be kept 1 to 2 feet up into the temporary casing so that the screen/riser is never exposed to the open borehole. The filter pack shall be extended to between 3 and 5 feet above the top of the screen. Allow sufficient time for the filter pack to settle through the water column before measuring and recording the final filter pack level.

Following filter pack placement, install a minimum 5-foot-thick bentonite pellet or chip seal or a minimum 10-foot-thick bentonite slurry seal. Pellets or chips shall be poured slowly to minimize bridging. Bentonite slurry seals shall be mixed to between 20 and 30 percent solids and pumped through a tremmie pipe for placement. Repeated depth soundings to monitor the bentonite seal level shall be taken using either measured tremmie pipe or a weighted tape. Bentonite chip and pellet seals shall be allowed to hydrate a minimum of 1 hour before the placement of the grout seal. Bentonite slurry seals shall be allowed to set before placement of grout.

Grout the remaining annulus from the top of the bentonite seal to the surface using the grout mixture and procedures specified in Section 5.5.6. If the annular distance is greater than 100 feet, additional lifts of grout will be required. Each lift shall be allowed to harden before a new lift is placed. The grout shall be placed by tremmie pipe as specified in Section 5.5.8. All grout batches mixed and pumped shall be weighed using a mud scale; the weight of the grout should be between 13 and 15 pounds per gallon. All grout weights, gallons of water, and quantities of bags of cement and bags of bentonite powder used shall be recorded on the borehole logs and/or in the field book.

Before the last lift of grout sets, center the protective steel casing around the monitoring well casing and insert the steel casing approximately 5 feet into the grouted annulus. Insert a temporary spacer between the protective casing locking lid and the monitoring well cap to prevent the protective casing from settling. Label the monitoring well.

After the last grout lift has set for 24 hours, check it for settlement and add additional grout, if necessary.

3.5 MEASUREMENTS

Measurements made during drilling of the borehole shall be performed to the nearest foot. Measurements made during well construction and of well construction materials shall be performed to the nearest 0.1 foot. Measurements shall consist of the following:

Total depth of borehole at end of drilling below ground surface (bgs)

Total depth of open borehole bgs, before the start of well construction

Lengths of the endcap, screen sections, riser blank sections, and stickup of well above ground surface

The depth bgs of the top of the filter pack, top of the bentonite seal, and the top of each grout lift.

Following well completion, the horizontal location of the monitoring well shall be determined by civil survey or with the use of a global positioning system (GPS) receiver. The elevation of the top of the protective casing, ground surface, top of PVC well, and water level measuring point (e.g., the top of the PVC well) shall be determined.

1. Survey points for monitoring wells shall be located to the nearest 0.1 ft horizontally and vertically.

3.6 WELL DEVELOPMENT

General: After the well has been completely constructed in accordance with the requirements of the Contract Documents, the CONTRACTOR shall notify the ENGINEER and make the necessary arrangements for conducting the well development. Well development will consist of swabbing, bailing, and pumping. Well development shall begin no earlier than 48 hours after the grout has been placed. Well development will be performed using one or more of the following methods: surging, over-pumping, or bailing, as determined by the ENGINEER. The method to be used will be selected based on specific hydrogeologic conditions at the Site but will generally consist of a sequence of bailing, surging, bailing, and then pumping. A minimum of 3 casing volumes of water or a volume indicated by the ENGINEER shall be removed. Water exiting the well shall be containerized allowing time for any suspended solids to settle prior to being discharged to the local stormwater inlet. Well development shall continue until the water is reasonably sand-free and turbidity is reduced. As appropriate, pH, specific conductance, turbidity, and temperature will be measured by the ENGINEER to evaluate the adequacy of monitoring well development.

3.7 DISPOSAL OF DEVELOPMENT AND TEST WATER

General: The CONTRACTOR shall provide collection~~pipeline~~ and conveyance~~facilities~~ for discharging water from the well to pit 3 or other location is directed by the ENGINEER.

3.8 ABOVE GROUND COMPLETION/WELL HEADS

General: Wellheads shall be constructed as indicated.

3.9 WELL ACCEPTANCE

It is the responsibility of the CONTRACTOR to properly construct and install, develop, and test wells so that the wells are suitable for water level monitoring and/or a water quality compliance monitoring program. If the CONTRACTOR installs wells that are not functional or not in accordance with requirements, the ENGINEER will disapprove the well as Defective WORK and will direct the CONTRACTOR to repair or replace it at the ENGINEER's option. Repair of Defective WORK shall be done as part of the WORK.

3.10 REMEDIAL WORK

If remedial WORK becomes necessary to make the well acceptable because of accident, loss of tool, defective material, or for any other cause, the CONTRACTOR shall propose in writing a method for correcting the problem. Suggested methods shall be reviewed and approved by the ENGINEER before WORK proceeds. Remedial WORK shall not be justification for extending the length of the Contract.

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SECTION 02050 - DEMOLITION

PART 1 -- GENERAL

1.1 SUMMARY

A. Furnish all labor, materials, equipment and incidentals required for demolition, removal, and recycle.

B. Disposal and relocation as shown and as specified herein.

C. Demolition includes structural concrete, foundations, structural steel, metals, roofing, masonry, attachments, appurtenances, piping, electrical and mechanical equipment, and similar existing facilities, above and below ground. Demolished items shall be disposed of within the Waste Containment Area (WCA) as Unclassified Waste, as defined in Section 02205 – Waste Excavation and Disposal, and as shown on the Drawings.

Items to be demolished include:

Item	Description
Water Treatment Plant	Pre-engineered steel frame building, associated interior/exterior tanks, piping, and appurtenances
Seep Collection Facilities	Wood and metal frame buildings with associated tanks, pumps, and piping
Decontamination Facility	Wood frame building
Misc. Outbuildings	Various small steel frame buildings located near the west edge of Western Drainage and other locations
Culverts	Galvanized steel various lengths
Storm Water Storage Pond	Single 40-mil HDPE geomembrane for pond liner. Geofabric in the spillway area (under riprap). 12-inch HDPE outlet pipe/decant riser.
Construction Support Facilities	Various temporary facilities installed to support the WORK shall be demoilished upon completion of the RA.
Access Controls	Fencing and other existing access contols that will be removed or replaced by final access controls.

D. Asbestos may be present in the areas to be demolished. The CONTRACTOR shall assess the extent of the asbestos and perform the necessary abatement and removal prior to beginning demolition work. Asbestos abatement and disposal shall be performed in accordance with 40 CFR Part 61, NESHAPS; 40 CFR Part 763, AHERA; WAC 296-62 and 296-65, EPA Region 10, the Washington State Department of Ecology. Asbestos materials shall be segregated and transported off-site for disposal~~disposed of within the WCA as Unclassified Waste~~ in accordance with applicable Stevens County, Washington State, and Federal regulations. ~~Section 02205 – Mine Waste Excavation and Disposal.~~

E. PCB containing transformers and light ballasts may be located in the area designated for demolition and removal. The CONTRACTOR shall assess the condition and level of PCB contamination within these items prior to removal and shall dispose of these items according to the requirements of 40 CFR Part 761, WAC 173-303. PCB's shall be segregated and transported off-site for disposal in accordance with applicable Stevens County, Washington State, and Federal regulations.~~PCB's shall be not be disposed of in the WCA.~~

F. Lead-based paint may be present in the areas to be demolished. The CONTRACTOR shall assess the extent of the lead and perform the necessary abatement and removal prior to beginning demolition work. Lead abatement shall be performed in accordance with EPA Testing Method 1311 for TCLP, EPA Region 10. Materials contaminated with lead-based paint shall be segregated and transported off-site for disposal~~disposed of within the WCA as Unclassified Waste~~ in accordance with applicable Stevens County, Washington State, and Federal regulations~~Section 02205 – Mine Waste Excavation and Disposal~~.

G. Other hazardous materials not listed above shall be segregated and transported off-site for disposal in compliance with applicable Stevens County, Washington State, and Federal regulations.

~~G.~~H. Work shall conform to requirements of this Section for all references to demolition and removals in other Sections. Excavation and disposal of contaminated soils and sediments is addressed in Section 02205 – Mine Waste Excavation and Disposal.

~~H.~~I. Included under this Section shall be the removal and relocation or re-routing of any existing piping, valves, conduit, equipment and appurtenances which are not specifically shown on the Drawings or described in the Specifications, but are found to interfere with completion of required demolition.

1. As used above, the terms “relocation” and “re-routing” shall include the furnishing and installation of all new piping, conduits, wires, insulation, and the like; with all new fittings, gaskets, supports, anchors, fasteners, painting and miscellaneous appurtenances required in order to relocate or re-route the system or equipment as necessary and to return the system or equipment to service capable of providing the full range of service and function originally intended.

2. All new materials shall meet the requirements of similar materials specified in these Specifications.

3. Existing materials, with the following exceptions shall not be reused. The filter press, membrane squeeze tank, and associated pumps and electrical control panels shall be reused in the new water treatment plant.

J. Included under this Section shall be the relocation, or removal and replacement of any existing fencing found to interfere with completion of the WORK.

1. Where fencing must be temporarily removed to accommodate the WORK, then fencing shall be replaced in a similar configuration.

2. Where fencing must be relocated to accommodate the work, the fencing shall be constructed of similar materials and in a configuration approved by the ENGINEER.

3. Existing fencing materials shall be reused where practical. New materials shall be of similar quality to existing materials.

~~I.~~K. The CONTRACTOR is encouraged to visit the work site during the bidding period to determine the hazards, working conditions, accessibility and true extent of the Demolition work required under this Section.

1.2 REFERENCE REDEDIAL ACTION WORK PLANS

A. The work under this section shall be conducted in substantial compliance with the following work plans included as part of the Contract Documents in accordance with Section 01015 – Remedial Action Work Plans:

1. Remedial Action Work Plan

2. Staging/Temporary Stockpiling Plan

1.3 REFERENCE CODES AND STANDARDS

A. Comply with all Federal, State laws or ordinances, as well as applicable codes, standards, regulations and/or regulatory agency requirements including the partial list below:

1. Occupational Safety and Health Administration (OSHA); 29 CFR Part 1926 Safety and Health Regulations for construction.

1.4 SUBMITTALS

A. The Submittals indicated below shall conform to Section 01300 – CONTRACTOR Submittals.

B. Submit to the ENGINEER for review proposed methods, equipment, and operations sequence. Include coordination for shut-off, capping, temporary services, continuation of utility services, and other applicable items to ensure no interruption of the COMPANY'S operations.

C. **Structural Assessment:** OSHA requires that an engineering assessment be conducted and documented in writing prior to the start of demolition operations [29 CFR 1926.850(a)] to evaluate the structural integrity and the potential for an unplanned collapse. This assessment shall be completed by the CONTRACTOR and submitted to the ENGINEER prior to the initiation of demolition activities.

1.5 SCHEDULING

A. Conduct work so as to avoid interference with operations and work in the existing facilities.

B. Comply with the staged construction/demolition requirements as outlined on the Drawings and as described herein.

1.6 COORDINATION

A. Review the demolition requirements described in other Sections of the Specifications or shown on the Drawings and coordinate with the general work requirements in this Section. Unless more specific direction is given by a particular project specification or drawing detail, the requirements of this Section shall govern insofar as they pertain to the repair of surfaces which are exposed by the demolition or which shall remain exposed upon the completion of this Contract.

B. The CONTRACTOR shall be responsible for any additional or differing demolitions, removals and subsequent repair of exposed surfaces which may be found necessary

due to the selection of alternate equipment or the requirements of miscellaneous appurtenances of the equipment specified.

C. Any removal and/or connections, which require downtime for any treatment equipment, shall be scheduled in advance with the COMPANY.

PART 2 -- PRODUCTS (NOT USED)

PART 3 -- EXECUTION

3.1 EXAMINATION

A. Examination and Verification of Condition:

1. Before demolition begins, the CONTRACTOR shall inspect existing structures and equipment that shall remain in place within and adjacent to the demolition area for existing defects and damage. Record and notify the ENGINEER of defects and damage found during this inspection.

2~~3~~. Prior to demolition of the WTP the CONTRACTOR and ENGINEER shall conduct a joint inspection to identify equipment that shall be salvaged for reuse. Equipment to be salvaged shall be inspected for existing defects and damage.

3.2 PREPARATION

A. Notification

1. Do not start any equipment removal or demolition operations without the permission of the COMPANY.

B. Protection

1. Before demolition begins, disconnect all mechanical and electrical services affected by the work. Interconnecting piping and electrical services that are to remain in service either permanently or temporarily shall be capped or rerouted in a manner that shall not interfere with the operation of the existing facilities to remain and the demolition work.

2. Execute the demolition and removal work to prevent damage or injury to structures, occupants thereof and adjacent features which might result from falling debris, exposure to weather or other causes, and so as not to interfere with the use, and free and safe passage to and from adjacent structures.

3. Provide fire safety measures at all times in areas where burning torches are being used. Maintain all these items during the demolition period.

4. Perform testing and air purging where the presence of hazardous material, gases, flammable materials or dangerous substance is apparent or suspected. Eliminate the hazard before demolition is started.

5. Do not close or obstruct roadways adjacent to the work by the placement or storage of materials.

6. Conduct all operations with a minimum interference to on-going operations of adjacent concurrent construction activities.

7. Erect and maintain safety barriers, lights, and other required protective devices.

8. Repair damage done to facilities to remain, or to any property belonging to the COMPANY.

9. Provide adequate lighting at all times during demolition operations.

10. Provide warning signs as required, for personnel and the public.

11 Provide temporary supports and bracing of all existing structures, equipment and utilities that shall remain in the service.

12. Provide adequate drainage of water from dust control or precipitation during demolition activities.

3.3 DEMOLITION PHASING

A. Due to overall construction sequencing, demolition of some structures must occur before a suitable disposal area within the WCA has been prepared. In these situations, demolition debris shall be placed in a temporary stockpile within the MWA as shown on the Drawings. Alternative stockpile locations shall only be used if approved by the ENGINEER. .

B. Structures and facilities shall be demolished/removed in the following order unless otherwise approved by the Engineer:

Anticipated Demolition Order	Facility or Structure	Schedule
1	Existing structures in the proposed construction support facilities area (west edge of the Western Drainage)	Start of RA (Early Works)
2	Pipelines and structure in the Western Drainage below the toe of the South Waste Rock Pile	Phase 2
3	Existing WTP and appurtenant structures	Phase 2
4	Pump houses and pipelines in the Eastern and Far East Drainages	Phase 2
5	Pump houses, pipelines, and other facilities in the Central Drainage, including those associated with the Pollution Control Pond	Phase 3
6	Fencing associated with construction support facilities (New Construction)	End of RA
7	Crew meeting/lunch trailers (New Construction)	End of RA
8	Construction offices (New Construction)	End of RA
9	Storage trailers (New Construction)	End of RA
10	Maintenance/electrical shop (New Construction)	End of RA
11	Decontamination office (New Construction)	End of RA
12	Locker, shower, and laundry building (New Construction)	End of RA
13	Construction fuel and water storage and delivery systems (New Construction)	End of RA
14	Ambulance garage (New Construction)	End of RA
15	Safety/Emergency Services Office (New Construction)	End of RA

16	Restroom trailers (New Construction)	End of RA	
17	Demolition of existing site access control fencing	End of RA	

C. Buried pipelines and other non-essential utilities not identified on the drawings shall be removed during the course of the WORK as they are encountered. Culverts and power-lines shall be removed as necessary and in a manner that prevents interruption of surface water management or power supply to operating facilities.

3.4 APPLICATION

A. Possession of Removed Items

1. Removed Items to Remain Property of the COMPANY

a. All items to be removed under this project are to remain the property of the COMPANY.

B. Pollution Controls

1. Use water sprinkling, temporary enclosures, and other suitable methods to limit the amount of dust and dirt rising and scattering in the air to the lowest practical level.

a. Do not use water when it may create hazardous or objectionable conditions such as ice, flooding, and pollution.

b. Clean adjacent structures, facilities, and improvements of dust, dirt, and debris caused by demolition operations.

c. Upon completion of removal operations in the area, clean and return adjacent areas to conditions existing prior to the start of the work.

2. The Contractor shall be required to provide containers for any hazardous or dangerous waste identified during demolition. Materials Identified shall at the sole discretion of the ENGINEER either be disposed of in the WAC or be removed from the site and disposed of in accordance with applicable laws and codes.

C. Structural Removals

1. Sequence

a. The extent of structural demolition area shall first be outlined by the Contractor so as to demonstrate that the true extent and nature of the removal is completely understood.

b. Limits of Removal

1) All aboveground and underground portions of the structures shall be demolished. Slabs on grade and concrete foundations shall be broken up and removed.

c. Demolition Debris shall be sorted and sized in general accordance with the following guidelines:

Demolition Debris Material	Sizing Guidelines
Structural Steel	Straight 10 foot length
Concrete Rubble	2 foot maximum dimension
Concrete Walls	4 foot x 4 foot x 1 foot
Structural Wood	8 foot maximum dimension

d. Disposal of Materials:

1) Demolition debris shall be disposed of in the WCA as Unclassified Waste as shown on the Drawings, and in accordance with Section 02205 – Waste Excavation and Disposal.

2) Compressible materials shall be crushed and then covered with backfill. Incompressible materials shall be placed in the disposal area, with the void spaces outside of the materials filled with backfill.

3) Materials such as pipe and tubing have a varying degree of compressibility, depending on the diameter and wall thickness of the pipe. Pipe with a 12-inch diameter or larger shall be crushed or filled with soil for burial, and pipe with smaller diameter shall be crushed before burial.

4) Vessels and tanks shall either be crushed (if thin-walled and compressible) or cut open (if thick-walled and incompressible). Vessels that are to be cut open and filled, shall be placed in the disposal area such that fill can also be placed around them and compacted. Thick-walled tanks or vessels that cannot be cut open due to cutting difficulties or worker health concerns shall be placed in the designated area of disposal, with interior voids spaces filled with grout.

5) Metallic debris shall be placed by sizes so that larger pieces are not stacked on top of each other at angles. Large structural shapes shall either be laid edge to edge so that they can be covered by backfill or they shall be spaced far enough apart that equipment can operate between them to spread backfill. Long structural (incompressible) members shall be oriented horizontally.

6) Demolition debris shall be comingled with the backfill, to minimize the void spaces.

7) Demolition debris shall be distributed throughout designated areas of the backfill to avoid concentrated areas of debris.

8) Demolition debris shall be placed and spread in maximum 2 foot thick loose lifts. The debris is then covered with backfill in a maximum 2-foot loose lift.

9) To the extent practical, uncontaminated material associated with demolition of the Construction Support Zone facilities shall be sent off-site for reuse or disposal.

D. Water Management Ponds

1. Piping and appurtenances shall be removed from water management ponds prior to demolition of the liner system.

2. Synthetic liner materials and geotextiles shall be cut in manageable pieces and removed in folder pieces or rolls.

3. Rolls shall not exceed 25 feet in length and flat pieces or folded sections shall not exceed 250 square feet when placed in the WCA.

4. Liner materials shall be distributed throughout designated areas of the backfill to avoid concentrated areas.

Liner materials shall be covered with backfill in a maximum 2-foot lift.

E. Mechanical Removals

1. Process Piping

a. Facility equipment and structures shall have remaining reagents, residues, and fluids removed and disposed.

b. Water lines shall be drained to appropriate locations for storage and treatment.

F. Clean-Up

1. General

a. Remove all debris resulting from the demolition operations as it accumulates.

b. Upon completion of the work, remove all materials, equipment, waste, and debris of every kind and leave the premises clear, neat and orderly.

G. Safety Barriers

1. Erect and maintain safety barriers, warning lights and other protective devices as required around all areas of structural demolition and/or openings in the operating floors, walls or roofs.

2. All areas of open excavation or partially removed floors shall be kept lighted at all times, 24 hours per day, with floodlights or other lighting devices.

- END OF SECTION -

SECTION 02100 - SITE PREPARATION

PART 1 -- GENERAL

1.1 SUMMARY

A. Site Preparation shall include clearing, grubbing, stripping; and re-grading certain areas, in accordance with the Contract Documents.

B. The CONTRACTOR shall protect existing fences, structures and associated improvements, roads, and utilities downslope of construction area from damage due to boulders, trees, or other objects dislodged during Site Preparation.

C. This section does not address site preparation of the Rhoades Borrow Area. Rhoades Borrow Area site preparation is addressed in Section 02105 – Rhoades Borrow Area.

1.2 SITE INSPECTION

A. Prior to mobilizing onto the Site, the CONTRACTOR shall inspect the Site conditions and review maps delineating the COMPANY's property and right-of-way lines.

PART 2 -- PRODUCTS (NOT USED)

PART 3 -- EXECUTION

3.1 PRIMARY SITE ACCESS

A. The CONTRACTOR shall develop any necessary access to the Site, including access road improvements and access barriers 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 PROTECTION OF MIGRATORY BIRDS~~

~~A. INSERT RESTRICTED CLEARING GUIDELINE DATES, IF ANY, AT 100%~~

~~3.3~~3.2 TIMBERING

A. Removal and salvage of merchantable timber shall be conducted under a separate contract. CONTRACTOR shall not remove and salvage merchantable timber unless otherwise directed by the ENGINEER in writing.

~~3.4~~3.3 CLEARING AND GRUBBING

A. General

1. Clearing limits shall be marked by the CONTRACTOR and approved by the ENGINEER prior to starting any clearing and grubbing activity.

2. Trees and other natural vegetation outside clearing limits shall be protected from damage during construction.

3. Burning of cleared and grubbed debris shall not be allowed.

B. **Areas Not Subject to Excavation of Contaminated Soils and Sediments**

1. Construction areas shall be cleared of structures, trees, logs, and any other objectionable material which would interfere with the performance or completion of the WORK or create a hazard to safety. Trees, shrubs, and debris removed during clearing operations shall be stockpiled on Site at locations designated by the ENGINEER. Trees and other natural vegetation outside the actual lines of construction shall be protected from damage during construction.

2. 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, and other objectionable material. Material removed during clearing and grubbing shall be hauled to on-Site stockpile locations designated by the ENGINEER.

3. Brush and cleared debris shall be chipped is for use as mulch.

C. **Areas Subject to Excavation of Contaminated Soil and Sediments:**

1. Prior to clearing and grubbing, an initial soil contamination evaluation shall be performed by the COMPANY to verify areas where removal of contaminated soil shall be necessary. These areas shall be delineated by the COMPANY.

2. Phasing: Contaminated soil and sediment excavation and disposal shall be conducted in phases, in accordance with Section 02205 – Excavation and Disposal of Waste Materials. Clearing and grubbing in areas of contaminated soil and sediment excavation shall be conducted in similar phases.

3. Areas subject to excavation of contaminated soils and sediments shall be cleared of structures, trees, logs, and any other objectionable material which would interfere with the performance or completion of the WORK or create a hazard to safety. Trees, shrubs, and debris removed during clearing operations in contaminated areas shall be considered contaminated and shall be stockpiled at a location designated by the ENGINEER.

4. Areas subject to excavation of contaminated soil and sediment shall not be subject to grubbing. Surface vegetation remaining in these areas after clearing shall be removed as part of the excavation of contaminated soil and sediments.

5. Brush and vegetative debris, including leftover slash from timbering, shall be chipped and disposed of in the WCA as unclassified waste in accordance with Section 02205 – Mine Waste Excavation and Disposal. Chipped material shall be placed in lifts of less than 6-inch thickness and mixed with the backfill.

~~3.5~~3.4 STRIPPING

A. Areas subject to excavation of contaminated soils and sediment shall not be subject to stripping.

B. For all other areas, upon completion of grubbing operations, areas to be affected by construction shall be stripped to a depth of 1.5-feet below the existing ground contours, or as otherwise directed by the ENGINEER. The stripped materials shall be stockpiled at a location designated by the ENGINEER.

~~3.6~~3.5 OVEREXCAVATION, REGRADING, AND BACKFILL UNDER FILL AREAS

A. After the fill areas have been cleared, grubbed, and stripped, the areas to receive fill may require over-excavation to remove wet, soft, or otherwise undesirable material prior to fill placement.

B. Material removed during over-excavation shall be stockpiled at on-Site locations designated by the Engineer.

C. The excavated ground surface shall be re-contoured for keying the fill and removing severe or abrupt changes in the topography of the Site. The over-excavated areas shall be backfilled with compacted fill in accordance with the requirements of Section 02200 - Earthwork.

- END OF SECTION –

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SECTION 02105 – RHOADS BORROW AREA

PART 1 -- GENERAL

1.1 SUMMARY

A. The CONTRACTOR shall provide all labor, equipment and materials for development and reclamation of the Rhoads Borrow Area in accordance with the Contract Documents.

B. CONTRACTOR shall excavate, haul and stockpile cover soil from the Rhoads Borrow Area.

1.2 SITE INSPECTION

A. Prior to mobilizing onto the Site, the CONTRACTOR shall inspect the Site conditions and review maps delineating the COMPANY's property and right-of-way lines.

1.3 REFERENCE PLANS~~PLAN~~ OF OPERATION~~OPERATIONS~~

A. The work under this section shall be conducted in substantial compliance with the following plans~~plan~~ of operation~~operations~~ included as part of the Contract Documents:

1. Rhoads Property Plan of Operations and Reclamation

2. Remedial Action Work Plan

1.4 CONTRACTOR SUBMITTALS

A. Submit the following in conformance with Section 01300 – Contractor Submittals

B. Submit a Stormwater Pollution Prevention Plan (SWPPP) specific to the Rhoads Borrow Area in accordance with Paragraph 1.5.

C. Submit manufacturer's product data/ information and weed-free certifications on all materials used to construct sediment and erosion control features.

1.5 SWPPP SUBMITTALS

A. The CONTRACTOR shall prepare and submit a Storm Water Pollution Prevention Plan (SWPPP) specific to the Rhoads Borrow Area.

1. The Rhoads Borrow Areas SWPPP shall comply with the Construction Stormwater General Permit (CSWGP) administered by the Washington State Department of Ecology (Ecology).

B. SWPPP: Submit two signed copies of the SWPPP to the ENGINEER for approval. Deliver these documents to the ENGINEER no less than forty-five (45) days before the construction begins. The ENGINEER will review the SWPPP submittals within thirty (30) days. Submittals will be returned to the CONTRACTOR, and marked as either requiring modification or as approved by the ENGINEER.

C. SWPPP Submittal Requirements:

1. Sign and certify the approved SWPPP according to the CSWGP requirements, before submitting the eNOI. The SWPPP must also be signed and certified by the ENGINEER.

2. Submit the eNOI to Ecology and submit a copy of the eNOI to the ENGINEER at the same time. The ENGINEER will submit the COMPANY'S eNOI to Ecology. Allow adequate time for State processing of all eNOIs, before beginning construction activities.

D. Basis of Work: The active status eNOIs, approved SWPPP, and CSWGP are the basis of the Work required for the Rhoads Borrow Area erosion, sediment, and pollution control.

E. Ending Permit Coverage: Within thirty (30) days of when the Rhoads Borrow Area is stabilized as determined by the ENGINEER, submit the eNOT to Ecology and send a copy of the eNOT to the ENGINEER. Upon receipt of the eNOT, the COMPANY will submit the OWNER's eNOT to Ecology, and will terminate the CSWGP coverage.

F. SWPPP personnel, content, and implementation shall be in accordance with Specification Section 01570 –SWPPP.

PART 2 -- PRODUCTS (NOT USED)

PART 3 -- EXECUTION

3.1 HAULAGE

A. A temporary haul road shall be constructed as shown on the Drawings.

1. Gravel running surface shall be Crushed Aggregate Surface~~Base~~ Course as defined in Specification Section 02200.

2. Drainage features and culverts~~Culverts~~ shall be installed in conformance with Section 02200 – Earthwork and Section 02567 – Corrugated Pipe.

B. Haulage shall be conducted in a manner that does not result in contamination of the temporary haul road, excavation areas, or undisturbed areas.

C. Haulage vehicles shall travel only on clean roads and borrow material shall be stockpiled in clean areas such that it will not be required to decontaminate vehicles between trips from~~form~~ the mine site to the Rhoads Borrow Area.

D. All vehicles and equipment shall be pressure washed prior to use within the Rhoads Borrow Area for noxious weed and contamination control.

3.2 TIMBERING

A. Removal and salvage of merchantable timber shall be conducted by others under a separate contract. CONTRACTOR shall not remove and salvage merchantable timber unless otherwise directed by the ENGINEER in writing.

3.3 UNDISTURBED AREAS

A. A 25-foot buffer at the property boundary shall not be disturbed.

B. CONTRACTOR shall avoid disturbance of the duff layer, topsoil, and natural vegetation in areas not subject to disturbance as shown on the Drawings.

C. A minimum 50-foot buffer on either side of Whitetail Creek shall not be disturbed. The COMPANY shall delineate the buffer zone prior to commencement of the WORK.

D. The temporary haul road shall cross Whitetail Creek at the location shown on the Drawings.

E. Areas with slopes of steeper than 3H:1V shall not be disturbed.

3.4 SEQUENCING

A. The borrow area shall be developed in segments as described in the Rhoads Property Plan of Operations and Reclamation referenced in Paragraph 1.3 and included with the Contract Documents.

3.5 CLEARING AND GRUBBING

A. Clearing shall be limited to the area required for the current segment of excavation.

B. Clearing limits shall be marked by the CONTRACTOR and approved by the ENGINEER prior to starting any clearing and grubbing activity.

C. Construction areas shall be cleared of structures, trees, logs, and any other objectionable material which would interfere with the performance or completion of the WORK or create a hazard to safety. Trees, shrubs, and debris removed during clearing operations shall be stockpiled on Site at locations designated by the Engineer.

D. 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, and other objectionable material. Material removed during clearing and grubbing shall be hauled to on-Site stockpile locations designated by the ENGINEER.

E. Trees and other natural vegetation outside clearing limits shall be protected from damage during construction.

F. Burning of cleared and grubbed debris shall not be allowed.

G. Brush and cleared debris shall be chipped is for use as mulch.

3.6 STRIPPING

A. Upon completion of grubbing operations, areas to be affected by construction shall be stripped to a depth of 1.0-feet below the existing ground contours, or as otherwise directed by the ENGINEER. The stripped materials shall be stockpiled at a location designated by the ENGINEER.

3.7 BORROW EXCAVATION

A. Borrow material shall be excavated in phases in accordance with Paragraph 3.4 and shall be hauled to the mine site for use as cover soil.

B. Excavation of borrow material shall progress from areas of higher elevation to areas of lower elevation.

C. A minimum 1-foot thick layer of native soil shall be left in-place over the underlying weathered bedrock.

3.8 RECLAMATION

A. Each segment of borrow area development shall be reclaimed upon completion of excavation, and concurrent with the development of the subsequent segment.

B. A minimum 1-foot layer of residual soil shall be left in place at the bottom of excavations.

C. The excavated surface of each segment shall be ripped to a minimum depth of 1.5 feet, along contour, with a track-mounted dozer equivalent to a Caterpillar D-8 or larger, with a three-toothed ripper.

D. A one-foot layer of salvaged topsoil shall be replaced on the excavated surface and the area shall be graded to blend in with the surrounding terrain.

E. Re-contoured surfaces shall have slopes of 3H:1V or flatter.

F. Revegetation shall be conducted in accordance with Section 02970 – Revegetation.

- END OF SECTION -

SECTION 02120 – ROAD AND STAGING AREA MAINTENENCE

PART 1 -- GENERAL

1.1 SUMMARY

A. The CONTRACTOR shall perform grading and maintenance on existing and new haul roads, staging areas and parking areas throughout construction. This WORK shall include all appurtenant work and equipment including the furnishing and placement of graders, backhoes, compaction equipment, surfacing material, and disposal of excess or waste material, all in accordance with the Contract Documents.

B. CONTRACTOR shall execute the WORK in a manner that does not result in contamination of roads, staging or parking areas that are indicated in the Contract Documents as uncontaminated or "clean."

PART 2 -- PRODUCTS

2.1 ROAD SURFACING

A. Crushed Aggregate Surface Coarse and Crushed Aggregate Base Coarse shall conform to Section 02200 – Earthwork

PART 3 -- EXECUTION

3.1 MAINTENANCE OF ROADS

A. **General:**

1. CONTRACTOR shall maintain temporary roads and parking to continuously provide at the Site access for construction vehicles and trucks, ENGINEER vehicles, deliveries for ENGINEER, emergency vehicles, and parking areas for ENGINEER'S personnel.

2. Public roads shall be passable at all times unless a road closure is allowed in writing by ENGINEER.

3. When temporary roads and parking without hard surfacing become contaminated with soil and create a nuisance, remove contaminated material and replace with clean aggregate as required.

B. Dust resulting from CONTRACTOR'S activities shall be controlled in accordance with Section 01560 – Temporary Environmental Controls.

C. Provide temporary, heavy-duty steel roadway plates to protect existing manholes, handholes, valve boxes, vaults, and similar buried facilities.

3.2 ROAD SUBGRADE REPAIR

A. In areas of temporary construction roads and public roads where the road subgrade has deteriorated, CONTRACTOR shall repair these areas using the materials, methods and compaction requirements per Section 02200 - Earthwork.

3.3 COVER

A. Maintain a minimum of two feet of cover over culverts and buried utilities. Material for the cover shall be as per Section 02200 - Earthwork.

3.4 CUTTING

A. CONTRACTOR shall cut the entire road surface, edge to edge, to a sufficient depth as to remove all superficial potholes and washboards. All cut material shall be windrowed to the center or outside edge of the roadway.

3.5 LAY BACK

A. Windrowed material shall be spread uniformly across both lanes to provide a normal centerline crown. Windrowed material shall not be bladed over the road shoulder into the drainage ditch.

3.6 COMPACTION

A. CONTRACTOR SHALL ensure that road subgrade and surfacing repaired or replaced is evenly graded and compacted. The compaction requirements shall be as per Section 02200 - Earthwork.

3.7 SHAPE

A. The final road cross section shall be as shown on the Drawings.

3.8 SAFETY BERMS

A. Safety berms shall be provided and maintained on the banks of roadways where a drop-off exists of sufficient grade or depth to cause a vehicle to overturn or endanger persons in equipment or as otherwise shown on the Drawings.

B. Safety berms shall be at least mid-axle height of the largest equipment which usually travels the roadway.

~~A.~~C. Safety berms shall be maintained throughout construction.

~~B.~~D. Safety berms shall be replaced when removed by maintenance activities.

E. Safety berm material shall be as indicated on the drawings. Compaction shall be as needed to retain shape and reduce erosion.

3.9 SAFETY BARRIERS AND SIGNAGE

A. Safety barriers must be maintained during construction and not damaged by grading operations. The ENGINEER shall be notified immediately if safety barriers are damaged or otherwise repairs are required.

3.10 CULVERT AND DITCH MAINTENANCE

A. Culvert and ditch maintenance shall be conducted in accordance with the Interim Operations and Maintenance Plan.

B. Culvert and ditch maintenance must only occur when culverts and ditches are dry.

- END OF SECTION -

SECTION 02140 – DEWATERING AND CONTROL OF WATER

PART 1 -- GENERAL

1.1 THE REQUIREMENT

A. The CONTRACTOR shall dewater trench, sump, and structure excavations, and store and treat water as required, in accordance with the Contract Documents. The CONTRACTOR shall secure all necessary permits to complete the requirements of this section of the Specifications, and shall conform to all applicable laws and permit requirements, including but not limited to water quality and erosion regulations.

B. The CONTRACTOR shall design, construct, operate, and maintain River (as defined below) diversions, cofferdams and dewatering systems of sufficient size and capacity to allow construction in the work areas and structure excavations to occur in the dry, in accordance with the Contract Documents. Designs shall accommodate the possibility of highly porous and permeable materials that are expected in a natural River environment.

C. The CONTRACTOR shall design and furnish all materials and construct and maintain all temporary diversions, water quality systems and protective works necessary for diversion and care of water during construction, including but not limited to cofferdams, channels, pipelines, flumes, drains, pumps, sumps and water quality systems. It shall be the CONTRACTOR's responsibility to perform all investigations necessary and to provide designs for dewatering systems which meet the requirements of these Specifications. Any dewatering systems shown in the Drawings are provided to demonstrate possible system concept(s) that meet the construction requirements and environmental protection requirements of the Project that have been conveyed to the agencies for the acquisition of OWNER-furnished Project permits.

D. The CONTRACTOR shall, at a minimum, provide for the protection of fish by executing the work within any fish bearing River as expediently as practical and without delay.

1.2 DEFINITIONS

A. The word "River" in this section shall include Blue Creek, Lake Roosevelt, and all natural streams, creeks and waterways.

1.3 CONTRACTOR SUBMITTALS

A. The submittals indicated below shall conform to Section 01300 – Contractor Submittals.

B. Construction Dewatering Plan

1. The intent of the Construction Dewatering Plan submittal is for the CONTRACTOR to clearly communicate the CONTRACTOR's plan for control of water throughout the entire site, through all activities of the Work, to the OWNER and ENGINEER. The Construction Dewatering Plan shall include sufficient detail to convey that the WORK shall be conducted in such a manner as to ensure the safety of workers and shall be conducted in accordance with the requirements of the permits and Contract Documents.

2. Prior to commencement of any work within or adjacent to the River, dewatering or excavation, the CONTRACTOR shall submit a Construction Dewatering Plan including final detailed plans and operation schedule for dewatering of isolated in-

water work areas and excavations including the care and disposal of the water and sediment. The CONTRACTOR shall be required to demonstrate the system proposed and to verify that adequate equipment, personnel and materials are provided to divert water and dewater the excavations at all required locations and times.

3. The CONTRACTOR's Construction Dewatering Plan is subject to review by the ENGINEER. The CONTRACTOR shall submit the Construction Dewatering Plan at least 30 Days prior to commencement of any excavation or work in the River.

4. The CONTRACTOR shall address each of the following areas individually, in separate sections:

   a. Pit 3 and Pit 4 Dewatering

   b. Effluent Pipeline Installation – Blue Creek

   c. West Pond Excavation

   d. Miscellaneous trench and structure excavation dewatering

5. Construction Dewatering Plan, at a minimum, shall include:

   a. Complete description of construction methods and equipment for in-water work.

   b. Complete descriptions of each water control facility to be installed and the construction and removal techniques.

   c. Descriptions of proposed diversions and groundwater and surface water control facilities including, but not limited to, equipment, methods, standby equipment and power supply, means of measuring discharge due to dewatering, pollution control facilities, discharge locations to be utilized.

   d. Drawings showing locations, dimensions, and relationships of all diversions, water control facilities and elements of each system. Drawings shall reflect all phases of construction and revisions to the system as work progresses.

      1) The CONTRACTOR'S attention is brought to the following: Pit 3 and Pit 4 dewatering requires initial dewatering prior to sediment removal and installation of the underdrain system and dewatering sumps. Subsequent dewatering requires repeated reconfiguration of dewatering piping as waste placement proceeds. Construction Dewatering Plan shall address the required phasing and reconfiguration of these systems.

   e. Design calculations demonstrating adequacy of proposed diversion and dewatering systems and components.

   f. Back-up diversion and dewatering provisions for the event of power or equipment failure.

   g. Summary bar chart type schedule demonstrating the following activities for each dewatering area:

      1) Mobilization

2) Site Preparation

3) Excavation/Installation

4) Construction, use and removal of diversion and water control facilities

5) Restoration/Demobilization

6) In-water work windows

h. Component data and capacities of the hydraulic structures of diversion and water control facilities.

i. Coordination between dewatering areas identified in this Specification section.

j. Fish salvage and protection plan for all dewatered areas.

1.4 QUALITY CONTROL

A. It shall be the sole responsibility of the CONTRACTOR to control the rate and effect of diversions and 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 diversion and dewatering systems, reference points shall be established and observed at frequent intervals to detect any settlement which may develop. The responsibility for conducting the dewatering operation in a manner which shall 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. As may be needed, the CONTRACTOR shall submit a repair plan, stamped and signed by a licensed Professional Engineer in the State of Washington, for approval by the ENGINEER. The repair shall be monitored by the ENGINEER's or the OWNER's appointed representative. Any such restorations or repairs, including design, review and approval, and monitoring, shall be at the sole expense of the CONTRACTOR.

D. The CONTRACTOR shall take all necessary measures to assure compliance with the water quality standards listed in the Project permits. Concrete preparation and placement activities in dewatered River work areas and in the River shall be carefully carried out and monitored to avoid concrete contamination of surface waters that may result in elevate pH conditions which may harm fish. For instream work areas, the CONTRACTOR shall allow adequate curing time for concrete before area is re-watered in order to avoid pH contamination from not adequately cured concrete.

1.5 RESERVOIR AND CREEK DISCHARGE REQUIREMENTS

A. Control of Reservoir and Stream Flows: The CONTRACTOR shall be responsible for the management and removal of River flows passing through the Work areas, and for general protection of the Work. The CONTRACTOR shall, at its own expense, design and construct temporary facilities to route River flows past the Work site as indicated herein.

PART 2 -- PRODUCTS

2.1 EQUIPMENT

A. Water diversion and dewatering, where required, may include the use of well points, sump pumps, cofferdams, temporary pipelines for water disposal, rock or gravel placement, and other means.

B. Keep sufficient pumping equipment and machinery on hand at all times for emergencies, including electric power failures.

C. Keep experienced personnel familiar with diversion and dewatering equipment available at all times to operate pumping equipment, machinery, and appliances.

PART 3 -- EXECUTION

3.1 GENERAL REQUIREMENTS

A. The CONTRACTOR shall provide all equipment necessary for dewatering. It shall have on hand, at all times, sufficient pumping equipment and 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 in the event of a primary dewatering system failure.

B. Dewatering for structures and pipelines conducted prior to being encountered in any excavation, 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. Where excavations may obstruct the natural flow of a watercourse, implement measures to control and dispose of the surface water that will not adversely affect water quality or beneficial use of the water course. Divert watercourse flows around excavation areas by constructing barriers, cofferdams, sandbags, temporary culverts and pipelines or other appropriate means.

D. Do not allow water containing mud, silt, or other pollutants from aggregate washing or other construction to enter a water course or be placed in locations that may be subjected to high storm flows or spillway releases.

E. 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.

F. Dewatering shall at all times be conducted in such a manner as to not disturb or reduce the bearing capacity of the subgrade soils or rock at the proposed bottom of excavation.

G. If foundation soil or rock are disturbed or loosened by the seepage of water or an uncontrolled flow of water, the affected areas shall be excavated and replaced with drain rock.

H. The CONTRACTOR shall maintain the water level below the bottom of excavation in all work areas where groundwater occurs during excavation construction, backfilling, and up to acceptance of the work.

I. 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 which may result from failure to adequately keep excavations dewatered.

J. If well points or wells are used, they shall be adequately spaced to provide the necessary dewatering and shall be sandpacked 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.

K. The CONTRACTOR shall dispose of water from the WORK in a suitable manner. 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. Water shall be filtered using an approved method to remove sand and fine-sized soil particles before disposal into any drainage system.

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 and pipelines.

M. 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 unit and lump sum prices in the price bid, unless a separate bid item has been established for dewatering.

N. No equipment shall be allowed to operate below ordinary high water of the River without first diverting the creeks upstream, controlling runoff from the work area and as allowed by permit.

O. Diversion and dewatering facilities shall be removed prior to the start of any winter shut-down or other temporary shutdown of construction activities where they would interfere with natural flow of the River, unless otherwise approved by the ENGINEER. Any facilities not removed, even if allowed by the ENGINEER, shall be at the sole risk of the CONTRACTOR and costs due to damage thereto shall be borne entirely by the CONTRACTOR.

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SECTION 02160 – SEDIMENT AND EROSION CONTROL

PART 1 -- GENERAL

1.1 SUMMARY

A. The CONTRACTOR shall develop and implement sediment and erosion control program and practices in accordance with the approved Storm Water Pollution Prevention Plan required by Section 01570.

B. Design, construct, maintain, and remove temporary drainage facilities as necessary to control surface water runoff, groundwater seepage, dewatering system discharges, and stream flows at the construction site so that water from these sources does not disturb the constructed facilities, cause erosion of the existing topography, or adversely impact downgradient water.

C. Furnish all materials and labor to construct sediment fences, to place wood fiber wattles, construct rock or log check dams, construct brush barriers, install turf reinforcement mats and erosion control blankets, and other permanent or temporary~~and other~~ sediment control methods as detailed in the SWPPP and/or Drawings required for reduction of erosion and protection of water courses.

D. Maintain and remove all temporary sediment and erosion facilities.

1.2 REFERENCE REMEDIAL ACTION WORK PLANS

A. The work under this section shall be conducted in substantial compliance with the following work plans included as part of the Contract Documents in accordance with Section 01015 – Remedial Action Work Plans.

1. Remedial Action Work Plan

2. Master Stormwater Management Plan

1.3 CONTRACTOR SUBMITTALS

A. Submit the following in conformance with Section 01300 – Contractor Submittals

B. The CONTRACTOR shall prepare and submit a Construction Storm Water Pollution Prevention Plan (CSWPPP) in conformance with Section 01570 – Storm Water Pollution Prevention Plan.

C. Submit manufacturer's product data/ information and weed-free certifications on all materials used to construct sediment and erosion control features.

D. Rolled Erosion Control Products (RECP):

1. The Contractor shall provide the Engineer a certificate stating the name of the RECP manufacturer, product name, style, chemical compositions of filaments or yarns and other pertinent information to fully describe the geotextile.

2. The Manufacturer is responsible for establishing and maintaining a quality control program to assure compliance with the requirements of the specification. Documentation describing the quality control program shall be made available upon request.

3. The manufacturer's certificate shall state that the furnished RECP meets MARV requirements of the specification as evaluated under the manufacturer's quality control program. The certificate shall be attested to by a person having legal authority to bind the Manufacturer.

1.4 EROSION CONTROL REQUIREMENTS

A. The CONTRACTOR shall design and implement erosion and sediment control measures for correcting conditions unforeseen during the design of the project, and for emergency situations that develop during construction. Measures and methods proposed by the CONTRACTOR shall be reviewed and approved by the ENGINEER prior to installation.

B. The CONTRACTOR shall incorporate into the project all erosion and sediment control features, as well as spill prevention and containment measures, at the earliest practicable time as outlined in the acceptable schedule.

C. If erosion occurs in completed WORK before permanent reclamation, the CONTRACTOR shall place temporary soil stabilization to stop the erosion. The CONTRACTOR shall not be entitled to additional payment for any temporary soil stabilization.

D. The CONTRACTOR shall continuously maintain all erosion and sediment control measures so that they perform their intended function during construction and WORK suspensions until the project is completed. If the CONTRACTOR fails to maintain the erosion and sediment control features, the ENGINEER/COMPANY may at the expiration of a period of 48 hours, after giving the CONTRACTOR written notice, proceed to maintain the features as deemed necessary. The cost thereof shall be deducted from any compensation due, or which may become due to the CONTRACTOR.

E. Disturbed areas of the construction site in which construction activities will not occur for a period of more than 10 days shall have erosion and sedimentation control measures implemented.

F. Temporary erosion and sediment control measures shall be removed upon completion of the project unless otherwise directed by the ENGINEER or COMPANY. At the completion of the Contract, removed temporary erosion control items shall become the property of the CONTRACTOR.

G. Sediment removed during maintenance of erosion control features shall be disposed of by the CONTRACTOR at a location approved by the ENGINEER or COMPANY.

PART 2 -- PRODUCTS

2.1 GENERAL

A. All products, including those not specifically listed herein, shall be approved by the ENGINEER.

B. Seed, Fertilizer and Mulch: In accordance with Specification Section 02940 - Revegetation.

2.2 SEDIMENT FENCES

A. Sediment fences for sediment control shall consist of fabric and posts suitable for sedimentation control application. Sediment fence fabric shall be UV (ultra-violet) protected. Posts shall be metal or wood with a minimum length of 3.3-feet. Metal posts

shall be “studded tee” or “U” type with a minimum weight of 1.2 lbs. per foot. Wood posts shall have a minimum diameter or cross section dimension of 2 inches. When used, wire mesh reinforcement for filter fabric shall be minimum 14 gauge with a maximum mesh opening of 6 inches.

2.3 ROCK CHECK DAMS

A. Rock check dams shall consist of well-graded rock between 2 inches to 10 inches.

2.4 WOOD FIBER WATTLES

A. Wood~~Straw and wood~~ fiber products shall be certified as free of noxious weed by the United States Department of Agriculture, Natural Resources Conservation Service, Local Soil and Water Conservative District, Alaska Weed Free Forage Certification Program.

B. Wooden stakes shall have a minimum diameter or cross-section dimension of 2 inches.

~~B.~~C. Straw wattles shall not be used.

2.5 BRUSH BARRIERS

A. Brush barriers shall be constructed of slash and timber from on-site clearing activity. Imported materials shall not be used in brush barrier construction.

2.6 LOG CHECK DAMS

A. Log check dams shall consist of hardwood or other durable wood between 12 inches to 20 inches in diameter.

2.7 EROSION CONTROL BLANKET (ECB)

A. Machine fabricated ECB covered on both sides by netting and sewn together on two inch centers with minimum 840 denier, Ultraviolet (UV) stabilized polypropylene thread.

B. Fiber shall be 100 percent coconut fiber, homogeneously blended and distributed evenly throughout the ECB.

C. Netting shall be UV stabilized polypropylene with mesh openings of approximately 0.625 in by 0.625 in.

D. Minimum Average Roll Values:

Property	**Test Method**	**Units**	**Property Requirement**
Thickness	ASTM D-6525	mm (in)	7.6 (0.30)
Tensile Strength	ASTM D-6818	kN/m (lbs./ft)	2.2 x 2.2 (150 x 150)
Tensile Elongation	ASTM D-6818	percent	25

E. Approved Products:

1. Propex Landlok C2, or equal

2.8 TURF REINFORCEMENT MAT (TRM)

A. Three-dimensional, lofty woven polypropylene geosynthetic specially designed for erosion control applications on steep slopes and vegetated waterways.

B. Matrix composed of monofilament yarns woven into uniform configuration of resilient pyramid-like projections.

C. Material to exhibit very high interlock and reinforcement capacity with both soil and root systems and demonstrate high tensile modulus.

D. Minimum Average Roll Values:

Property	**Test Method**	**Units**	**Property Requirement**
Thickness	ASTM D-6525	mm (in)	10.2 (0.40)
Resiliency	ASTM D-6524	percent	80
Mass Per Unit Area	ASTM D-6566	G/sq m (oz/sy)	457.7 (13.5)
Tensile Strength	ASTM D-6818	kN/m (lbs/ft)	58.4 x 43.8 (4,000 x 3,000)
Tensile Elongation	ASTM D-6818	percent	40 x 35
Light Penetration (% Passing)	ASTM D-6567	percent	15 (max)
UV Resistance	ASTM D-4355	percent	90 at 6000 hrs 85 at 10000 hrs

E. Approved Products:

1. Propex Pyramat, or equal.

F. RECP Ground Anchoring Devices:

1. Length: 200 to 450 mm (8 to 18 inches); sufficient ground penetration to resist pullout. Use longer anchors for loose soils.

2. U-shaped wire staples, metal pins, or triangular wooden stakes.

3. Wire staples: Minimum 8 gauge.

4. Metal pins: Steel, minimum 5 mm (0.20 in) in diameter with 40 mm (1.5 in) steel washer.

PART 3 -- EXECUTION

3.1 GENERAL

A. All BMP's shall be installed in locations indicated on the approved CSWPPP and at additional locations as may be required to comply with the erosion and sediment control requirements of the CSWPPP.

B. Install prescribed BMP's at the locations shown on the Drawings.

3.2 SEDIMENT RETENTION PONDS

A. Install sediment ponds to the lines and grades shown on the Drawings.

3.3 INSTALLING SEDIMENT FENCES

A. Drive posts or stakes vertically into the ground to a minimum depth of 1.6 feet.

B. The height of the reinforced sediment fence from the ground surface shall be a minimum of 2 feet, but shall not exceed 3 feet.

C. Excavate a trench approximately 0.5 feet wide by 1 foot deep along the line of posts or stakes, and upslope from the reinforced sediment fence. The bottom 1 foot of the reinforced sediment fence fabric shall be buried into this trench. Backfill the trench with compacted fill using the excavated materials.

D. Fasten filter fabric securely to metal posts using wire tires, or to wood stakes with 0.8 inches long No. 9 heavy duty staples.

E. Minimize the use of joints.

F. Space stakes or posts a maximum of 10 feet apart.

G. If wire mesh is used, fasten wire mesh support fence securely to the upslope side of the posts using heavy duty wire staples at least 0.8 inches long, tie wires or hog rings. The wire mesh shall extend into the trench a minimum of 2 inches and shall not extend more than 3 feet above the original ground surface.

H. Install the reinforced sediment fence along the toes of fills and along a level contour. Provide area behind the fence for runoff to pond and sediment to settle. Maintain a minimum of 5 feet between the slope toe and the reinforced sediment fence.

I. Sediment shall be removed from behind the reinforced sediment fence when it accumulates to one half the exposed fabric height.

J. Sediment fence shall not be placed perpendicular to concentrated flow.

3.4 INSTALLING ROCK CHECK DAMS

A. Key into the channel bottom a minimum of 24 inches. Base of key trench shall be a minimum of 24 inches.

B. Drainage area shall not be greater than 2.5 ac.

C. Height shall not be greater than 40 inches.

D. Check dams shall be spaced as necessary in the channel so the toe of the downstream dam is 1.5 times the height of the downstream dam below the elevation of the toe of the upstream dam.

E. Place check dams perpendicular to the direction of flow.

3.5 INSTALLING ~~STRAW~~ WOOD FIBER WATTLES

A. Entrench and backfill wood fiber wattle. Excavate trench the width of a wattle and the length of the barrier to a minimum depth of 4 inches. Backfill against each wattle with soil excavated from the trench. Backfill soil should match the original ground surface on each side of the wattle.

B. Securely anchor each wattle using wood stakes. Drive stakes a minimum of 1 foot into the ground. Re-bar shall not be allowed for staking bales.

C. Install the wattles at the toe of fills and along level contours.

3.6 INSTALLING LOG CHECK DAMS

A. Key into the channel bottom a minimum of 12 inches. Key into banks 1.5 to 3 feet.

B. Drainage area shall not be greater than 0.5 ac.

C. Height shall not be greater than 40 inches.

D. Check dams shall be spaced as necessary in the channel so the toe of the downstream dam is 1.5 times the height of the downstream dam below the elevation of the toe of the upstream dam.

1. Place check dams perpendicular to the direction of flow.

3.7 INSTALLING BRUSH BARRIERS

A. Brush shall be windrowed along contour and may require machine compaction (excavator bucket). Stumps may be placed within brush barriers.

3.8 INSTALLING RECP

A. Grade and compact areas to be treated with RECP and compacted as indicated or as directed by Engineer.

B. Remove large rocks, soil clods, vegetation, and other sharp objects that could keep RECP from intimate contact with subgrade.

C. Construct anchor trenches as indicated, or as otherwise required to adequately anchor the RECP for the required application.

D. Install RECP at elevation, alignment, and extents indicated.

E. Extend RECP 2 to 3 feet over crest of slope, secure into trench with anchoring devices, backfill, and compact with specified soil or as directed by Engineer.

F. Unroll RECPs downslope, overlapping adjacent rolls minimum 6 in. Lay material loosely, maintaining direct contact with soil.

G. Secure RECP to slope with ground anchoring devices as follows:

H. Alternate installation methods must be approved by Engineer prior to execution.

~~3.8~~3.9 TEMPORARY SEEDING

A. Temporary seeding shall be in compliance with Specification Section 0297~~02940~~ - Revegetation.

B. Within 24 hours of installing a culvert, temporary seed the disturbed area or within a 25-foot radius of the inlet and outlet of the culvert, whichever is greater.

~~3.9~~3.10 M MAINTENANCE~~MAINTENANCE~~ OF SEDIMENT CONTROL MEASURES

A. The CONTRACTOR shall inspect sediment control measures regularly as defined in the SWPPP. Sediment control measures that are damaged shall be repaired as soon as possible and prior to the next precipitation event. If sediment accumulates in sediment control measures designed to trap sediment then it shall be removed. Removed sediment shall be considered for use as a component of cover soils.

B. In locations where silt fences are used, sediment trapped by the silt fence shall be removed by the CONTRACTOR when one-third of the height of the silt fence is covered by sediment.

C. In locations where sediment retention ponds are used, the CONTRACTOR shall remove sediment buildup in the pond when the sediment has filled 2/3 or more of the pond volume, of if the buildup begins to interfere with the proper drainage of the site. Sediment retention ponds that remain in place at the end of each phase of the WORK shall be excavated to design profile depths and slopes regardless of the volume of sediment collected.

~~3.10~~3.11 R REMOVAL~~REMOVAL~~ OF TEMPORARY FACILITIES

A. Do not remove erosion and sediment control facilities without approval from the ENGINEER.

B. Removed sediment and erosion control materials shall be disposed of in the Waste Containment Area (WCA) at a location designated by the ENGINEER.

C. Remove and dispose the sediments collected in the sediment control systems at a location approved by the ENGINEER or COMPANY.

- END OF SECTION -

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SECTION 02200 – EARTHWORK

PART 1 -- GENERAL

1.1 SUMMARY

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

B. Fill materials placed outside of the waste containment area (WCA) and as part of the cover system shall be placed in accordance with this section.

C. Excavation of above grade mine waste materials and contaminated soils and sediments, and disposal of these materials within the WCA shall be conducted in accordance with Section 02205 – Mine Waste Excavation and Disposal.

1.2 REFERENCE REMEDIAL ACTION WORK PLANS

A. The work under this section shall be conducted in substantial compliance with the following work plans included as part of the Contract Documents in accordance with Section 01015 – Remedial Action Work Plans:

1. Remedial Action Work Plan
2. Staging/Temporary Stockpiling Plan
3. Master Stormwater Management Plan
4. Construction Quality Assurance Plan
5. Analytical Support and Verification Plan

1.3 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. Washington State DOT Standard Specifications for Road, Bridge, and Municipal Construction (latest edition).

B. ASTM C33 – Standard Specifications for Concrete Aggregates

C. ASTM C117 - Standard Test Method for Materials Finer than 75-µm (No. 200) Sieve in Mineral Aggregates by Washing

D. ASTM C136 - Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates

E. ASTM C150 - Standard Specification for Portland Cement

F. ASTM D75 – Standard Practices for Sampling Aggregates.

G. ASTM D422 – Standard Test Method for Particle Size Analysis of Soil.

H. ASTM D698 – Standard Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort.

I. ASTM D2487 – Standard Practice for Classification of Soils for Engineering Purposes.

J. ASTM D3665 – Standard Practice for Random Sampling of Construction Materials.

K. ASTM D4220 – Standard Practices for Preserving and Transporting Soil Samples.

L. ASTM D4718 – Standard Practice for Correction of Unit Weight and Water Content for Soil Containing Oversize Particles.

M. ASTM D6913 – Standard Test Method for Particle Size Distribution (Gradation) Using Sieve Analysis.

~~M.~~N. ASTM D6938 – Standard Test Method for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth)

1.4 CONTRACTOR SUBMITTALS

A. Submit in accordance with Section 01300 – Contractor Submittals.

B. Submit CONTRACTOR's Detailed Shoring Plan as follows:

1. The CONTRACTOR, prior to beginning any trench or structure excavation 4 feet deep or deeper, shall submit to the ENGINEER and shall be in receipt of the ENGINEER's written acceptance of the CONTRACTOR's detailed plan showing the design of 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.

2. If such plan varies from the shoring system standards established by OSHA, such alternative systems plans shall be prepared by a civil or structural engineer licensed in the State of Washington.

3. The ENGINEER's acceptance of said plan shall be for verification of submittal of the plan with this requirement.

C. Submit product Information for imported and on-site processed materials including pertinent information to evaluate proposed materials for compliance with the specifications such as grain-size distribution, soil classification, durability data, and other pertinent material information.

D. Samples: The CONTRACTOR shall submit samples of materials proposed for the WORK, if requested by the ENGINEER.

E. Blasting Plan: Blasting Plan submittal for rock excavation shall be in accordance with Section 02210 Blasting.

PART 2 -- PRODUCTS

2.1 FILL AND BACKFILL MATERIAL REQUIREMENTS

A. General:

1. Fill materials that shall be placed outside of the WCA and as part of the cover system shall meet the soil cleanup standards set forth below.

Contaminant of Concern	Cleanup Level
Uranium (total)[1]	43 mg/kg
Lead-210	7.5 pCi/g*
Radium-226	4.7 pCi/g

2. Fill and backfill materials and placement locations shall conform to the Drawings.

3. Fill materials that are 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.

2.2 DEFINITIONS

A. Suitable Materials:

1. Materials not defined below as unsuitable shall be considered as suitable materials and may be used in fills, backfilling, and embankment construction subject to the indicated requirements. Suitable materials may be obtained from on-Site excavations, or may be processed on-Site materials.

2. Suitable materials may be imported. If imported materials are required by this Section or are required in order to meet the quantity requirements of the WORK, the CONTRACTOR shall provide imported materials as part of the WORK, unless a unit price item is included for imported materials in the Bidding Schedule.

B. Unsuitable materials:

1. Materials that do not meet the soil cleanup standards of Part 2.1 A of this Section.

2. Materials that in the opinion of the ENGINEER 1) exhibit poor strength or durability qualities; 2) are compressible or expansive; 3) are too wet or dry to be placed or compacted properly; 4) are frozen; 5), contain contaminants, organics, debris, or other deleterious materials; 6) are corrosive or react with concrete or steel; or 7) are otherwise not suitable for the intended use of the material. Unsuitable material placed as fill in unapproved areas shall be removed and replaced with suitable material in accordance with these Specifications at the CONTRACTOR's expense.

C. General Fill and Structural Fill

1. General Fill and Structural Fill shall consist of suitable materials with no cobbles or rock larger than six inches, and a maximum of 12% passing the #200 sieve. Fines shall be non-plastic. ~~.~~

D. Attenuation Berm Embankment Fill

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[1] Throughout this document, "uranium" refers the natural (total) form unless an isotopic form (e.g. U-238) is specified.

* Note that Table 8-3 in the Midnite Mine Record of Decision (ROD; EPA, September 2006) lists the units for Lead-210 as pCi/kg. It is assumed that this is a typographical error and the correct units should be pCi/g as stated in Table 8-4.

1. Attenuation Berm Embankment Fill shall be suitable materials with no cobbles or rock larger than six inches and with a minimum percent 20% passing the #200 sieve.

E. Cover Soil

1. Cover Soil shall be materials obtained from the Rhoads Borrow Area; or from excavated soils and waste soils, including sediments removed from erosion control devices, that meet the site cleanup standards in Part 2.1 A of this Section.

2. Cover Soil shall be suitable material and shall meet the following gradation requirements.

Sieve Size	PERCENTAGE PASSING
3-inch	100
1-inch	90-100
No, 4	65-100
No. 40	30-80
No. 200	10-50

F. Crushed Aggregate Base Course

1. Crushed Aggregate Base Course shall be crushed rock or gravel, durable and free from slaking or decomposition under the action of alternate wetting or drying.

2. Crushed Aggregate Base Course shall be uniformly graded, and shall meet the following gradation requirements.

Sieve Size	PERCENTAGE PASSING
1 1/4-inch	100
1-inch	80 -100
5/8-inch	50 – 80
No. 4	25 – 45
No. 40	3 – 18
No. 200	7.5 max.

G. Crushed Aggregate Surface Course

1. Crushed Aggregate Surface Course shall be crushed rock or gravel, durable and free from slaking or decomposition under the action of alternate wetting or drying.

2. Crushed Aggregate Surface Course shall be uniformly graded, and shall meet the following gradation requirements:

Sieve Size	PERCENTAGE PASSING
3/4 – inch	100
1/2-inch	80 – 100
No. 4	46 – 66
No. 40	8 – 24
No. 200	10 max.

H. Pea Gravel

1. Pea Gravel shall be crushed rock or gravel, durable and free from slaking or decomposition under the action of alternate wetting or drying.

2. Pea Gravel shall be uniformly graded, and shall meet the following gradation requirements:

Sieve Size	PERCENTAGE PASSING
½-inch	100
3/8-inch	85 – 100
No. 4	10-30
No. 8	0-10
No. 16	0-15

I. Clean Drain Gravel

1. Clean Drain Gravel shall be crushed rock or gravel, durable and free from slaking or decomposition under the action of alternate wetting or drying.

2. Clean Drain Gravel shall meet the following gradation requirements:

Sieve Size	Percent Passing (by weight)
3 inch	100
1 ½ inch	100
1 inch	0 - 90
¾ inch	0 - 40
½ inch	0 - 20
3/8 inch	0 -10
No. 4	0 – 5
No. 200	0 – 5

~~I.~~J. Pipe Bedding

1. Pipe Bedding shall be suitable material classified per ASTM D2487 as GW, GP, GM SW, SP, GW-GC, or SP-SM, with 100 percent passing the ¾ -inch sieve. Pipe bedding shall have a maximum of 12% passing the #200-seive, and fines shall be non-plastic.

K. Geomembrane Bedding Material

1. Geomembrane bedding material shall consist of suitable materials with a maximum particle size of ¾-inch.

~~J.~~L. Filter Sand

1. Filter Sand shall be imported material conforming to ASTM C33 Standard Specifications for Concrete Aggregates, Fine Aggregate. Filter sand shall not contain any unsuitable material.

2. Filter Sand shall have the following grain-size distribution:~~:~~

Sieve Size	Percentage Passing
3/8 –inch	100
No. 4	95 – 100
No. 8	80 – 100
No. 16	50 – 85
No. 30	25 – 60
No. 50	5 – 30
No. 100	0 – 10

M. Intermediate Filter Sand

1. Intermediate filter sand shall be imported material conforming to ASTM C33 Standard Specifications for Concrete Aggregates, No. 67 Coarse Aggregate.

2. Intermediate filter sand shall have the following grain size distribution:

Sieve Size	Percent Passing (by weight)
1 inch	100
¾ inch	90 – 100
½ inch	20 – 55
3/8 inch	0 – 10
No. 4	0 – 5

~~K.~~N. Rip Rap and Filter

1. Rip Rap and Filter materials shall conform to Section 02273 Rip Rap and the Drawings. These materials shall not contain any unsuitable material.

2.3 SLUSH GROUT

A. Slush Grout – Slush Grout is Portland cement grout used to fill open fractures exposed at the surface of storm water channels excavated in rock

B. Slush grout shall be composed of neat cement Type I grout or cement, sand, and water and shall be approved by the ENGINEER. The ratios of the materials may vary to ensure penetration of the crack or crevice being slush grouted. The ratio of sand to cement shall not exceed two parts sand to one part cement by weight. Adequate water shall be mixed thoroughly into the cement or cement and sand mixes to produce a workable mixture for proper placement as approved by the ENGINEER. The grout mixture shall be prepared by a mechanical mixer and shall be used within 30 minutes after mixing.

C. Cement for slush grout shall be Type II conforming to ASTM C150. A sufficient quantity of cement shall be available at the site to ensure that slush grouting operations will not be delayed by shortage of materials. Cement shall be used in the same sequence that it is received at the work site. Deliver and store cement at a temperature not exceeding 120 degrees F.

D. Sand for slush grout shall conform to ASTM C33 for deleterious substances and soundness requirements and shall meet the following gradation requirements:

Sieve Size	Percent Passing by Weight
No. 16	100
No. 100	10 – 30
No. 200	0 – 5

E. Water shall conform to the requirements of Section 03300 – Cast-in-Place Concrete.

2.4 MATERIALS TESTING

A. Testing of on-site processed materials and imported materials to verify conformance to specified standards shall be performed by the CONTRACTOR and submitted to the ENGINEER for approval.

B. Soils testing of samples submitted by the CONTRACTOR shall be performed by a testing laboratory approved by the ENGINEER.

C. The ENGINEER may direct the CONTRACTOR to supply samples for testing of any material used in the WORK.

D. Particle size analysis of soils and aggregates shall be performed using ASTM D422.

E. Sample Collection and Handling

1. Samples shall be collected in accordance with ASTM D75.

2. Samples selection shall be conducted in accordance with ASTM D3665.

3. Samples shall be preserved and transported in accordance with ASTM D4220.

2.5 SOIL CLASSIFICATION

A. Soils Classification for all aspects of the WORK, including references in these Specifications and the Drawings to soil classification types and standards shall have the meanings and definitions indicated in ASTM D 2487.

B. Rock Classifications for all aspects of the WORK, including references in these Specifications and the Drawings to rock classification types and standards shall have the meanings and definitions indicated in the U.S. Bureau of Reclamation (USBR) Field Manual, unless specifically noted otherwise.

C. The CONTRACTOR shall be bound by applicable provisions of ASTM D 2487 and the U.S. Bureau of Reclamation (USBR) Field Manual in the interpretation of soil and rock classifications.

2.6 DETECTABLE IDENTIFICATION TAPE

A. Unless otherwise indicated, detectable identification tape shall be placed above buried pipelines that are not comprised of magnetic components at least in part. Culverts are exempt from this requirement.

B. Identification tape shall be 6-inches wide, yellow in color, composed of polyethylene, and provided with an integral metallic wire.

C. Tape shall be labeled with CAUTION – BURIED UTILITIES.

PART 3 -- EXECUTION

3.1 SURFACE PREPARATION

A. Clearing, grubbing, and stripping shall be conducted in accordance with Section 02100 – Site Preparation prior to performing any excavation or placing any fill.

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

C. Frozen Material

1. Do not place material on surfaces that are muddy, frozen, or contain frost and/or ice.

2. Fill containing any frozen materials shall be considered unsuitable material.

3.2 DRAINAGE

A. Provide for the collection and disposal of surface and subsurface water encountered during construction. Completely drain construction site during periods of construction to keep soil materials sufficiently dry.

B. Construct any storm drainage features at the earliest stages of site development, and throughout construction grade the construction area to provide positive surface water runoff away from the construction activity or provide temporary ditches, swales, and other drainage features and equipment as required to maintain dry soils.

C. When unsuitable working platforms for equipment operation and unsuitable soil support for subsequent construction features develop, remove unsuitable material and provide new suitable material as specified herein. It is the responsibility of the CONTRACTOR to assess the soil and ground water conditions presented by the plans and specifications and to employ necessary measures to permit construction to proceed.

3.3 DEWATERING

A. Dewatering shall be conducted in accordance with Specification 02140 – Dewatering and Control of Water.

3.4 TEMPORARY STOCKPILES

A. The CONTRACTOR shall establish their stockpile areas in accordance with Section 01552 – Staging and Stockpile Areas. Stockpile locations and sequencing shall be as show on the Drawings and as described in the Staging//Temporary Stockpiling Plan

B. Inactive stockpiles shall be stabilized in accordance with the Construction Stormwater Pollution Prevention Plan (CSWPPP).~~CSWPPP.~~ Keep stockpiles in a neat and well drained condition, giving due consideration to drainage at all times.

C. Protect stockpiles of suitable materials from contamination which may destroy the quality and fitness of the stockpiled material.

D. If the CONTRACTOR fails to protect the stockpiles, and any material becomes unsuitable, remove and replace such material with suitable material from approved sources.

E. Removal and Restoration:

1. Permanent stockpiles shall not be allowed.

2. Upon depletion of any stockpile, the area shall be graded to match the surrounding topography. Stockpile areas shall be revegetated in accordance with Section 2970~~02940~~ – Revegetation.

3. Repair or replace drainage paths and other landscaping items affected by temporary stockpiles.

4. All restoration shall be approved by the ENGINEER.

3.5 TOPSOIL STOCKPILE EXCAVATION

A. The existing Southwest, Southeast, Northwest, and Northeast topsoil stockpiles shall be excavated to the limits detailed in the Drawings, or as otherwise directed by the ENGINEER.~~.~~ These materials shall be characterized and temporarily stockpiled at a location defined by the ENGINEER based on the result of characterization. Characterization sampling is the responsibility of the COMPANY and shall be conducted in accordance with the Analytical Support and Verification Plan.

B. If these materials meet soil cleanup levels, they shall be used as soil cover.

C. If these materials do not meet soil cleanup standards, they shall be stockpiled within existing mine waste areas and consolidated in the WCA in accordance with Section 02205.

3.6 GENERAL EXCAVATION

A. General:

1. Perform excavation of every type of material encountered within the limits of the project to the lines, grades, elevations, and tolerances indicated and as specified. Except when specifically provided to the contrary, excavation shall include the removal of materials, including obstructions that would interfere with the proper execution and completion of the WORK.

2. Excavate unsuitable materials encountered within the limits of the Work below grade and replace with Suitable materials as directed. Include such excavated material and the suitable material ordered as replacement in excavation.

3. Excavations shall commence from high to low elevation with a horizontal working surface and an elevated surface at the downhill portion of the active excavation area to retain storm water within the excavation area.

4. Excavate material required for fill, embankment, or cover in excess of that produced by excavation within the grading limits from the borrow areas indicated or from other approved areas as designated by the ENGINEER.

B. Ditches and Channels

1. Finish excavation of ditches and channels by cutting accurately to the cross sections, grades, and elevations shown on the Drawings. Do not excavate ditches or channels below grades shown.

2. Backfill any excessive open ditch or channel excavation with thoroughly compacted suitable material to grades shown.

3. Maintain excavations free of leaves, brush, sticks, trash, and other debris until final acceptance of the Work.

C. Over-Excavation:

1. Indicated: Where areas are indicated to be over-excavated, excavation shall be to the depth indicated, and fill shall be installed to the grade indicated.

2. Not Indicated: When ordered to over-excavate areas deeper and/or wider than required by the Contract Documents, the CONTRACTOR shall over-excavate to the dimensions ordered and fill to the indicated grade.

3. Neither Indicated nor Ordered: Any over-excavation carried below the grade that is neither ordered or indicated shall be filled and compacted to the required grade with the indicated material as part of the WORK and at the CONTACTOR'S expense.

D. Rock Excavation

1. Rock excavation shall include removal and stockpiling at an on-site location designated by the ENGINEER of the following items:

   a. Boulders measuring 1/3 of a cubic yard or more in volume;

   b. Rock material in ledges, bedding deposits, and un-stratified masses that cannot be removed using conventional equipment as defined herein and which require systematic drilling and blasting for removal;

   c. Conglomerate deposits or weathered bedrock that are so firmly cemented that they possess the characteristics of solid rock and cannot be removed using conventional equipment as herein defined and require systematic drilling and blasting for removal.

2. Explosives and Blasting: Blasting shall not be permitted at any location other than the Pit 3 and Pit 4 sumps unless authorized in writing by the ENGINEER. Blasting shall be performed in accordance with Section 02210 - Blasting.

E. Exploratory Excavations:

1. The CONTRACTOR shall excavate and expose buried points of connection to existing utilities as indicated on the Drawings.

2. Excavation shall be performed prior to the preparation of Shop Drawings for connections and before the fabrication and installation of the pipe

3. The data obtained from exploratory excavations shall be used in preparing the Shop Drawings.

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

5. Damage to utilities from excavation activities shall be repaired by the CONTRACTOR at their expense.

3.7 TRENCH EXCAVATION

A. General

1. Excavate the trench as shown on the Drawings.

2. The CONTRACTOR shall furnish, place, and maintain supports and shoring required to maintain stability of all aspects of the excavations.

3. 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 (29 CFR 1926).

4. Below the top of pipe elevation, do not exceed a trench width of 24 inches plus pipe outside diameter (O.D.) for pipes of less than 18 inches inside diameter, and do not exceed 36 inches plus pipe O.D. for sizes larger than 18 inches inside diameter. Where recommended trench widths are exceeded, provide redesign, stronger pipe, or special installation procedures by the CONTRACTOR. The CONTRACTOR is responsible for the cost of redesign, stronger pipe, or special installation procedures without any additional cost to the OWNER.

B. Trenching in Embankments, Fills and Structural Backfills:

1. 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.

2. Upon completion of the embankment or structural backfill, a trench conforming to the appropriate detail may be excavated and the pipe may be installed.

C. Trench Bottom Preparation:

1. Grade the bottoms of trenches accurately and uniformly to the bottom of Pipe Bedding.

2. Remove particles of 3-inch or greater, unless otherwise specified by the pipe manufacturer, to avoid point bearing.

3. Removal of unsuitable material: Where Unsuitable material is encountered in the bottom of the trench, remove such material to the depth directed and replace it to the proper grade with General Fill. When removal of unsuitable material is required due to the CONTRACTOR's fault or neglect in performing the Work, the CONTRACTOR is responsible for excavating the resulting material and replacing it at the expense of the CONTRACTOR.

D. Open Trenches:

1. The maximum amount of open trench permitted in any one location for the WTP influent/effluent, and groundwater collection pipelines shall be 500 feet or the length

necessary to accommodate the amount of pipe installed in a single day, whichever is greater.

2. 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~~Day~~.

3. These requirements for backfilling or use of steel plate shall be waived in cases where the trench is located further than 100 feet from any traveled roadway or occupied structure; in such cases, however, barricades and warning signs meeting appropriate safety requirements shall be provided and maintained.

E. Trench Shield

1. If a moveable trench shield is used during excavation operations, the trench width shall be wider than the shield such that the shield is free to be lifted and then moved horizontally without binding against the trench sidewalls and causing sloughing or caving of the trench walls.

2. If the trench walls cave 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.

3. If a moveable trench shield is used during excavation, pipe installation, and fill operations, the shield shall be moved by lifting the shield free of the trench bottom or fill and then moving the shield horizontally.

4. The CONTRACTOR shall not drag trench shields along the trench causing damage or displacement to the trench sidewalls, the pipe, or the bedding and fill.

3.8 EXCAVATION FOR APPURTENANCES

A. Provide excavation for manholes or similar structures of sufficient size to permit the placement and removal of forms for the full length and width of structure footings and foundations as shown. Clean rock or loose debris and cut to a firm surface either level, stepped, or as directed by the ENGINEER. Remove loose disintegrated rock, thin strata, or unstable material. When concrete or masonry is to be placed in an excavated area, take special care not to disturb the bottom of the excavation. Structures shall be constructed as soon as practical following the completion of excavation.

3.9 EXCAVATION BENEATH STRUCTURES AND EMBANKMENTS:

A. The subgrade areas beneath fills and embankments shall be excavated to remove all deleterious, loose, and otherwise unsuitable material and not less than the top 6 inches of native material. Where such subgrade is sloped, the native material shall be benched.

B. After the required excavation or over-excavation for fills and embankments has been completed, the exposed surface shall be scarified to a depth of 6 inches, brought to -1% to +3% of optimum moisture content, and rolled with heavy compaction equipment to obtain 95 percent of maximum density as determined by the Standard Proctor Test (ASTM D 698).

C. Ensure that foundation and footing subgrades have been inspected and approved by the ENGINEER prior to concrete placement.

D. Notification of ENGINEER:

1. The CONTRACTOR shall notify the ENGINEER at least 3 Days in advance of completion of any structure or roadway 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 fill or with any construction materials.

3.10 SLUSH GROUT

A. Channels~~Use slush grout to fill storm water channels~~ excavated in rock shall be slush grouted to seal open fractures~~at locations~~ as required by the ENGINEER.

B. Care shall be taken to confine slush grout to the fracture being slush grouted. Avoid grout spillage and feather-edging of slush grout.

C. All fractures to be treated shall be thoroughly cleaned of all loose material to a depth of at least six inches by using high-pressure air or water or other methods approved by the ENGINEER and shall be wetted immediately before placement of the slush grout material.

D. Placement of slush grout shall be by pouring, rodding, or funneling into individual cracks, and brooming with a stiff-bristled broom over surfaces containing closely spaced fractures or by other approved methods.

3.11 FILL – ALL TYPES

~~A.~~ General

1. Fill shall not be dropped directly upon any structure or pipe.

2. Fill shall not be placed around nor upon any structure until the concrete has attained sufficient strength to withstand the loads imposed.

3. Fill 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. Pre-Placement Conditions

1. Surface preparation beneath structures and embankments shall conform to Part 3.9 of this specification.

~~1.~~2. Except for drain gravel being placed in over-excavated areas or trenches, fill shall be placed after water is removed from the excavation and the trench sidewalls and bottom have been dried to a moisture content suitable for compaction.

~~2.~~3. Immediately prior to placement of fill materials, the bottoms and sidewalls of trenches and structure excavations shall have any loose, sloughing, or caving soil and rock materials removed.

~~3.~~4. Trench sidewalls shall consist of excavated surfaces that are in a relatively undisturbed condition before placement of fill materials.

C. Placement

~~1. Fill shall not be dropped directly upon any structure or pipe.~~

~~2.~~1. ~~Fill shall not be placed around nor upon any structure until the concrete has attained sufficient strength to withstand the loads imposed.~~

~~3.~~1. ~~Fill 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.~~

~~4.~~1. Fill materials shall be placed and spread evenly in horizontal lifts, and shall be mixed as necessary to promote uniformity of material.

~~5.~~2. Unless otherwise indicated, when compaction is achieved using mechanical equipment, the horizontal lifts shall be evenly spread such that when compacted each horizontal lift shall not exceed 12 inches in compacted thickness.

D. Moisture Content

1. Where the fill material moisture content is below the specified moisture content range, water shall be added before or during spreading until the proper moisture content is achieved.

2. Where the fill material moisture content is above the specified moisture content range, the material shall be dried until the proper moisture content is achieved.

3.12 TRENCH BACKFILL

A. General

1. Backfill trenches as approved by the ENGINEER to the grade shown.

2. Replacement of Unyielding Material – Replace unyielding material removed from the bottom of the trench with Pipe Bedding Material.

3. Replacement of Unstable Material – Replace unstable material removed from the bottom of the trench or excavation with Pipe Bedding as directed in lifts not exceeding 6 inches in uncompacted thickness.

4. Immediately prior to placement of fill materials, the bottoms and sidewalls of trenches shall have any loose, sloughing, or caving soil and rock materials removed.

5. Trench sidewalls shall consist of excavated surfaces that are in a relatively undisturbed condition before placement of fill materials.

B. Trench Shield:

1. If a moveable trench shield is used during fill operations, the shield shall be lifted to a location above each layer of fill material prior to compaction of the layer.

C. Definitions

~~1.~~ Pipe Bedding Zone:~~:~~ The bedding is defined as that portion of ~~pipe zone fill material between~~ the trench ~~subgrade and the bottom of the pipe.~~

2. Pipe Zone: The pipe zone is defined as that portion of the vertical trench cross-section lying between a plane 6-below the bottom surface of the pipe and a plane at a point 1 foot above the top surface of the pipe as indicated.

3. Embedment Zone: The embedment zone is defined as that portion of the pipe zone fill material between the bedding and the springline of the pipe.

4.1. Trench Zone: The trench zone is defined as that portion of the vertical trench cross-section lying as indicated between a plane above the top surface of the pipe and a plane at a point 18 inches below the bottom of the pipe and a plane 12-finished surface grade, or if the trench is under pavement, 18 inches abovebelow the top of the pipe. roadway subgrade.

5.2. Trench Backfill Zone: The trench backfill zoneFinal Fill: Final Fill is defined as fill in the trench cross-sectional area fromwithin 18 inches of finished grade, or if the toptrench is under pavement, fill within 18 inches of the bedding zone to final grade, or roadway subgrade.

D. Bedding:

1. Pipe Bedding shall be used for the Bedding Zone backfill.

2. Pipe Bedding shall be compacted to the density specifiedplaced in Part 3.16 A.

1.3. The first lift of the embedment zone (below the pipe)lifts that shall not exceed 6 inches when compacted to the required density. Each lift shall be compacted by means of at least 2 passes from a vibratory compactor that is capable of achieving the required density in 2 passes and that is acceptable to the ENGINEER.

2.4. After compacting the initial liftbedding, the CONTRACTOR shall perform a final trim using a stringline for establishing grade, such that each pipe section when first laid shall be continually in contact with the bedding along the extreme bottom of the pipe.

3.5. Excavate bell holes to the necessary size at each joint or coupling to eliminate point bearing.

E. Pipe Zone/Embedment Zone Fill:

1. Pipe Bedding shall be used for the Pipe Zone/Embedment Zone backfill.

2.6. The CONTRACTOR shall exercise care in order to prevent damage to the pipeline coating, cathodic bonds, and the pipe itself during the installation and fill operations.

3.7. Fill shall be manually spread evenly around the pipe, maintaining the same height on both sides of the pipe such that when compacted, the pipe zone fill shall provide uniform bearing and side support.

4.8. Fill shall be placed and compacted under the haunch of the pipe and up each side evenly so as not to move the pipe during the placement of the fill.

5.9. Fill shall be placed in lifts that shall not exceed 6 inches when compacted to the required density. In addition, fill shall be subjected to vibratory compaction at the springline of the pipe and the top of the pipe zone fill.

~~6.~~10. Fill around and over pipelines that is mechanically compacted shall be compacted using light, hand-operated vibratory compactors and rollers that do not damage the pipe.

~~F.~~E. Trench Backfill Zone Fill

1. Backfill trenches with General Fill.

~~2. Place the material in successive horizontal lifts of loose material not more than 12 inches in depth. Spread each lift uniformly and moisten or aerate as necessary and compact to 90% Standard Proctor density at plus or minus 2% of optimum moisture content as determined by the Standard Proctor test (ASTM D 698).~~

~~G.~~F. ~~Final Backfill Zone~~ Fill the remainder of the trench as designated below:

1. Beneath Roadways/Embankments/Structures: Place General Fill backfill up to the required subgrade elevation as specified. Deposit backfill in lifts of a maximum of 12 inches loose thickness. Do not permit water flooding or jetting methods of compaction. Spread each lift uniformly and moisten or aerate as necessary and compact to the density specified in Part 3.16 A.

2. Open Areas: Place General Fill backfill up to the required subgrade elevation as specified. Deposit backfill in lifts of a maximum of 12 inches loose thickness. Do not permit water flooding or jetting methods of compaction. Spread each lift uniformly and moisten or aerate as necessary and compact to the density specified in Part 3.15 A.

~~H.~~G. Identification Tape

1. Install identification tape as indicated.

2. Terminate the tape in a precast concrete box either adjacent to or part of the valve box, manhole, vault, or other structure into which the non-metallic pipe enters or at the end of the non-metallic pipeline.

3. The termination box shall be covered with a cast iron lid.

4. The box shall be located at grade in paved areas or 6 inches above grade in unpaved areas.

5. The CONTRACTOR shall not displace the pipe or fill while the shield is being moved.

3.13 GENERAL FILL

A. Fill in open areas shall be placed and spread evenly in horizontal lifts, and shall be mixed as necessary to promote uniformity of material.

B. ~~General~~ Fill shall not be mechanically compacted unless otherwise indicated.

C. Safety Berms: Safety berms shall be constructed as per Section 02120 – Road and Staging Area Maintenance.

~~3.13~~3.14 STRUCTURAL FILL~~BACKFILL~~

~~A.~~ General

1. Fill for appurtenances, roadways, and structures shall be placed and spread evenly in horizontal lifts, and shall be mixed as necessary to promote uniformity of material, with each lift moistened and aerated as necessary.

2. Unless otherwise approved by the ENGINEER, no lifts shall exceed 12 inches of compacted thickness.

B. Structural Fill shall be compacted to the density specified in Part 3.16 A.

~~3.~~1. Flooding, ponding, and jetting shall not be used for fill around structures, for final fill materials, or aggregate base materials.

~~B.~~C. Backfill for Appurtenances

1. After the manhole, inlet, outlet or similar structure has been constructed and the concrete has been allowed to cure in accordance with Section 03000 – Cast-in-Place Concrete, place, backfill in such a manner that the structure is not damaged by the shock of falling earth. Deposit the backfill material, compact it as specified, and bring up the backfill evenly on all sides of the structure to prevent eccentric loading and excessive stress.

~~C.~~D. Heavy Equipment:

1. Equipment weighing more than 10,000 pounds shall not be used closer to walls than a horizontal distance equal to the vertical depth of the fill above undisturbed soil at that time.

2. Hand-operated power compaction equipment shall be used where the use of heavier equipment is impractical or restricted due to weight limitations.

3.15 EMBANKMENT FILL

~~3.14 EMBANKMENTS~~

A. West Pond Embankment

1. West Pond Embankment shall be constructed with Structural~~compacted General~~ Fill.

2. Place the material in successive horizontal lifts of loose material not more than 12 inches in depth. Spread each lift uniformly on a soil surface that has been moistened or aerated as necessary. After spreading moisten or aerate as necessary to achieve the ~~specified~~ compaction specified in Part 3.16 A.

B. Attenuation Berms

1. Attenuation Berms shall be constructed with Attenuation Berm Embankment Fill as defined in Paragraph 2.2 D of this Section. Place the material in successive horizontal lifts of loose material not more than 12 inches in depth. Spread each lift uniformly on a soil surface that has been moistened or aerated as necessary. After

spreading moisten or aerate as necessary to achieve the ~~specified~~ compaction specified in Part 3.16 A.

C. Miscellaneous

1. When an embankment is to be constructed and compacted against hillsides or fill slopes steeper than 4:1, the slopes of the hillsides or fills shall be horizontally benched in order to key the embankment to the underlying ground.

2. Hillside or fill slopes 4:1 or flatter shall be prepared in accordance with Paragraph A, above.

~~3.15~~3.16 COMPACTION REQUIREMENTS

A. The following compaction requirements shall be in accordance with the Standard Proctor test (ASTM D 698). If more than 5% of the material is larger than ¾-inch in size, an oversize correction shall ~~-~~be applied~~-~~ in accordance with ASTM D4718.

TRENCHES	% of Maximum Dry Density	% Optimum Moisture
~~Pipe Bedding~~	~~95~~	~~+/- 2%~~
Pipe Bedding~~Embedment Zone/Pipe~~ Zone	90~~95~~	+/- 2%
~~Trench Zone~~	~~90~~	~~+/- 2%~~
Trench Backfill~~Final Fill~~ Zone: ~~—~~Beneath Roads/Structures/Embankments	95	+/- 2%
Trench Backfill~~Final Fill~~ Zone: ~~—~~ Open Areas	90	+/- 2%

~~**STRUCTURAL**~~ **FILL/BACKFILL**	% of Maximum Dry Density	% Optimum Moisture
General Fill	No mechanical compaction unless otherwise indicated~~90~~	~~+/- 2%~~
Structural Fill~~ Beneath Roadways/Structures~~	95	+/- 2%
Safety Berms~~Backfill for Appetences~~	Compact with bucket tamping or other methods to retain shape and reduce erosion;~~95~~	~~+/- 2%~~
~~Final Fill Zone – Open Areas~~	~~90~~	~~+/- 2%~~

Deleted Cells

Deleted Cells

EMBANKMENTS	% of Maximum Dry Density	% Optimum Moisture
West Pond Embankment~~ Fill~~	95	-1% to +3%
Attenuation Berms	95	-1% to +3%

B. 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 within the specified moisture content range.

~~3.16~~3.17 TEST FILLS

A. Method specifications for compaction of rock fill or materials that contain more than 30% by weight material greater than ¾-inch in size may be used when authorized in writing by the ENGINEER.

B. A test fill shall be used to define appropriate placement procedures including :

1. Lift thickness

2. Compaction equipment type

3. Number of passes

4. Moisture conditioning

C. Test Fills shall be conducted in the presence of the ENGINEER.

~~3.17~~3.18 COVER PLACEMENT

A. Cover shall be placed on mine waste containment areas and graded mine waste areas as shown on the Drawings.

B. Grading control shall be achieved with the use of GPS guided equipment.

C. Any equipment that contacts mine waste shall be decontaminated before contacting cover material.

D. Placement

1. Cover Soil shall be placed in one or more lifts, with the initial lift a minimum of 18 inches thick.

2. Placement and spreading shall be performed with a low ground pressure bulldozer and compaction of material shall be minimal.

3. Soil cover placement shall commence in an upslope or cross-slope direction when placement is occurring over the geomembrane cover.

~~3.~~4. Cover material shall be placed in a manner that prevents damage to the geomembrane cover.

~~4.~~5. Compaction effort should be limited to the compaction resulting from incidental passes by the tracked equipment used to place the material. No compactive effort is required or recommended by the use of vibratory or sheepsfoot compactors.

E. Finishing and Plantings

1. Finishing and planting shall conform to Section 02970 Revegetation.

2. Finished surface shall be graded with a uniform surface to the slopes and grades shown on the drawings.

3.183.19 FIELD TESTING

A. Field testing shall be performed by the COMPANY or a COMPANY-retained testing laboratory.

B. When test results indicate that compaction is not as specified, remove the material, replace and recompact the tested material to meet Specification requirements. Tests shall be performed on recompacted areas to determine conformance with Specification requirements.

C. The following number of tests, if performed at the appropriate time, shall be the minimum acceptable for each type operation.

1. Fill and Backfill Material Gradation:

a. Gradation of fill and backfill material determined in accordance with ASTM C117, ASTM C136, or ASTM D6913 as appropriate for the material being tested.

b. Frequency:

1.2. **Pipe Bedding**: One [TBD] tests per 2,500 cubic yards of stockpiled or in-place source material, or, in the determination of the ENGINEER, as source materials change. Gradation of fill and backfill material determined in accordance with ASTM C117 or ASTM C136 as appropriate for the material being tested.

a. General **Fill**: One test per 5,000 cubic yards of stockpiled or in-place source material, or, in the determination of the ENGINEER, as source materials change.

b. **Structural Fill**:

1) Roads, Appurtenances, Miscellaneous Uses: One test per 2,500 cubic yards of stockpiled or in-place source material, or, in the determination of the ENGINEER, as source materials change.

2) West Pond Embankment: One test per 5,000 cubic yards of material placed, or, in the determination of the ENGINEER, as source materials change.

c. **Attenuation Embankment Fill**: One test per 5,000 cubic yards of material placed, or, in the determination of the ENGINEER, as source materials change.

d. **Cover Soil**: One test per 10,000 cubic yards of material placed, or, in the determination of the ENGINEER, as source materials change.

2.3. Density:

a. Where soil material is required to be compacted to a percentage of maximum density, the maximum density at optimum moisture content shall be determined in accordance with the Standard Proctor test (ASTM D 698).

b. Field density in-place tests shall be performed with the nuclear density gauge method (ASTM D 6938), or by such other means acceptable to the ENGINEER.

c. Frequency:

1) **Trench Fill**: One test per 150~~[TBD]~~ linear feet, or fraction thereof, of each lift of trench fill (all types).

2) **Structural Fill**:

a) One test per 2,000~~[TBD]~~ square feet, or fraction thereof, of each lift of fill or backfill areas compacted by other than hand-operated machines. A minimum of two tests should be performed on fill or backfill that will support a structure.

b) One test per 500~~[TBD]~~ square feet, or fraction thereof, of each lift of fill or backfill areas compacted by hand-operated machines and backfill around appurtenances.

c) One test per 150~~[TBD]~~ linear feet, or fraction thereof, of each lift of structural fill beneath roadways.

3) Embankments

a) West Pond Embankment: One test per 13,500~~[TBD]~~ square feet, or fraction thereof, of each lift of fill.

b) Attenuation Embankments: One test per 13,500~~[TBD]~~ square feet, or fraction thereof, of each lift of fill.

~~3.~~4. Optimum Moisture and Laboratory Maximum Density

a. Tests for each type material or source of material including borrow material shall be performed to determine the optimum moisture and laboratory maximum density values. One representative test may be performed per material used of fill and backfill, or when any change in material occurs which may affect the optimum moisture content or laboratory maximum density.

D. CONTRACTOR's Responsibilities:

1. The CONTRACTOR shall provide test trenches and excavations, including excavation, trench support and groundwater removal for the COMPANY's field soils testing operations.

2. The trenches and excavations shall be provided at the locations and to the depths as required by the COMPANY.

- END OF SECTION -

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SECTION 02205 – MINE WASTE EXCAVATION AND DISPOSAL

PART 1 -- GENERAL

1.1 SUMMARY

A. The WORK under this Section includes excavation of above grade mine waste materials and contaminated soils and sediments, and disposal of these materials in the waste containment area (WCA).

B. Other mine waste materials associated with the WORK including demolition debris, waste and debris from historical mining operations, cleared vegetation from areas subject to excavation of contaminated soils and sediments, and CONTRACTOR generated waste that cannot be decontaminated, shall be classified and disposed of in accordance with this section.

C. Mine waste materials that shall be regraded and disposed of in place are also addressed by this section.

1.2 REFERENCE REMEDIAL ACTION WORK PLANS

A. The work under this section shall be conducted in substantial compliance with the following work plans included as part of the Contract Documents in accordance with Section 01015 – Remedial Action Work Plans:

1. Remedial Action Work Plan

2. Staging/Temporary Stockpiling Plan

3. Master Stormwater Management Plan

4. Construction Quality Assurance Plan

5. Analytical Support and Verification Plan

a. The CONTRACTOR's attention is brought to the sampling and verification procedures and sequencing contained in the Analytical Support and Verification Plan. Areas subject to excavation of contaminated soil and sediments will require verification and final cleanup. CONTRACTOR shall coordinate the WORK with these requirements and shall execute the WORK in a manner that does not re-contaminate areas that have been verified as clean.

1.3 REFERENCE STANDARDS

A. ASTM C33 – Standard Specifications for Concrete Aggregates

B. ASTM C136 - Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates

~~B.~~C. ASTM D698 – Standard Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort.

D. ASTM D6913 – Standard Test Method for Particle Size Distribution (Gradation) Using Sieve Analysis.

1.4 DISPOSAL OF NON-MINE WASTE MATERIALS

A. Cleared vegetation from areas not subject to excavation of contaminated soils and sediments shall be disposed of in accordance with Section 02100 - Site Preparation

B. Contractor generated waste materials shall be disposed of in accordance with Section 01560 – Temporary Environmental Controls.

1.5 CLASSIFICATION OF MINE WASTE MATERIALS

A. Mine Waste Materials shall include those materials which are excavated from the designed excavations at the site which are not suitable for use in construction; contaminated soils and sediments; sediments removed from erosion control devices; demolition debris; and other construction debris.

B. Mine Waste Materials include cleared vegetation from areas subject to excavation of contaminated soil and sediments.

C. Materials to be disposed of shall be classified as Low Activity Waste/Low Reactivity Waste or Unclassified Waste as defined below:

1. **Low Activity Waste/Low Reactivity Waste**: Low Activity/Low Reactivity Waste includes excavated mine waste materials from the following locations:

a.	Hillside Waste Rock Pile	b.	East Waste Rock Pile
c.	South Waste Rock Pile	d.	Pit 4 Overburden Pile
e.	Central Drainage Sediments	f.	Western Drainage Sediments
g.	Eastern Drainage Sediments	h.	Impacted Foundation Sediments
i.	Access Road Cleanup	j.	South Pond Excavation

2. **Unclassified Waste**

a. Unclassified waste includes higher activity mine wastes excavated from the following locations:

a.	Protore Stockpile 1	b.	Protore Stockpile 2
c.	Ore Stockpile 3	d.	Ore Stockpile 4
e.	Ore & Protore Stockpile 5	f.	Ore & Protore Stockpile 6
g.	Ore Stockpile 7	h.	Lime Protore Stockpile 8
i.	Pit 4 Bottom Sediments	j.	Pit 3 Bottom Sediments
k.	Pit 4 Rockfall/Grading Spoils	l.	Pit 3 Rockfall/Grading Spoils
m.	Adit Pit Waste	n.	PCP Spoils

b. Cleared vegetation from areas subject to excavation of contaminated soils and sediments.

c. Unclassified waste includes demolition and construction debris waste materials including, but not limited to, demolished concrete, reinforcing steel, power poles, demolished pipe, miscellaneous metalwork, refuse, and debris.

1.6 SUBMITTALS

A. Submit in accordance with Section 01300 – Contractor Submittals.

B. Submit CONTRACTOR's Rock Fall Protection Plan as follows:

1. The CONTRACTOR, prior to beginning operations within Pit 3 or Pit 4, shall submit to the ENGINEER, and shall be in receipt of the ENGINEER's written acceptance of, the CONTRACTOR's detailed plan showing the design of provisions for worker protection against the hazard of rock fall.

2. The ENGINEER's acceptance of said plan shall be for verification of submittal of the plan with this requirement.

C. Submit CONTRACTOR's Detailed Shoring Plan for trench or structure excavations deeper than 4 feet in accordance with Section 02200~~02100~~ Earthwork.

D. Submit CONTRACTOR's Blasting Plan in accordance with Section 02210 Blasting.

E. Submit product Information for imported and on-site processed materials including pertinent information to evaluate proposed materials for compliance with the specifications such as grain-size distribution, soil classification, durability data, and other pertinent material information.

F. Samples: The CONTRACTOR shall submit samples of materials proposed for the WORK, if requested by the ENGINEER.

G. Submit CONTRACTOR proposed procedures for installation of settlement monitoring monuments for ENGINEER review and approval. Installation procedures shall be protective of the underlying geosynthetic liner system and minimize cover material compaction.

PART 2 -- PRODUCTS

2.1 HSWRP PROCESSED MATERIALS

A. General

1. Drain Rock, Drain Gravel and Liner Bedding Material used in underdrain construction shall be obtained by on-site processing of material from the Hillside Waste Rock Pile (HSWRP). HSWRP materials shall be processed by the CONTRACTOR at the location shown in the Drawings.

2. The materials defined in this section shall not be used outside the WCA.

3. Materials shall be screened and/or crushed, sand and gravel; free of shale, clay, friable material and debris

B. Drain Rock

a. Drain Rock shall meet the following gradation requirements:

Sieve Size	Percent Passing (by weight)
6 inch	100
2 inch	0 – 5
No. 200	0 -3

C. Drain Gravel:

1. Drain Gravel shall meet the following gradation requirements:

Sieve Size	Percent Passing (by weight)
3 inch	100
1 ½ inch	100
1 inch	0 - 90
¾ inch	0 - 40
½ inch	0 - 20
3/8 inch	0 -10
No. 4	0 – 5
No. 200	0 – 5

D. Liner Bedding

1. Liner Bedding shall meet the following gradation requirements:

Sieve Size	Percentage Passing
1 1/2-inch	100
1 inch	90 – 100
3/4 inch	40 – 85
1/2 inch	10 – 40
3/8 inch	0 – 15
No. 4	0 – 5

2.2 OVERLINER PROTECTION

A. Overliner Protection material shall be minus ¼-inch in size and shall be obtained from processing of materials from on-site excavations, borrow areas, or shall be imported.

B. Material from on-site excavations shall be classified as Low Reactivity mine waste, or shall meet the soil cleanup standards listed in Section 02200; Part 2.1 A.

2.3 IMPORTED MATERIALS

A. Filter sand and intermediate filter sand shall be imported materials.

B. Drain Sand

1. Filter sand shall be imported material conforming to ASTM C33 Standard Specifications for Concrete Aggregates, Fine Aggregate.

2. Fine filter sand shall have the following grain-size distribution:

Sieve Size	Percentage Passing
3/8 –inch	100
No. 4	95 – 100
No. 8	80 – 100
No. 16	50 – 85
No. 30	25 – 60
No. 50	5 – 30
No. 100	0 – 10

C. Intermediate Filter Sand

1. Intermediate filter sand shall be imported material conforming to ASTM C33 Standard Specifications for Concrete Aggregates, No. 67 Coarse Aggregate.

2. Intermediate filter sand shall have the following grain size distribution:

Sieve Size	Percent Passing (by weight)
1 inch	100
¾ inch	90 – 100
½ inch	20 – 55
3/8 inch	0 – 10
No. 4	0 – 5

2.4 DEWATERING RISERS

A. Stainless steel risers shall be threaded, 12-inch, SCH 40 SS Type 304, solid well casing. Pipe lengths shall be 10-ft. Perforations shall be as shown on the Drawings. End treatments shall be as shown on the Drawings.

B. Friction sleeve risers shall be threaded 16-inch, Sch 20, low carbon steel, solid well casing. Pipe lengths shall be 10-ft.

C. Centralizers shall be stainless steel.

D. Friction sleeve liner material shall be 60-mil smooth HDPE geomembrane.

E. Well casing geonet material shall be HDPE with a minimum thickness of 175-mil.

2.5 SETTLEMENT MONITORING MONUMENT

A. Settlement monitoring monuments shall be fabricated by the CONTRACTOR as shown on the Drawings.

~~2.4~~2.6 MATERIALS TESTING

A. Testing of on-site processed materials and imported materials to verify conformance to specified standards shall be performed by the CONTRACTOR and submitted to the ENGINEER for approval in accordance with Paragraph 1.6 E

PART 3 -- EXECUTION

3.1 GENERAL

A. Excavated waste soils, including sediments removed from erosion control devices, shall first be considered for use as a component soil in the development of cover if they meet soil cleanup standards defined in Section 02200; Part 2.1 A.

B. The CONTRACTOR shall execute the WORK in a manner that does not result in the re-contamination of areas already remediated or contamination of areas that were previously uncontaminated. Areas where mine wastes have been remediated shall be barricaded, flagged, or otherwise marked as needed to prevent re-contamination from construction traffic.

3.2 WASTE REGRADING

A. Waste rock in the following areas shall be graded to the lines and grades shown in the Drawings to achieve a mounded, free-draining surface:

1. Pit 4 North

2. Area 5

3. Backfilled Pit Area (BPA)

B. Excess material generated from grading shall be disposed of in the WCA.

3.3 MINE WASTE EXCAVATION

A. Above-Grade Mine Wastes include wastes that are piled above the pre-mining topographic surface.

B. Excavation of Above-Grade Mine Waste shall be conducted in phases as shown in the Drawings.

C. Above-Grade Mine Wastes to be excavated as part of Phase 1 include:

1. Pit 4 Ridge grading as shown on the Drawings.
2. Hillside Waste Rock Pile (HSWRP) shall initially be excavated as required to provide material as needed to produce Pit 4 drain material and liner bedding material.
3. Pit 4 Overburden Pile shall be excavated to the native ground contact.
4. Excess material generated during Pit 4 North regrading.
5. Ore/Protore Stockpiles shall be excavated to the native ground contact.
6. The South Waste Rock Pile in the vicinity of the South Pond shall be excavated to provide a level bench as indicated in the Drawings.
7. The uphill portion of the South Waste Rock Pile material located in the Western Drainage, including waste material in Pit 2 and the Adit Pit, shall be excavated to the native ground contact.
8. Other miscellaneous waste piles.

D. Above-Grade Mine Wastes to be excavated as part of Phase 2 include:

1. Pit 3 Ridge grading as shown on the Drawings.
2. Remaining HSWRP material shall be excavated to the native ground contact.
3. Remaining South Waste Rock Pile material in the Western Drainage shall be excavated to the native ground contact.
4. The East Waste Rock Pile shall be excavated to the to the native ground contact.

E. Above-Grade Mine Wastes to be excavated as part of Phase 3 include:

1. Removal of the South Pond.
2. Remaining South Waste Rock Pile material in the Central Drainage shall be excavated to the native ground contact.

F. To the extent practicable, excavated materials shall be direct loaded into haul vehicles, transported, and placed within the mine waste containment areas without stockpiling. When direct haul is not practical, excavated materials shall be temporarily stockpiled at approved locations for impacted soils as shown on the Drawings or as defined by the ENGINEER prior to placement within the mine waste containment areas.

G. Verification of native soils underlying mine waste shall be conducted by the COMPANY. Excavation of native soils shall be conducted according to Paragraph 3.3 of this section.

H. Areas cleared of above-ground mine waste and meeting soil cleanup standards as defined in Section 02200; Part 2.1 A shall be graded to conform to the surrounding topography as shown in the Drawings.

I. Once an area has been excavated to the satisfaction of the ENGINEER, the CONTRACTOR shall barricade or otherwise delineate the area as closed to further activity while verification surveys are conducted by the COMPANY. Activity within these areas shall only be conducted upon the authorization of the ENGINEER.

J. CONTRACTOR shall execute the WORK in a manner that does not result in re-contamination of areas that have been verified as clean. Any area that is re-

contaminated due to CONTRACTOR activities will require excavation of contaminated materials and additional verification. The cost of excavation and verification of re-contaminated areas shall be borne by the CONTRACTOR.

3.4 CONTAMINATED SOIL AND SEDIMENT EXCAVATION

A. Contaminated soil and sediment excavation shall be conducted in Phases as shown on the Drawings.

B. To the extent possible, excavation of sediments in the drainages shall only occur during the summer and early autumn in order to avoid flowing water.

C. The actual extent of soil contamination shall be determined during the WORK. In each area of known contaminated soil or sediment, the depth of excavation shall be as directed by the ENGINEER or his designee.

~~D. The areas of known contaminated soil and sediment requiring excavation include:~~

~~1. Western Drainage sediments between the toe of the South Waste Rock Pile and the confluence with the Eastern Drainage.~~

~~2. Eastern Drainage sediments between the toe of the East Waste Rock Pile and the confluence with the Eastern Drainage, and in the Eastern Drainage between the East Access Road and the confluence with the Western Drainage.~~

~~3. East Access Road.~~

~~4. West Access and Internal Mine Roads. The Internal Mine Roads south of the Pollution Control Pond (PCP) provide access to wells and pumps in the Western Drainage and to wells and the PCP pumpback system in the Central Drainage. As such, the cleanup and or removal of these roads must be coordinated with water management activities.~~

~~5. Native soil in areas overlain by Above-ground Mine Waste and in areas adjacent to Mine Waste.~~

~~E.~~D. To the extent practicable, excavated materials shall be direct loaded into haul vehicles, transported, and placed within the mine waste containment areas without stockpiling. When direct haul is not practical, excavated materials shall be stockpiled at approved locations for impacted soils as shown on the Drawings or as defined by the ENGINEER prior to placement within the mine waste containment areas.

~~F.~~E. Once an area has been excavated to the satisfaction of the ENGINEER, the CONTRACTOR shall barricade or otherwise delineate the area as closed to further activity while verification surveys are conducted by the COMPANY. Activity within these areas shall only be conducted upon the authorization of the ENGINEER.

~~G.~~F. CONTRACTOR shall execute the WORK in a manner that does not result in re-contamination of areas that have been verified as clean. Any area that is re-contaminated due to CONTRACTOR activities will require excavation of contaminated materials and additional verification. The cost of excavation and verification of re-contaminated areas shall be borne by the CONTRACTOR.

G. Areas verified as clean shall be regraded to mimic native slopes and revegetated. Revegetation shall conform to Section 02970 – Revegetation.

3.5 WASTE CONTAINMENT AREAS

A. Waste Containment Areas (WCAs) shall be constructed in Pit 4 and Pit 3 in Phases as shown in the Drawings.

B. Pits shall be dewatered by the CONTRACTOR prior to commencement of pit bottom cleanup. Dewatering shall be conducted in accordance with Section 02140 – Dewatering and Control of Water.

C. **Pit-Bottom Cleanup and Grading**: Upon completion of pit dewatering, sediments and coarse rock material that have accumulated in the pit bottom shall be removed.

1. Prior to excavation, the pit bottom sediments shall be dried by natural evaporation or by adding drying agents. Drying agents and proposed application shall be submitted to the ENGINEER for approval prior to use.

2. Fine-grained sediments remaining after bulk cleanup shall be removed by hydraulic methods. Final cleanup up methods and sediment dewatering methods shall be proposed by the CONTRACTOR for acceptance by the ENGINEER.

3. Material removed during pit-bottom cleanup shall be stockpiled at a temporary location designated by the ENGINEER for replacement in the pit.

4. Upon completion of cleanup, the pit bottom shall be graded to allow water to flow under gravity to an underdrain sump. Areas that do not flow under gravity toward the underdrain sump shall be reworked to the extent practicable without ripping, drilling or blasting.

D. **Underdrain System**: This system collects groundwater before it contacts reactive mine waste disposed of in the pit.

1. Drain Gravel, and Liner-Bedding layers shall be placed in the locations and to the elevations presented in the Drawings.

2. Drain Gravel Placement: Drain Gravel shall be hauled, dumped and spread in uniform horizontal lifts with a thickness that does not result in segregation. No additional compaction of the Drain Gravel is required beyond that which results from spreading and incidental traffic over the waste surface by construction equipment. The final surface of the drain gravel shall be smooth and uniform and shall be approved by the ENGINEER prior to placement of Liner Bedding.

3. Liner Bedding Placement: Liner Bedding shall be hauled, dumped and spread in a single, uniform, horizontal lift with a nominal thickness of 1 foot. No additional compaction of the Liner Bedding is required beyond that which results from spreading and incidental traffic over the waste surface by construction equipment. The Liner Bedding surface shall provide a firm, unyielding foundation for the membrane with no sudden, sharp, or abrupt changes or break in grade. The Liner Bedding surface shall be approved by the ENGINEER prior to placement of the liner system.

4. Underdrain Sump:

a. An underdrain sump shall be constructed at the location shown in the Drawings. Blasting for rock excavation within the sump shall be in accordance with Section 02210 – Blasting.

b. Drain Rock for the sump shall be handled, dumped or spread into place in a manner that does not result in segregation and so as to secure a stone mass of the dimensions shown in the drawings.

5. Dewatering Risers: Dewatering risers shall be installed ~~in~~ within the sump as shown on the Drawings.

~~a.~~ Risers shall be shored and backfilled in a manner that maintains a vertical position and does not result in damage to the pipe. Backfill immediately adjacent to the riser pipes~~.~~

~~b.~~a. ~~Risers~~ shall be placed in one-foot nominal lifts and compacted~~installed in accordance~~ with hand operated equipment. Dozer placement of backfill shall not be allowed within 5-feet of riser pipes~~Section 02575 – Mine Waste Dewatering Risers~~.

~~c.~~b. Friction sleeves shall be installed as shown on the Drawings. The ENGINEER shall inspect and approve riser pipe and friction sleeve placement prior to backfilling each segment of pipe.

6. Sub-Waste Liner System: Following placement of Liner Bedding, a sub-waste liner system shall be installed as indicated in the Drawings. The liner cushion shall be installed and in accordance with Section 02274 - Geotextiles. The geomembrane shall be installed in accordance with Section 02272 – Geomembranes.

7. Overliner Protection: Following placement of the sub-waste liner, an Overliner Protection layer with a minimum thickness of 3 feet shall be placed in the locations and to the elevations shown in the Drawings.

   a. Overliner Protection shall be placed in one or more lifts, with the initial lift a minimum of 18 inches thick.

   b. Placement and spreading shall be performed with a low ground pressure bulldozer and compaction of material shall be minimal.

   c. Overliner Protection material shall be placed in a manner that prevents damage to the geomembrane liner.

   d. Compaction effort should be limited to the compaction resulting from passes by the tracked equipment used to place the material. No compactive effort is required or recommended by the use of vibratory or sheepsfoot compactors.

8. **Alternate to Overliner Protection Layer**: CONTRACTOR may replace the overliner protection layer with another liner cushion layer and a 3-foot lift of Liner Bedding at its option.

E. **Pit 4 Infiltration Collectors**: Infiltration collectors are lined channels constructed within native ground to collect water that may infiltrate through the mine waste during construction.

1. Seep collector channels shall be constructed accurately to the cross sections and locations shown on the Drawings.

2. A geosynthetic clay liner (GCL) shall be placed on the bottom and downslope side of the channel subgrade, as shown on the Drawings. GCL placement shall be in accordance with Section 02780 – Geosynthetic Clay Liner.

3. Drain Gravel shall be placed in the channel in a single, uniform lift with a nominal thickness of 1 foot. The drain gravel layer shall be shaped to conform to the cross-sections shown on the Drawings.

F. **Pit 3 Slope Drains:** Slope drains collect water from seeps in the Pit 3 walls.

1. Slope drains for collection of seeps shall be installed in the areas indicated and as shown in the Drawings.

2. Fine grained waste materials shall not be placed in contact with slope drains.

G. **Waste Dewatering Sump**: The dewatering sump collects water that infiltrates through the mine waste during construction.

1. The dewatering sump shall be constructed at the location shown in the Drawings.
2. Drain Gravel, Intermediate Filter, and Filter Sand layers shall be placed in the locations and to the elevations presented in the Drawings.
3. Drain Gravel Placement: Drain Gravel shall be hauled, dumped and spread in uniform horizontal lifts with a thickness that does not result in segregation. No additional compaction of the drain gravel is required beyond that which results from spreading and incidental traffic over the waste surface by construction equipment. The final surface of the drain gravel shall be smooth and uniform and shall be approved by the ENGINEER prior to placement of intermediate filter sand.

4. Intermediate Filter Placement: Intermediate Filter shall be placed and spread evenly and shall be mixed as necessary to promote uniformity of material, with each lift moistened and aerated as necessary. Intermediate Filter shall be placed in a single uniform lift with a nominal compacted thickness of 18-inches and compacted by means of at least 2 passes from a smooth drum vibratory compactor that is capable of obtaining the required density. Compaction shall be 95% of Standard Proctor density at plus or minus 2% of Standard Proctor optimum moisture content (ASTM D 698). The final surface of the intermediate filter shall be smooth and uniform and shall be approved by the ENGINEER prior to placement of filter sand.

5. Filter Sand Placement: Filter sand shall be placed and spread evenly and shall be mixed as necessary to promote uniformity of material, with each lift moistened and aerated as necessary. Filter Sand shall be placed in a single uniform lift with a nominal compacted thickness of 18-inches and compacted by means of at least 2 passes from a smooth drum vibratory compactor that is capable of obtaining the required density. Compaction shall be 95% of Standard Proctor density at plus or minus 2% of Standard Proctor optimum moisture content (ASTM D 698). The final surface of the filter sand shall be smooth and uniform.

6. Dewatering Risers: Dewatering risers shall be installed ~~in~~ within the sump as shown on the Drawings.

~~a.~~ Risers shall be shored and backfilled in a manner that maintains a vertical position and does not result in damage to the pipe. Backfill immediately adjacent to the riser pipes~~.~~

~~b.~~a. ~~Risers~~ shall be placed in one-foot nominal lifts and compacted~~installed in accordance~~ with hand operated equipment. Dozer placement of backfill shall not be allowed within 5-feet of riser pipes~~Section 02575 – Mine Waste Dewatering Risers~~.

~~c.~~b. Friction sleeves shall be installed as shown on the Drawings. The ENGINEER shall inspect and approve riser pipe and friction sleeve placement prior to backfilling each segment of pipe.

3.6 MINE WASTE PLACEMENT:

A. Mine waste shall be placed according to its classification and to the lines and grades shown in the Drawings.

1. Only Low Activity/Low Reactivity Waste shall be placed over the sub-waste liner and the side of the pit to a minimum thickness of 20 feet as shown on the Drawings. Unclassified Waste shall not be placed within 20 vertical feet of the sub-waste liner or the pit walls.

2. Only Low Activity/Low Reactivity Waste shall be placed within 20 vertical feet of the pit cover system as shown on the Drawings. Unclassified Waste shall not be placed within 20 vertical feet of the sub-waste liner or the pit walls.

3. Excess Low Activity/Low Reactivity Waste may be placed as Unclassified Waste.

B. Wastes shall be hauled, dumped and spread in uniform horizontal lifts with a maximum thickness of 10 feet, except horizontal lifts shall be 2 feet when backfilling demolition waste.

C. No additional compaction of the waste materials is required beyond that which results from spreading and incidental traffic over the waste surface by construction equipment.

D. PHASE 1 Mine waste placed in Pit 4 shall include:

a. Reject material from HSWRP~~,~~
b. Pit 4 Overburden Pile material~~,~~
c. Pit 4 North material~~,~~
d. Ore and Protore material~~,~~
e. Sediments from cleanup of Pit 4 bottom~~,~~
f. Pit 4 rockfall debris and pit-bottom grading spoils~~,~~
g. South Pond grading and excavation spoils~~,~~
h. Other South Waste Rock Pile excavation material~~.~~

E. PHASE 2 Mine waste placed in Pit 3 shall include:

a. Debris from South Pond demolition~~,~~
b. Pit 3 rockfall debris and pit-bottom grading spoils~~,~~
c. Sediments from cleanup of Pit 3 bottom~~,~~
d. Remainder of South Dump material from the Western Drainage~~,~~
e. Contaminated soil from the Western Drainage cleanup~~,~~
f. Sediment from Western Drainage cleanup~~,~~
g. Material from West Access Road cleanup~~,~~
h. Demolition debris from existing WTP and other structures~~,~~

i. Materials from East Waste Rock Pile~~,~~

j. Contaminated soil from East Waste Rock Pile area cleanup~~,~~

k. Sediment from Eastern and Far East Drainage cleanup~~,~~

l. Material from East Access Road cleanup~~,~~

m. Material from other internal mine road and contaminated soil cleanup~~.~~

F. PHASE 3 Mine waste placed in Pit 3 shall include:

a. Debris from South Pond demolition~~,~~

b. Remainder of South Waste Rock Pile material and PCP in Central Drainage~~,~~

c. Material from Central Drainage cleanup~~,~~

d. Material from other contaminated soil cleanup~~.~~

3.7 COVER SYSTEM PLACEMENT:

1. Cover System placement for mine waste containment areas and regraded areas shall be in accordance with the following sections:

a. Section 02200 – Earthwork

b. Section 02272 –Geomembranes

c. Section 02280 – Geocomposite Drainage Layers

3.8 SETTLEMENT MONITORING MONUMENT INSTALLATION

A. Install settlement monitoring monuments in the locations shown on the Drawings, or as otherwise directed by the ENGINEER.

B. Monuments shall be installed upon completion of cover placement and drainage work, and prior to revegetation.

C. Monuments shall be installed per the ENGINEER approved installation procedures submitted under PART 1.6 of this Section. Care shall be taken to prevent damage to the underlying geosynthetic cover system.

D. All monuments shall be installed in the presence of the ENGINEER or his designee.

E. Monuments shall be flagged and protected from construction vehicles and equipment.

3.9 FIELD TESTING

A. Field testing shall be performed by the COMPANY or a COMPANY-retained testing laboratory.

B. When test results indicate that compaction is not as specified, remove the material, replace and recompact the tested material to meet Specification requirements. Tests shall be performed on recompacted areas to determine conformance with Specification requirements.

C. The following number of tests, if performed at the appropriate time, shall be the minimum acceptable for each type operation.

1. Gradation:

   a. Gradation of HSWRP processed materials determined in accordance with ASTM C136 or ASTM D6913 as appropriate for the material being tested.

   b. Frequency:

   c. **Liner Bedding**: One tests per 5,000 cubic yards of stockpiled or placed material, or, in the determination of the ENGINEER, as source materials change.

   d. **Drain Gravel**: One test per 5,000 cubic yards of stockpiled or placed material, or, in the determination of the ENGINEER, as source materials change.

   e. **Drain Rock**: One test per 2,500 cubic yards of stockpiled or placed material, or, in the determination of the ENGINEER, as source materials change.

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SECTION 02210 - BLASTING

PART 1 -- **GENERAL**

1.1 DESCRIPTION

A. This section describes the methods, limitations, and reporting requirements for the use of explosives and blasting conducted during excavation operations.

B. The CONTRACTOR shall comply with all applicable laws, ordinances, safety code requirements, and regulations relative to the handling storage, and use of explosives and the protection of life and property.

1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. Occupational Safety and Health Administration Regulations (Standards-29 CFR) Standard 1926, Subpart U, Blasting and Use of Explosives.

B. National Fire Protection Association NFPA 495--Code for the Manufacture, Transportation, Storage, and use of Explosives and Blasting Agents.

C. RI 8507, "Structure Response and Damage Produced by Ground Vibrations from Surface Blasting," U.S. Bureau of Mines Report of Investigation by D.E. Siskind, M.S. Stagg, J.W. Kipps, and C.H. Dowding.

1.3 DEFINITIONS

A. Blasting Consultant: A person with specialized experience and academic knowledge of commercial explosives, controlled blasting applications, vibration and air-overpressure control; who uses this knowledge to evaluate, plan, and oversee the safe use of explosives in commercial applications in accordance with blasting industry and regulatory standards.

B. Controlled Blasting: Controlled blasting refers to any special blasting methods used to limit the effects of blasting to within the final lines and grades of an excavation. Only controlled blasting will be allowed on the Project.

C. Scaled Distance: The distance from a blast measured in feet divided by the square root of the weight in pounds of the charge per delay period in accordance with the following equation:

$$SD = D/W^{1/2}$$

where

SD = scaled distance

D = distance in feet

W = weight of charge in pounds.

D. Peak Particle Velocity: The maximum of the three velocity components of vibration.

E. Precision Blasting: The use of Presplitting, Smooth Wall, or Cushion Blasting to control the effects of a blast, create a smooth face, and limit damage to rock outside the blast area.

F. Pre-Splitting: The use of a line of small diameter holes on close spacings that are detonated ahead of the main production charge to develop a continuous or semi-continuous fracture between the holes

G. Smooth Wall Blasting: Smooth Wall Blasting: The use of a line of holes on close spacings that are detonated after the main production charge to create a smooth final face. Smooth Wall Blasting requires relief of the perimeter prior to detonation.

H. Cushion Blasting: The use of a line of holes on close spacings that are detonated after the main production charge, or as the last delay of a production charge, to create a smooth final face. Cushion Blasting requires relief of the perimeter prior to detonation

1.4 SUBMITTALS

A. Submittals shall be in accordance with Section 01300 – Contractor Submittals and shall be as follows:

B. Submit to the ENGINEER a copy of all applicable permits for transportation, storage, and use of explosives 10 days prior to commencing any blasting operations including the drilling of holes for explosives and/or the moving of explosives onsite.

C. **BLASTING PLANS**

1. GENERAL BLASTING PLAN: At least 30 days before commencing blasting operations, the CONTRACTOR shall submit to the ENGINEER, a detailed two-part General Blasting Plan which has been prepared by an independent blasting consultant and reviewed and approved by the CONTRACTOR's safety engineer.

a. Part 1: Part 1 of the General Blasting Plan shall include a complete summary of personnel, proposed methods for transporting, handling, storage, and use of explosives. The plan shall include a description of the experience record of the responsible blaster and copies of his or her Washington blasting license and any Explosives Permit(s) required by state or local jurisdictions.

b. Part 2: Part 2 of the conceptual plan shall include the proposed general concept for the blasting and for the control of noise, dust, fly rock, air blast, and vibrations. Test blasts planned by the CONTRACTOR shall be included in Part 2. Part 2 of the General Blasting Plan shall also contain samples of forms to be used.

c. The ENGINEER shall review and provide comments to the CONTRACTOR in accordance with Section 01300 – Contractor Submittals. CONTRACTOR shall make revisions and resubmit as needed to address ENGINEER comments. No blasting will be allowed to proceed until the CONTRACTOR has received notification from the ENGINEER that the General Blasting Plan has been accepted.

2. SHOT PLANS: Individual shot plans shall be submitted to the ENGINEER such that the plans are received by the ENGINEER at least 24 hours before loading holes with explosives. The individual shot plans shall be prepared by the blasting consultant in coordination with the CONTRACTOR's blasting supervisor and shall bear the blasting consultant's signature.

a. Individual shot plans shall include, but shall not be limited to:

1) Plans or sketches showing the location and spacing of blast holes and free faces fully dimensioned.

2) Number, diameter, and depth of holes.

3) Weight and type of powder to be loaded in each hole.

4) Total powder to be used in the blast.

5) Delays for each hole to be used in the blast.

6) Method of wiring the blast.

7) Number of pounds of powder per delay.

8) Water Conditions in each hole.

9) Date and time of expected blast.

10) Written descriptions of instrumentation equipment type, locations, and procedures.

11) Any other pertinent data indicating the CONTRACTOR's intent and purpose to produce smooth and sound surfaces of excavation, and to protect adjacent facilities

b. After acceptable standard drilling and blasting procedures have been developed, the subsequent Individual Shot Plans need not repeat these procedures but shall contain as a minimum the location, date, time of round detonation, supervisor's name, and reference with the drawing number of the previously submitted individual plan. All loading deviations from the previous Individual Shot Plan shall be noted to provide an accurate record of blasting operations. If conditions change, requiring modifications to the plan, a revised individual plan (including drilling and blasting procedures) shall be submitted to the ENGINEER.

3. The blasting plan shall be revised if the results of blasting do not conform to the overall project objectives and the technical requirements of these Specifications

4. The CONTRACTOR shall assume complete responsibility to protect the existing facilities and the Work under construction. The ENGINEER's acceptance~~receipt~~ of the CONTRACTOR's blasting plans and procedures is solely for the benefit of the COMPANY, and shall not relieve the CONTRACTOR of his responsibility to perform the Work in accordance with the Contract Documents and to protect life, property, and the Work under construction. All damage resulting from the blasting operations shall be repaired by the CONTRACTOR at no additional cost to the COMPANY.

5. Review and acceptance of any blasting plan by the ENGINEER shall not relieve the CONTRACTOR of his responsibility for obtaining adequate rock breakage and limiting rock breakage to within the design excavation final lines and grades.

D. POST BLAST REPORT:

1. Submit a Post Blast Report to the ENGINEER within 24 hours following each blast for review by the ENGINEER and a minimum of 4 hours prior to the subsequent blast.

2. ENGINEER review will be required prior to a request for approval of subsequent blasts.

3. Provide actual values of explosives loading, distribution, delay periods, maximum pounds of explosives detonated per delay period, misfires, under or overloaded holes, water in holes, variations in stemming, variations in drill rates, blast location, time of blast, distance to nearest improvement, identification of improvements, scaling time and approval of scaling by the CONTRACTOR's safety representative, an evaluation of the blast indicating advance (length pulled) and areas of significant overbreak or tights, planned adjustments to the blast design for the next blast, and other blast parameters that are typically included for quality control and construction record purposes.

E. Submit qualifications of the Blasting Consultant and Blasting Supervisor meeting the quality assurance requirements specified herein.

1.5 QUALITY ASSURANCE

A. Retain the services of a qualified Blasting Consultant specialist to assist in the preparation of the required blasting plans and verification of reports. The following requirements shall apply to the Blasting Consultant:

1. The CONTRACTOR shall retain an independent Blasting Consultant with at least 15 years of experience in blasting work. The Blasting Consultant shall have directly participated in at least three projects in the previous 5 years that were successfully completed and included controlled blasting and excavation of more than 10,000 cubic yards of material. One project reference shall include controlled blasting and excavation within 50 feet of an existing dam. Each project reference shall include sufficient information to verify conformance with these requirements.

2. The Blasting Consultant shall not be an employee of the CONTRACTOR or any affiliated companies or suppliers of products to the Project and the Blasting Consultant must not have any conflict-of-interest affiliations with the OWNER or other entities involved with the WORK.

B. Blasting Supervisor's Qualifications:

1. Submit to the ENGINEER written qualifications of the CONTRACTOR'S blasting supervisors, including general blasting experience and experience on jobs where they have been in responsible charge of blasting operations. Include project names, the name of a contact person, and their phone number.

2. Certify that the named blasting supervisors are to be in daily responsible charge of the blasting operations, and that these persons will be physically present on the blasting site for all decisions affecting either the execution of approved plans or any alterations in blasting operations or plans.

3. Such persons shall possess all required federal, state, and local licenses and/or permits. Blasting supervisors shall have, as a minimum, 5 years of blasting experience with 2 years of experience in responsible charge of blasting operations.

PART 2 -- **MATERIALS**

2.1 GENERAL

A. Furnish all materials, power, equipment and labor required to accomplish the WORK.

B. Handle, transport, use, control, store, and monitor explosives as prescribed by the most stringent of the rules promulgated by the provisions specified in the Federal (OSHA) Standards, these Specifications, and state and local codes and ordinances. Do not leave explosives in an unprotected manner in any area where such explosives could endanger persons or property.

C. Make blasting mats from closely woven galvanized steel mesh of 10-gauge minimum weighing at least 7.5 pounds per square foot. Mats shall be a minimum of 6 feet by 6 feet and shall be equipped with rings at each corner for tying down.

2.2 WARNING SYSTEMS

A. Erect signboards of adequate size stating that blasting operations are taking place in the area. Such signs shall be clearly visible at all points of access to the area. The signs shall clearly describe the audible signal system for warning of impending blasts.

B. Mark all storage places with signs stating clearly and boldly, “DANGEROUS EXPLOSIVES.” Follow all requirements of local, state, and federal agencies.

C. Institute a system of audible signals to warn of impending blasts.

2.3 BLAST MONITORING INSTRUMENTATION

A. Provide and operate approved seismographs at locations approved by the ENGINEER, to record particle velocity simultaneously along three mutually perpendicular axes. The seismographs shall be capable of producing a hard copy of the complete vibration record of particle velocity that can be submitted to the ENGINEER within time limit of the Blast Report.

B. Provide and operate a sound level meter equipped with a "true peak" detector. Limit peak overpressures to 100 dB at the nearest occupied structure. Monitoring locations will be as proposed by the CONTRACTOR and approved by the ENGINEER. Submit a hard copy of the peak overpressure as part of the Blast Report.

PART 3 -- **EXECUTION**

3.1 GENERAL REQUIREMENTS

A. Signs warning of blasting zones shall be erected on all access points and all roadways within a minimum of 1,000 feet from the blasting area, or longer distance as recommended by the blasting consultant. Schedule detonation with the ENGINEER and all personnel at least 24 hours in advance. Prior to detonation, utilize an audible warning system to ensure that any personnel in the area are forewarned of the impending detonation of explosives.

B. Notify the ENGINEER 24 hours in advance of loading holes with explosives. Submit an individual shot plan to the ENGINEER at the time of notification.

C. Unless approved by the ENGINEER, all blasting shall occur when a representative of the ENGINEER is present to witness each blast. The CONTRACTOR’s blasting consultant

shall, at a minimum, directly supervise the first three blasts, the first three blasts for each different blast type (pre-split, production, etc.), any blasts within 1,000 feet of existing facilities. Additionally, the blasting supervisor shall be present on the site to oversee all blasting operations.

D. Do not perform drilling or blasting work until the CONTRACTOR's plan for blasting operations has been submitted to and accepted by the ENGINEER. Limit blasting intensities as required to prevent damage to existing structures and utilities. Do not allow intensities to exceed the safety standards of particle velocity/frequency established by the U.S. Bureau of Mines (RI8507).

E. Prior to blasting, obtain the blasting permits/licenses as required by all applicable agencies having jurisdiction. Investigate these conditions during bid proposal preparation.

F. Conform to all applicable requirements of federal, state, and local regulations and codes for the transporting, handling, storage, and use of explosives. The locations, access and construction of explosive storage magazines shall be in accordance with the American Table of Distances for Storage of Explosives and approved by the presiding fire and law enforcement agencies.

3.2 REPORTING AND NOTIFICATION

A. No blasting shall be permitted until the CONTRACTOR receives notification in writing from the ENGINEER that the blasting plans have been reviewed and until all preblast inspections and reports have been completed

B. Provide two-work days' notice to all utility agencies or stake-holders whose facilities or interests may be influenced by the blasting operation. Provide the ENGINEER with a list of all people and agencies notified. Contact Underground Service Alert (USALERT/ DIGALERT) as required by State Law. Determine the blasting notification requirements of the OWNER and devise a procedure to provide the requested notification.

0.1 BLASTING REQUIREMENTS

A. All blasting shall be performed in accordance with modern practice using methods and techniques that will avoid fly rock, control particle size, and limit fracturing and dislocation of rock outside the shot area.

B. Precision Blasting techniques shall be used to create a smooth surface of all rock faces remaining after blasting. The method of Precision Blasting shall be Presplitting unless approved otherwise by the ENGINEER. The remaining face shall be primarily comprised of unshattered rock without fracturing, opening of existing seams or joints, and without dislocation or movement of the ground. The presence of half-casts will be used as an indication of the effectiveness of Precision Blasting.

C. All rock shattered outside the limits of excavation indicated on the Drawings or as specified herein shall be removed to the limits of undamaged rock. Immediately following blasting, all excavated surfaces shall be scaled of all shattered and loose material.

D. Blasting Limits: Limit blasting, at any one time, to 15,000 square feet of surface area.

E. Hole Depth and Spacing: Hole depth and spacing to be determined by the blasting consultant.

F. Test Shots: Demonstrate the proposed blasting method to the ENGINEER by making a test shot or shots. Test shots for fragmentation of the rock shall be within the interior of the excavation. Test shots shall be so placed that they will pose no threat to existing facilities. The ENGINEER shall be the sole judge as to the acceptability of the proposed method. If the test is unacceptable modify proposed blasting method and perform other tests until the method is acceptable. Unless the proposed method provides acceptable results as reviewed by the ENGINEER, do not use the proposed method of blasting against any final rock faces or in any place where the final face will be damaged by the test blast or blasts. Determine shock wave, best depth, hole spacing, and pounds of explosives to be shot at one time.

G. Stemming of Each Hole or Cover Over Explosives: Provide stemming sufficient to prevent surface blast wave, but in no case less than 42 inches or as modified by the blasting consultant in the Blasting Plan and approved by the ENGINEER.

H. Multiple Holes: Shoot using millisecond delays.

0.2 POST-BLAST REQUIREMENTS

A. Upon completion of blasting activities, the CONTRACTOR shall perform a post-blast survey of the same structures surveyed in the pre-blast survey to determine the effect of the blasting operations. Submit result of the survey to the ENGINEER.

0.3 LIMITATIONS

A. The following limitations are mandatory for all blasting operations:

1. Do not use explosives as a means of transporting material outside the excavation prism.

2. The use of "coyote" holes and sprung holes for concentration of charges is prohibited.

3. "Mud capping," or shaped charges for secondary blasting above ground or the water surface is prohibited.

4. All holes for blasting shall be 3 ½" inches or less in diameter, and such holes shall not be sprung or chambered. All holes greater than 3 inches shall be oversized only to accommodate loading in wet, groundwater conditions and not to increase the load or charge. Hole spacing and size shall be recommended by the blasting consultant and approved by the ENGINEER as part of the Blasting Plan and individual shot plans.

5. Unless controlled by other requirements in these Specifications, sub-drill for final lines and grades shall not be greater than 1.5 feet below excavation grade.

6. Design shots so that the explosive energy is directed toward the developed free face.

7. Explosives shall be of such quantity and quality and shall be used in such a manner as will neither open seams nor otherwise damage rock outside the prescribed limits of excavation. Control the firing systems of general blast holes by the use of delay detonators, and explosives used for any single period of delay, shall be the minimum required.

0.4 SAFEGUARDS

A. Where particle velocity is measured, the total particle velocity shall be the vector sum of the component particle velocities measured at any instant.

B. The first blasting operation at each location shall be monitored by both the CONTRACTOR and the ENGINEER as a test case, and the proper drilling pattern and amount and type of explosive to be subsequently used shall be determined from the results of this initial blasting operation. The scaled distance for test shots shall not be less than 70 using the distance to the nearest structure of concern or as recommended by the blasting consultant and approved by the ENGINEER. Furnish data recorded for each shot to the ENGINEER prior to drilling for the next blast. Make changes in drilling patterns and amount of explosives when records indicate vibration in excess of that specified herein.

C. In reporting a shot, note the distance for the shot to each recorder, amount of explosives used in each delay, the total amount of explosives used, and the time.

D. Prevent fly rock with the use of blasting controls, or cover the area to be shot with blasting mats or overburden material.

E. Give ample warning to all persons within the vicinity prior to blasting, and station men and provide signals warning of danger in suitable places to alert people before firing any blasts.

F. After a blast has been fired, make a careful inspection to determine that all charges have exploded before employees are allowed to return to the operation. Correct misfires in accordance with the requirements of the applicable portions of federal, state, and /or local safety codes for blasting. The CONTRACTOR shall be responsible for any and all damages to property or injury to persons resulting from blasting, or accidental or premature explosions that may occur in connection with his use of explosives.

G. Remove all loose and shattered rock or other loose material which may endanger the structure or the workers and make the excavation safe before proceeding with the work. After muck removal and before drilling of blast holes for a new round, clean and thoroughly examine the face for missed holes and unexploded powder. Develop and improve blasting techniques as work progresses. The fact that the removal of loose or shattered rock or other loose material may enlarge the excavation beyond the required limits shall not relieve the CONTRACTOR of the responsibility for removal of such material.

0.7 REPAIR OF DAMAGE

A. Perform blasting activities in such manner that no damage occurs to buildings, structures, pipelines, or facilities onsite of the Work, above or below ground.

B. In case of damage from blasting to any nearby structures, to any portion of the work, or to the material surrounding or supporting the same that is intended to remain, remove such damaged work, repair the work, and replace the material and perform such work for repair or replacement as the COMPANY shall order. Repair promptly, completely, and satisfactorily all damage caused by blasting to existing structures intended to remain, at the CONTRACTOR's sole expense.

0.8 BLASTING RECORDS

A. Maintain a record, similar to the attached Blast Report, of each blast detonated, and submit such record to the ENGINEER along with seismograph records within 24 hours after each blast but no less than 4 hours prior to the next subsequent blast. This record shall include the following:

1. Depth of blast holes and the location of the blast point in relation to project stationing; type and strength of explosives, type of blasting caps, and distribution of delays used; vibration record; total explosive loadings per round and per delay; comments by the blaster in charge regarding any misfires, unusual results or unusual effects; date and firing time of blast; name of person in responsible charge of loading and firing and blaster permit number; signature and title of person making recording entries; and other records required by state, federal, and local codes and/or regulations.

0.9 CLEANUP

A. Immediately collect all spilled or undetonated explosives and dispose in a manner approved by the ENGINEER. No undetonated explosives will be allowed to be disposed of in fills or dissolved in groundwater or runoff.

~~3.10 SUPPLEMENTS~~

~~A. The supplements listed below, following "END OF SECTION," are a part of the Specification.~~

~~1. Blast Report.~~

- END OF SECTION -

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SECTION 02223 – ALLUVIAL GROUNDWATER CONTROLS

PART 1 -- GENERAL

1.1 SUMMARY

A. This section details the requirements for Alluvial Groundwater Controls consisting of groundwater extraction trenches (Extraction Trenches) and ~~associated pipelines,~~ seepage barrier walls (Barrier Walls), and related work to be constructed in the Far East Seep, Central~~far east, central~~ and Western Drainages~~western drainages~~ as indicated on the drawings. The purpose of the Alluvial Groundwater Controls is to intercept groundwater in the impacted shallow aquifer and convey it to the Site water treatment plant (WTP).

B. The CONTRACTOR shall provide and furnish the necessary plant, labor, equipment, material and expertise for performing ~~all~~ operations associated with construction of~~to construct~~ the alluvial groundwater Extraction Trenches and SLCB Barrier Walls in accordance with this specification~~these specifications~~ and applicable drawings.

C. The Extraction Trenches shall be constructed using the Biopolymer (BP) Slurry Trench method or other approved method of trench stabilization, to the lines and grades shown~~indicated~~ on the drawings and in these specifications, or as directed by the Engineer.

D. The Barrier Walls shall consist of a series of overlapping wall panels formed by the slurry trench excavation method or other approved method to the lines and grades on the Drawings (Section 7 – Groundwater Controls), described in this specification, or as directed by the Engineer. The barrier wall shall consist of self-hardening~~using~~ slag-cement-bentonite (SLCB) slurry as the wall material. Other suitable methods for construction of deep, low-permeability barrier walls (e.g. Deep Soil Mixing) may be proposed by the Contractor.

1.2 REFERENCES

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

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

API Spec 13A	(2006; Errata 2008) Specification for Drilling-Fluid Material
API RP 13B-1	(2009) Recommended Practice for Field Testing Water-Based Drilling Fluids
~~ASTM C 136~~	~~Particle-Size Analysis for Fine and Coarse Aggregates~~
ASTM C 150	(2007) Standard Specification for Portland Cement
ASTM C 989	(2009a) Standard Specification for Ground Granulated Blast-Furnace Slag for use in Concrete and Mortars
ASTM D 2166	(2006) Standard Test Method for Unconfined Compressive Strength of Cohesive Soil

ASTM D 2488 (2009a) Description and Identification of Soils (Visual-Manual Procedure)

ASTM D 4380 (1984; R 2006) Standard Test Method for Density of Bentonitic Slurries

ASTM D 4832 (2010) Preparation and Testing of Controlled Low Strength Material (CLSM) Test Cylinders

ASTM D 4833 (2013) Test Methods for Index Puncture Resistance of Geotextiles, Geomembranes, and Related Products

~~ASTM D 5084 (2003) Measurement of Hydraulic Conductivity of Saturated Porous Materials Using a Flexible Wall Permeameter~~

ASTM D 7100 (2011) ~~1556~~ Standard Test Method for Hydraulic Conductivity Compatability Testing~~Density and Unit Weight of Soil in Place by the Sand-Cone Method~~

~~ASTM D 1557 Standard Test Method for Laboratory Compaction Characteristics~~ of Soils with Aqueous Solutions~~Using Modified Effort~~

CODE OF FEDERAL REGULATIONS

29 CFR 1910 Occupational Safety and Health Administration – Health and Safety Requirements

1.3 MODIFICATION OF EXTRACTION TRENCH OR BARRIER WALL GEOMETRIES~~DEPTHS~~

A. Modification to Groundwater Collection Trench Geometries~~Depth~~: The ENGINEER may at any time prior to or during construction require a change in Extraction Trench depth or horizontal alignment.~~.~~ The objective of the Extraction Trenches is to intercept potential seepage through alluvial materials. Performance of the Extraction Trenches may be optimized by increasing or decreasing their depths or horizontal location.

B. Modification to Barrier Wall Geometries~~Depth~~. The ENGINEER may at any time prior to or during construction require a change in barrier wall depth or horizontal alignment.~~.~~ The objective of the Barrier Walls is to block potential seepage through alluvial materials. Performance of the Barrier Walls may be optimized by increasing or decreasing their depths or horizontal location.

1.4 DEFINITIONS

A. BP Method of Excavation: A method of excavating a narrow vertical trench using a modification of the slurry trench method to temporarily support the trench walls and permit the placement of drainage features during construction

B. Bio-Polymer Slurry: A suspension of degradable polymer in water. The terms ~~"slurry" and~~ "bio-polymer slurry" and “BP slurry” are used interchangeably in these specifications.

C. Drain Sand~~Backfill~~: A freely-draining aggregate or gravel used as the final fill for the Groundwater Collection Trench

D. ~~Bio-Polymer~~ Slurry Specialist: An individual who has had proven and successful experience in slurry trench construction using SCB slurry and BP slurry.

E. Working Surface: The working surface is the top of the working platform as shown on the Drawings, from which the BP trench shall be constructed.

F. Broken or Degraded Slurry: BP slurry, which through natural or artificial means has degraded to water and a minute amount of a non-toxic residual.

G. Drain Activation: The process by which the BP slurry is degraded to permit the free flow of groundwater into and through the groundwater extraction trench.

H. Discharge Header: Vertical casings suitable to accept groundwater pumps for the removal of liquids from the completed trench.

I. Drain Pipe – Slotted flexible HDPE pipe installed near the bottom of the groundwater extraction trench to collect and divert groundwater collected in the trench to the discharge header.

J. Primary/Secondary Panel Excavation Method: The slurry trench excavation method where no two immediately adjacent panels are excavated sequentially. Initially, primary panels are completed, leaving gaps for future excavation of a secondary panel between primary panels. Secondary panels, which connect the primary panels to form a continuous wall, are not excavated until sufficient time has elapsed for the two adjacent primary panels to harden and provide additional support for secondary panel excavation due to arching effects.

~~J.~~K. Slurry Method of Excavation: The slurry method of excavation consists of excavating a vertical walled trench and at the same time keeping the trench filled with slag-cement-bentonite slurry or BP slurry~~.~~ The purpose of the slurry is to support the walls of the trench while excavating to the design depth. In the case of the SCB barrier wall, and the slurry ~~and~~ when hardened, will provide the required barrier wall properties.

~~K.~~L. Slag-Cement-Bentonite (SLCB) Slurry Barrier Wall: The slag-cement-bentonite slurry is used to stabilize the excavation ~~in the trench~~ and after hardening forms~~allow to set, and form~~ a low-permeability barrier wall to reduce seepage. The terms "slag-cement-bentonite slurry," “SCB slurry” and “slurry” are used interchangeably in these specifications.

~~L. Soil Bentonite Slurry (CB): A colloidal mixture of ordinary Portland cement, ground granulated blast furnace slag cement, bentonite, water, and additives mixed to form a stable, semi rigid, low permeability barrier to reduce fluid movement when the slurry mixture sets. These materials are abbreviated in these specifications as CB.~~

M. Ground Water Level: The ground water level is the piezometric level of the ground water as shown on the exploration logs.

N. Working Surface: The working surface is the top of the working platform as shown on the Drawings, from which the slurry trench shall be constructed.

O. CB Barrier Wall: The term CB barrier wall used in these specifications shall have the same meaning for the term slag-cement-bentonite slurry barrier wall (SLCB slurry barrier wall).

1.5 **SUBMITTALS**

A. The following submittals shall be submitted in accordance with specification Section 01300 Submittals.

1. Qualifications shall be submitted a minimum of 45 days prior to beginning the work for Extraction Trenches and Barrier Walls.

2. Work Plans shall be submitted a minimum of 21~~30~~ days prior to beginning work for Extraction Trenches and Barrier Walls.

B. Equipment. The CONTRACTOR shall submit to the ENGINEER a list of all equipment to be used in the performance of the construction work including descriptive data at least 60 days prior to start of the WORK.

C. Permits. A copy of all permits and/or license requirements per the Applicable or Relevant and Appropriate Requirements (ARARs), or other requirements necessary for execution of the WORK. As a minimum, the following requirements shall be met prior to the start of the WORK: all existing utilities shall be field located and the necessary excavation plans to protect existing utilities shall be submitted to the ENGINEER; all construction personnel shall meet the pertinent health and safety requirements specified in OSHA Standard 29 CFR 1910.120 and copies of personnel training certificates shall be provided.

~~B.~~D. **Qualifications**. Submit qualifications of personnel and subcontractor(s) utilized to construct both the Extraction Trenches and the Barrier Walls. Qualifications will be reviewed to ensure the CONTRACTOR has sufficient expertise, will employ competent experienced personnel, and will use proven methodologies and equipment to carry out the operations specified.

1. Qualifications for G~~g~~roundwater Extraction Trench Construction

a. CONTRACTOR and associated SUBCONTRACTOR(s), joint venture partner(s), or merged company shall demonstrate experience and competency for construction of Extraction Trenches using the biopolymer method. Evidence shall include references from at least two~~five~~ similar and successful projects constructed over the last five~~10~~ years. Project descriptions shall include type of slurry used and a description of materials installed.

b. BP Slurry Specialist: Provide name and resume for proposed BP Slurry Specialist who will supervise the BP slurry operations and quality control testing. Proposed individual shall be knowledgeable in: (1) the proper mixing methods employed to mix BP slurry, (2) the use, degrading, testing and control of degradable polymers as a slurry, (3) construction equipment, (4) excavation and backfill operations, and (5) testing for quality control of Extraction Trenches constructed using BP slurry. The BP Slurry Specialist shall have at least five years of experience and two~~five~~ projects in successful construction of BP slurry trenches.

c. Provide qualifications for each excavation equipment operator.

2. Qualifications for Barrier Wall Construction. Provide names and qualifications for the following:

a. The CONTRACTOR, his SUBCONTRACTOR, joint venture partner, or merged company shall have successfully constructed a minimum of two SLCB trench projects in the last 5 years. ~~of similar size and complexity as this project with similar access constraints, and as a minimum, similar depth and length of projects. Multiple slurry trench segments under one contract will be considered to be one project.~~ The qualifications and experience of personnel who shall be responsible for conducting the operations shall include references of the previously completed project with project company name; telephone number; address; and project description including depth, length, and construction method of the CONTRACTOR's previous successful SLCB barrier wall construction projects. An individual's experience from former companies shall not qualify as the present CONTRACTOR's experience. However this experience can be used as individual experience such as for the Barrier Wall Specialist.

b. Barrier Wall Specialist. The Barrier Wall Specialist shall have experience with at least two projects and five years of experience in all aspects of barrier wall construction which includes, but is not limited to:

(1) 1) The use, testing, and control of SLCB slurries~~.~~
(2) 2) The mixing methods required to properly mix SLCB slurry as required
~~(~~3) Trench excavation, slurry trench filling, and backfilling procedures~~.~~
~~(~~4) A thorough knowledge of construction equipment and material testing required for barrier wall construction, including de-sanding methods and equipment~~.~~
~~(~~5) Show successful construction of at least two SLCB slurry barrier walls having similar access constraints and at a minimum as deep and at least as long as this project~~.~~

c. Trench Excavation Equipment Operator – Each trench excavation equipment operator shall have previous successful experience using similar trench excavation equipment to be used for this contract on a minimum of two successfully completed projects of similar or greater length and depth.

d. Trench Logger(s) - The description and classification of the excavated material shall be performed by a geologist, geotechnical engineer~~ENGINEER~~, or civil engineer~~ENGINEER~~ with ~~a minimum of two years of experience~~ using field soil classification techniques described in ASTM D 2488. Submit experience that includes project name, phone number of customer and point of contact, date of construction, description of project feature in which classification of material was performed

e. Provide name(s) and resume(s) for Construction Supervisor and Barrier Wall Specialist.

f. Provide names and qualifications of all trench excavation equipment operators.

~~C.~~E. Submittals Specific to Extraction Trench Construction

1. Work Plan for Extraction Trench Construction:

The CONTRACTOR shall submit a~~an Extraction Trench~~ preconstruction work plan for approval to the ENGINEER in advance of the work as described in 1.5.A.2. The plan shall include, but not be limited to, the proposed method for constructing the

working platforms, extraction trenches, slope stability and shoring plan, details on proposed GCL and slotted drainage piping materials, method for the installation of the drainage piping and drain sand backfill, GCL, and methods and equipment proposed for constructing the extraction trenches. Details of specific methods to be employed to control potential environmental contamination or pollution arising from trench construction shall also be included. Specifically, details on on-site staging and storage areas, and disposal of trench spoil.~~, at least 30 days prior to beginning Groundwater Extraction Trench construction work.~~ No work shall be performed until the ~~CONTRACTOR has been notified in writing that the~~ plan has been approved and no~~by the ENGINEER. No~~ deviation from the approved work plan will be permitted w~~r~~ithou~~ten~~ approval from the ENGINEER.~~ The work plan shall at a minimum include the following:~~

a. The CONTRACTOR shall submit plans, details, and calculations for trench safety and temporary shoring where shoring is to be used in lieu of stabilizing BP slurry. The submittal shall be for information purposes only. This submittal and any review does not relieve the CONTRACTOR of the full responsibility for the adequacy of safety requirements and temporary shoring design.

~~a. Listing of supervisory personnel: Name and experience of the various persons, their roles and primary responsibilities.~~

~~b. Proposed construction methods, equipment, and schedules, including:~~

~~1) Dewatering plan.~~

~~2) Slope stability and shoring plan.~~

~~3) Construction Means and Methods: List of equipment and capabilities; construction steps; BP slurry production; excavation; backfill placement; ballasting methods for headers and pipes; handling of trench spoil; drain activation and slurry degradation; utility crossings; work platform construction, maintenance and removal; method for the installation of drainage piping and GCL.~~

~~c.~~b. Incorporated Materials: Certificates of compliance; test reports and data; and manufacturer catalog cut sheets for all permanent materials that become part of the final installation including :

1) Drain~~age~~ Sand: Testing data documenting the gradation of the drain sand shall be submitted to the ENGINEER at least 14 days prior to start of the WORK~~drainage sand~~.

2) Geosynthetic Clay Liner: A manufacturer-supplied data sheet and mill results, and other items as indicated in Section 02278 – Geosynthetic Clay Liner.

3) Admixtures

4) Perforated drainage piping materials.

5) Bio-Polymer (BP) Slurry: The name type, and characteristics of the degradable BP slurry intended to be used in construction. Information shall indicate whether the BP slurry is natural or synthetic and any

residuals expected after degradation. MSDS for each BP slurry ingredient shall be included.

d.c. Construction Quality Control Plan: The CONTRACTOR shall submit a Construction Quality Control Plan to the ENGINEER at least 30 days prior to construction. The plan shall include a list of test methods and minimum standards with which to gauge the quality of the work including trench and pipe depth measurements, verification of plumbness of piping assemblies, control of pipe grades, control of GCL extent and overlap. In addition, the plan shall provide. Provide a detailed quality control program covering all aspects of the use and degradation of the BP slurry, i.e., limits for BP slurry viscosity and pH, sampling methods, testing frequencies, depth measuring methods, backfill placement controls, rate and pore volumes of pumping during Extraction Trench activation, extraction well spacing for BP slurry degradation, and corrective measures, depth measurements, verification of plumbness of piping assemblies, control of pipe grades, and control of GCL overlap.

e.d. Cleanup: Site restoration plans, spoils disposal, etc.

f.e. Schedule: Schedule shall be provided with a bar chart. The following shall be included: starting and ending dates for major segments of the work, estimated production rates, days and hours of operation.

g.f. Extraction Trench Development Plan. Plan shall include methods and equipment proposed for developing the Extraction Trenches and details of specific methods to be employed to control potential contamination or pollution arising from trench construction shall also be included.

2. Quality Control Testing.

a. The CONTRACTOR shall be responsible to ensure that all work is performed to the standards of this specification.

b. Submit test results shall include analyses and interpretation of results. The Quality Control testing, including the BP material, shall be in both hardcopy and digital format. A summary table for the BP material shall be updated and submitted on a weekly basis.

c. Submit shipped materials test reports:

1) Geosynthetic Clay Liner: Mill results shall include date shipped, log number, test results, and roll number.

2) Admixtures: A copy of test results from the admixture manufacturer for each lot of fluidizing agentsfluidifiers, retarders, softening agents, or as approved, shipped to the site and a certificate of compliance stating that the admix complies with all applicable standards.

3. Extraction Trench Construction Diagram: During the construction of each extraction trench,Soundings and Material Description: Submit an as-built profile of the trench bottom, and backfill slope, including descriptions of material (i.e. soil classification) encountered in the trench excavation shall be continuously maintained by the CONTRACTOR. These records, data and drawings shall be made available daily and shall be furnished no later than 24 hours after the measurements and descriptions have been made.

4. BP Slurry. A record of BP slurry mix quantities, proportions of additives utilized, and adjustments for each production batch including the date mixed, wall panel, and the mixing plant and crew.

5. Closeout Submittals:

   a. As-built Drawing: Upon completion of the Extraction Trench construction, an as-built diagram of the trench shall be recorded by the CONTRACTOR's Construction Supervisor. Information to be provided in the as-built diagram shall include as a minimum the following: project and site names, extraction trench identification and dates of construction; extraction trench location; types of equipment; average trench width; location, thickness and brief description of each stratum; total depth of the completed trench; type and location of drainage piping, collection sump details, including volumes and materials of construction; backfill type and gradation; and the name and signature of the CONTRACTOR's Construction Supervisor. The CONTRACTOR shall prepare a graphic as-built diagram to scale showing the required details.

   b. Field books and notes.

E. **Submittals Specific to Barrier Wall Construction**

1. Work Plan for Barrier Wall Construction:

   The CONTRACTOR shall submit a preconstruction work plan for approval to the ENGINEER, in advance of the work as described in 1.5.A.2.~~at least 30 days prior to beginning Barrier Wall construction work.~~ No work shall be performed until the CONTRACTOR has been notified in writing that the plan has been approved by the ENGINEER. No deviation from the approved plan will be permitted written approval from the ENGINEER. The work plan shall at a minimum include the following:

   a. Listing of supervisory personnel: Name and experience of the various persons, their roles and primary responsibilities.

   b. Proposed construction methods, equipment, and schedules, including:

      1) Description of the general work sequence and layout of operations

      2) Baseline schedule for completing Barrier Wall construction

      ~~2)~~3) Scale drawings which depict SLCB preparation and storage areas in the layout of operations.

      ~~3)~~4) Construction means and methods: List of equipment and capabilities; method of trench excavation; production rates; planned panel dimension; planned work schedules including number of shifts and hours worked per shift; use or disposal of excavated material; bottom cleaning; SLCB slurry preparation and maintenance; SLCB preparation and placement; and site cleanup. The plan shall include a system for locating stations along the individual barrier wall alignments and relating them to the design drawings.

         ~~a) CONTRACTOR shall include in the work plan proposed methods for grouting open discontinuities in the SLCB barrier wall, including grout~~

~~mix design, and grout injection procedures and equipment for review and approval by the ENGINEER.~~

c. Incorporated Materials: Certificates of compliance; test reports and data; and manufacturer catalog cut sheets for all permanent materials that become part of the final installation including :

1) Backfill Material: Include information and data that verify the proposed backfill meets project specifications.

2) Bentonite

3) Cements and grouts

d. Deflocculants and other additives

~~d.~~e. Sampling. Include information on equipment and procedures for collecting samples of backfill material.

~~e.~~f. Construction Quality Control Plan: The plan shall provide a description~~Description~~ of quality control equipment, testing equipment, and required test procedures, sample test forms for reporting test results, onsite and/or offsite laboratory proposed for use, sample storage on site and method of transporting samples to laboratory. Laboratory quality control testing procedures shall be included: Information on sample preparation, sample storage, confining pressure application method, methods of checking saturation, samples of test data sheets and sample data reduction to obtain unconfined compressive strength and hydraulic conductivity shall be included.

~~f.~~g. Reporting schedule for completed SLCB slurry density tests, unconfined compressive strength tests, and permeability tests. Include reporting schedule for offsite independent laboratory.

h. The plan shall include a written description of the method for verifying vertical tolerances.

2. Samples.

~~a. Bentonite: A minimum of 10 pounds of the proposed bentonite shall be submitted at least 14 days prior to use.~~

~~b. Portland Cement: A minimum of 50 pounds of each type of proposed Portland Cement shall be submitted at least 14 days prior to use.~~

~~c. Ground Granulated Blast-Furnace Slag Cement: A minimum of 50 pounds of each type of proposed ground granulated blast furnace slag cement at least 14 days prior to use.~~

~~d.~~a. Barrier Wall Key-in Material. Provide sample of barrier wall key-in material upon request to the ENGINEER.

3. Test Reports - Pre-Construction SLCB Slurry Test Report

a. A report summarizing the procedures and results of the Pre-construction SLCB slurry mix tests.

b. The report shall include a description of mix proportions, water-cement ratio, water and slurry temperatures, densities, permeability, and unconfined compressive strength and hydraulic conductivity of five (5) samples of the final SLCB slurry mix and mixture with site soils at the anticipated inclusion rates that may occur within the trench. Mix design testing shall be performed~~sand contents~~ using the cement bentonite, and additives if any, proposed for use.

4. Quality Control Testing

a. Submit results from required quality control testing to the ENGIN~~G~~EER in a timely manner.

b. Tests results shall include analysis and interpretation of the results. The Quality Control testing including the SLCB material shall be in both hardcopy and digital format. A summary table for the SLCB material shall be updated and submitted on a weekly basis. The summary table shall include as a minimum the sample ID number, batch number, cast date, station number, depth, hydraulic conductivity, compressive strength test data, and comments relating to interpretation of the results.

c. Submit ~~shipped materials~~ test reports for materials delivered to the site:

1) Bentonite~~ Certificates~~ - A copy of the test results from the bentonite powder manufacturer for each lot shipped to the site and a certificate of compliance stating that the bentonite complies with applicable standards.

2) Portland and Slag Cement: Submit a copy of the test results from the cement manufacturer for each Portland Cement Type I-II and Ground Granulated Blast-Furnace Slag cement lot shipped to the site and a certificate of compliance stating that the cement complies with all applicable standards.

3) Admixtures: Submit a copy of the test results from the admixture manufacturer for each lot of fluidizing agents~~fluidifiers~~, retarders, softening agents, or as approved, shipped to the site and a certificate of compliance stating that the admix complies with all applicable standards.

d. SLCB Slurry: A record of slag-cement-bentonite slurry mix quantities, proportions of additives utilized, and adjustments for each production batch including the date mixed, wall panel, and the mixing plant and crew.

5. Chain of Custody Form for Quality Control and Quality Assurance – Samples: The CONTRACTOR shall submit a sample of the chain of custody form used to keep track of all Quality Control (QC) and Quality Assurance (QA) samples taken by the CONTRACTOR. The form shall include who formed the samples; transfer of company; ship dates; time; batch number; and location (e.g. stationing, heading number, etc.) of the QC and QA samples.

6. Trench Soundings and Material Description: An as-~~-~~built profile of the trench bottom, backfill slope including descriptions of material (i.e. soil classification) encountered in the excavation shall be continuously maintained by the CONTRACTOR. These records, data, and drawings shall be made available daily furnished no later than 24 hours after the measurements and descriptions have been made.

7. Closeout Submittals:

a. As-built Drawing: Submit a scale drawing (CAD drawing) providing a log of the subsurface materials excavated from the trench, and a profile of the completed slurry trench with bottom elevations. The limits of each batch of CB slurry (with date) shall be delineated as placed in each panel or secondary panel.

b. Final Test Report of SLCB Material: Submit a final test report of SLCB material in both hardcopy and digital format. The test report shall include a summary table for the SLCB material that includes as a minimum the sample ID number, batch number, cast date, hydraulic conductivity, compressive strength test data, and comments relating to interpretation of the results. In additional laboratory test data sheets shall be included in the final test report.

c. Field log books and notes.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Protect materials delivered and placed in storage from the weather, dirt, dust or other contaminants.

1.7 GEOTECHNICAL SITE CONDITIONS

A. Exploration Borings

~~1. All Preconstruction Submittals shall be submitted within 60 calendar days after Notice to Proceed is issued.~~

~~a.~~ Subsurface data have been obtained by the COMPANY to provide information regarding~~determine~~ the character of materials to be excavated. Locations of borings are shown on the Drawings and included in the Alluvial Groundwater Collection System Geotechnical Report included as Attachment G-4 to Appendix G of the 100% Basis of Design Report.~~boring logs are attached to this specification.~~ The COMPANY assumes no responsibility for interpretation or deductions made by the CONTRACTOR from the data provided. Local variations in the subsurface materials are to be expected, and if encountered will not be considered as materially different. Soil classifications shown on the logs are the result of field visual ~~and laboratory~~ classifications. The subsurface material is classified in accordance with the Unified Soil Classification System. The available borings within the limits and proposed depths of this contract are included in the contract drawings. Groundwater levels indicated in the explorations were observed at the time of drilling and can vary depending on time of year and creek stage.

2. Subsurface Conditions

a. The excavation for the Extraction Trenches and Barrier Walls~~barrier walls~~ will be from the working platform and extend through alluvium and weathered bedrock. The material to be excavated generally consists of silty sand, clayey sand, and poorly graded gravel with sand. Cobble and boulder-size material may be encountered during excavating.

b. Water levels encountered during drilling are shown on the logs and represent the depth at which water was encountered~~level only~~ at the time of drilling.

3. Knowledge of Subsurface Data

a. It is the CONTRACTOR's responsibility to become acquainted and satisfied as to the character, quality, and quantity of surface and subsurface materials by inspecting the site, perform~~ing~~ additional borings as necessary for soil classification and mix design formulation, and by evaluate~~ing~~ information derived from the exploration work performed for this project and included in the documents referenced in 1.7.A. Failure~~these plans and specifications. Any failure~~ by the CONTRACTOR to become acquainted with ~~all~~ the available information and ~~any~~ other site specific conditions such as utilities will not relieve the CONTRACTOR from responsibility for properly estimating the difficulty or cost of successfully performing the work.

1.8 ENVIRONMENTAL PROTECTION

A. The CONTRACTOR shall take all precautions necessary to prevent contaminated water or nuisance water having undesirable physical or chemical characteristics from leaving the site. All waters shall be collected and conveyed to the appropriate storage facility for treatment. All contaminated soil shall be transported to the mine area for disposal.

B. Contractor shall comply with relevant~~all~~ site-wide specific plans including the Construction Spill Prevention Control and Countermeasures Plan; and the Construction Stormwater Pollution Prevention Plan.

C. Excavation~~All excavation~~ equipment shall be free from leaks of fuel, hydraulic fluid, and oil which may contaminate the ground surface. It is expressly understood that toxic and/or contaminating substances shall not be used during ~~any part of the~~ trench excavation, piping installation, or trench development process.

D. The raw materials and other supplies used in the construction of the extraction trenches, barrier walls and any spoil disposed of within the project limits shall be non-hazardous to prevent, and provide for abatement and control of, any environmental pollution arising as a part of the work

E. Excess slurry and/or saturated materials shall be allowed to drain from excavated materials or solidify prior to loading and hauling to the designated disposal area to avoid release of slurry onto construction roads or other areas at the Site. If excavated materials must be hauled prior to draining of excess fluids or solidification, they shall be transported in fully lined haul vehicles.

PART 2 -- PRODUCTS

2.1 PRODUCTS SPECIFIC TO GROUNDWATER EXTRACTION TRENCH CONSTRUCTION

A. Polymer. The polymer shall be a natural or synthetic material capable of temporarily supporting slurry trench excavation and later naturally and/or artificially degrading to a non-toxic water solution after backfilling of the trench is complete. The polymer shall have a minimum molecular weight of 1,250,000. The polymer slurry shall be water-based. The slurry and degraded slurry shall not form a filter cake on the trench walls or materially decrease the transmissivity of the backfill or the trench walls. The degraded slurry shall be non-toxic.

B. Water. The water used to make the slurry shall be suitable to provide slurry with adequate viscosity and useful life to complete the extraction trench excavation and groundwater collection system installation and backfilling operations.~~.~~ Fresh water, free of excessive amounts of deleterious substances, especially bio-organisms with natural polymers and certain anions with synthetic polymers, that may adversely affect the properties of the slurry shall be used to manufacture the slurry. It is the responsibility of the CONTRACTOR to ensure that the slurry resulting from the water shall ~~always~~ meet the standards of this specification.

C. Slurry. The BP slurry shall consist of a suspension of polymer in water and shall be controlled in accordance with the following requirements:

1. The density and viscosity of the BP slurry shall be sufficient to provide adequate stabilization to complete the trench excavation and backfilling without contamination of drain sand backfill or deformation of extraction trench components due to collapse or deformation of the trench walls.~~At the time of introduction of the slurry into the trench, and when in use in the trench, the slurry shall have a minimum viscosity of 60 seconds (viscosity requirement may be reduced for more stable soil types or increased for less stable soils) Marsh Funnel Viscosity (MFV),~~

2. The minimum pH of the slurry shall be 8.5 (this value only appropriate for natural polymer slurries) when in use in the trench

3. When fully degraded, the slurry shall have a maximum viscosity of 30 seconds.

D. Admixtures. Admixtures of the type used in the control of fracturing fluids such as water treatment chemicals, softening agents, dispersants, or bridging agents may be added to the water or the slurry to permit efficient use and proper workability of the slurry. Additives specially designed for used with the particular BP slurry may also be used and these include biocides, bio-starters, and enzyme breakers, sterilants, and oxidizers. The ENGINEER shall be advised of all additives used.

E. Drain Sand. Extraction trench drain sand shall be imported material conforming to ASTM C33 Standard Specifications for Concrete Aggregates, Fine Aggregate. Drain Sand~~Filter sand~~ shall not contain any unsuitable material. Drain Sand shall have the following grain-size distribution:

Table 1. Grain Size Distribution

Sieve Size	Percentage Passing
3/8 –inch	100
No. 4	95 – 100
No. 8	80 – 100
No. 16	50 – 85
No. 30	25 – 60
No. 50	5 – 30
No. 100	0 – 10

F. Geosynthetic Clay Liner. Geosynthetic clay liner shall conform to Section 02780.

G. Slotted Drainage Piping.

1. Pipe sizing shall as shown on the Drawings (Section 7 – Groundwater Controls).~~.~~

2. High density polyethylene piping shall conform to Section 02594.

3. The slotted high density polyethylene piping shall have a minimum water inlet opening area of 0.25 square feet (36 square inches) per linear foot of pipe. All measurement of perforation fabrication shall be made with instruments accurate to 0.01 inch.

4. The CONTRACTOR shall be qualified to lay, pull and perform heat fusion joining of the HDPE pipe.

5. Applicable manufacturer requirements including buried polyethylene pipe, bend radius, and allowable tensile loads shall be observed.

6. Connections: Connection fittings shall be HDPE flange adaptors with metal backup rings for full restraining, the connection fittings shall be compatible with the HDPE pipe and the existing valves, piping, or other appurtenances to be tied into.

7. Joints: Pipe sections and fittings shall be joined by heat fusion, except at tie-in points to exiting pipe where flanges or other proven and accepted mechanical joint systems for HDPE pipe.~~ is required as shown on the drawings~~

8. Provision for pipe expansion and contraction should be made. When assembled outside the trench, the pipe should be allowed to cool in the trench before backfilling to minimize stress due to thermal contraction.

H. Riser and Discharge Piping.

1. Solid wall high density polyethylene piping shall conform to Section 02594.

2. Joints: Pipe sections and fittings shall be joined by heat fusion, except at tie-in points to exiting pipe where flanges or other proven and accepted mechanical joint systems for HDPE pipe~~ is required as shown on the drawings~~.

3. Provision for pipe expansion and contraction should be made. When assembled outside the trench, the pipe should be allowed to cool in the trench before backfilling to minimize stress due to thermal contraction.

I. BP Material Storage Facility. The CONTRACTOR shall provide all necessary materials, equipment and personnel to store the BP materials and other additives under conditions to prevent moisture or other contaminants from mixing with the materials prior to use in the slurry plant.

~~J. Environmental Protection. The raw materials and other supplies used in the construction of the extraction trench and any spoil disposed of within the project limits shall be non-hazardous to prevent, and provide for abatement and control of, any environmental pollution arising as a part of the work~~

2.2 PRODUCTS SPECIFIC TO BARRIER WALL CONSTRUCTION

A. Portland and Slag Cement. Cement to be used in preparing the SLCB slurry shall be Portland Cement Type I-II and~~/or~~ Ground Granulated Blast-Furnace Slag cement Grade

100 or higher in accordance with ASTM C 150 and~~/or~~ ASTM C 989. Use of reclaimed cement or cement containing lumps or deleterious matter shall not be allowed. ~~Cement to be used in preparing the SLCB slurry shall be Portland Cement Type I II and/or Ground Granulated Blast-Furnace Slag cement Grade 100 or higher in accordance with ASTM C 150 and/or ASTM C 989. Use of reclaimed cement or cement containing lumps or deleterious matter shall not be allowed.~~

B. Bentonite. The bentonite shall be sodium cation based montmorillonite powder that conform~~s~~ to API Spec 13A, Section 9. ~~Bentonite shall be new, pulverized, high-swelling natural sodium cation montmorillonite (Premium Grade Wyoming type bentonite).~~ Chemically treated bentonite will not be allowed. No bentonite~~ from the bentonite manufacturer~~ shall be used prior to acceptance by the ENGINEER. Bentonite not meeting specifications shall be promptly removed from the site at the CONTRACTORs expense. Bentonite shall be protected from moisture during transit and storage.

C. Water. The CONTRACTOR shall supply and condition water required for mixing with cement and bentonite to produce slurry as needed. The water shall be clean, fresh, and comply with the standards specified below. The CONTRACTOR shall furnish water quality test results for water used for mixing the bentonite slurry to assure conformance to these standards. The hardness limit is a recommendation only.

Table 2. Parameters for Water Used in SCB Slurry

Standards	
pH value	7.0 +/- 1.0
Total dissolved solids	<500 ppm
Oil, organics, acids, or other deleterious	<50 ppm each
Hardness	< or = 50 ppm

D. Admixtures. Admixtures such as fluidifiers, defloculants, and retarders may be used as approved for use in preparing the SLCB slurry mixture. Admixtures of softening agents, dispersants, retarder or plugging or bridging agents may be added to the water or the slurry to permit efficient use of materials and proper workability of the slurry~~grout~~. No additives shall be used except as approved by the ENGINEER after test results show that the performance of the SCB slurry is~~will~~ not ~~be~~ adversely affected.~~ Admixtures shall be non-toxic.~~ CONTRACTOR shall have on file a written statement from the admixture manufacturer regarding the use of the admixture, and its effect on the environment. No other admixture types shall be used unless approved by the ENGINEER.

E. Barrier Wall Backfill.

1. The initial design mix for the barrier wall backfill shall be selected by the CONTRACTOR and approved by the ENGINEER based upon target permeability and strength requirements and advanced testing as specified herein. Modifications to the initial design mix shall be made only with the approval of the ENGINEER

2. Materials shall be thoroughly mixed, and at the time of placement, the backfill material shall conform to the mixing and placement requirements.

F. Material Storage Facility. The CONTRACTOR shall provide all necessary materials, equipment and personnel to store the bentonite, cement and other additives under conditions to prevent moisture or other contaminants from mixing with the materials prior to use in the slurry plant.

~~G. Environmental Protection. The raw materials and other supplies used in the construction of the barrier wall and any spoil disposed of within the project limits or at any landfill shall be non-hazardous to prevent, and provide for abatement and control of, any environmental pollution arising as a part of the work~~

~~H.~~G. Disposal Site. Barrier wall trench excavated material ~~that is not suitable for backfill material~~ shall be disposed of at the Site in an area~~on-site location~~ designated by the ENGINEER.

~~I.~~H. Trench Plates. The minimum plate thickness shall be 1-1/4 inches for the specified trench width. Steel plates also known as steel plate bridging shall consist of steel designed for HS20-44 truck loading

2.3 SLCB SLURRY

A. The SLCB slurry used to support ~~the sides of~~ the excavated trench shall consist of a stable colloidal suspension of bentonite, ground granulated blast-furnace slag cement, and Portland cement in water. The SLCB slurry shall have at the time of its introduction into the trench a minimum unit weight of 67.0~~69.6~~ pounds per cubic foot, in accordance with the standard test procedures described in API RP 13B-1. The properties of the mix shall be such that the completed slurry trench will provide a continuous low-permeability barrier at the specified horizontal locations and corresponding specified depths, and have the following properties:

1. An unconfined compressive strength (ASTM D4832/D2166) between 25~~50~~ pounds per square inch (psi) and 300 pounds per square inch when cured for 28 days.

2. A hydraulic conductivity (ASTM D7100) not greater than $5x10^{-7}$ cm/sec when measured at 28 days using site groundwater as the permeant.

B. Trial Mixes

1. Mix design for the SLCB slurry shall be the responsibility of the CONTRACTOR and ~~shall~~ take into account the subsurface conditions along the project alignment. The CONTRACTOR shall fabricate a sufficient number of cast samples to support the proposed mix design.

2. Minimum number of mix designs shall be three~~five~~ covering a range of percentages with a minimum of 10~~12~~ percent solids. The SLCB slurry selected

for production work shall undergo a second series of tests in which the range of entrained site soil and groundwater~~sand~~ contents that can be expected during Barrier Wall construction are intermixed within the slurry.

3. Only those materials approved shall be used to fabricate the test specimens. These materials include Portland cement, ground granulated blast furnace slag, bentonite, water, and approved admixtures.

4. The CONTRACTOR shall submit a Pre-Construction SLCB Slurry Test report containing the results of the tests as specified. Only mixes meeting or exceeding the test requirements shall be approved for use. The CONTRACTOR shall establish the minimum time required for the CB slurry to harden sufficiently to allow for excavation of adjacent panels through design and results of the trial mixes.

2.4 CONSTRUCTION STAKING

A. The CONTRACTOR shall provide, install and maintain all layout and necessary construction staking to locate centerlines of the groundwater collector trenches and barrier walls within the allowable ranges of installation and the lengths as shown on the contract drawings. Surveyor's caps, appropriately identified and mounted on a 2-inch diameter, 2-foot-long steel pipe, driven into the ground, shall be provided at the ends of each groundwater extraction trench and each barrier wall and at bends in horizontal alignment or at 100-foot maximum intervals between the ends. Coordinates and elevations shall have units consistent with the contract drawings. A tabulated list containing survey control numbers, grid coordinates, and elevations shall be submitted to the COMPANY within five working days of completing each heading. The beginning and ending of the barrier wall and any internal points shall be identified on this list.

B. Permanent Metal Marking Stakes. Upon completion of each groundwater extraction trench or barrier wall, permanent metal marker stakes shall be placed at the trench or barrier wall endpoints. The locations of these markers shall be surveyed and referenced to the corresponding project coordinate system for horizontal and vertical control.

PART 3 -- EXECUTION

3.1 GENERAL CONSTRUCTION REQUIREMENTS

A. The groundwater extraction trenches and the barrier walls shall be constructed to the lines, grades, and cross-sections shown on the drawings and in accordance with these specifications. The ENGINEER may modify the dimensions and quantities of the work as needed to meet project requirements.~~determined necessary.~~ Final acceptance of the groundwater extraction trenches and barrier walls will be based on results of quality assurance testing as described in this specification.

B. All applicable Federal, State, and local regulations shall be met prior to personnel entering an excavation area. The CONTRACTOR shall take all necessary steps to ensure the safety of personnel. The CONTRACTOR shall detail temporary shoring methods to be employed and these methods shall be approved by the ENGINEER prior to implementation.

~~C. Construction Staking. The CONTRACTOR shall provide, install and maintain all layout and necessary construction staking to locate centerlines of the groundwater collector trenches and barrier walls within the allowable ranges of installation and the lengths as shown on the contract drawings. Surveyor's caps, appropriately identified and mounted~~

~~on a 2-inch diameter, 2-foot-long steel pipe, driven into the ground, shall be provided at the ends of each groundwater extraction trench and each barrier wall and at 100-foot maximum intervals between the ends. Coordinates and elevations shall have units consistent with the contract drawings. A tabulated list containing survey control numbers, grid coordinates, river station number, and elevations shall be submitted to the COMPANY within five working days of completing each heading and a summary list at the completion of all survey controls. The beginning and ending of the barrier wall and utility crossings shall be identified on this list.~~

~~1. Initial and Final Elevation:~~

~~The caps shall be surveyed to establish initial elevation and final elevation to an accuracy of plus or minus 0.01-foot and these stakes shall be maintained and protected from damage or movement throughout the work. The CONTRACTOR shall submit a report to the COMPANY for the barrier wall installation showing any settlements that occurred. The barrier wall stations shall have the design elevations of the bottom of the barrier wall established, and furnished as part of the submittal. A system for locating stations along the barrier wall alignment and relating them to the plans shall be established by the CONTRACTOR and submitted to the COMPANY for approval.~~

~~D. Permanent Metal Marking Stakes. Upon completion of each groundwater extraction trench or barrier wall, permanent metal marker stakes shall be placed at the trench or barrier wall endpoints. The locations of these markers shall be surveyed and referenced to the corresponding project station location.~~

~~E.~~C. Working Surface. Groundwater extraction trench and barrier wall construction shall be accomplished from the working platform, as shown on the drawings. The working platform as shown on the drawings shall constitute the top of the groundwater extraction trench or barrier wall.

~~F.~~D. Temporary Working Surface Preparation.

1. Prepare the temporary working surface from which trench excavation, backfill mixing, and backfilling operations are to be performed. ~~Form the working platform at least 4 feet above the groundwater table to facilitate constructability.~~ The grade in direction of trenching is not to exceed 1 percent. Level the working surface to facilitate excavation of a vertical trench.
2. Maintain control of gravity drainage along the working surface. Maintain the working surface free of excessive amounts of excavated soils and slurry. Maintain CSWPPP BMPs in accordance with the approved plan.

3.2 EXECUTION SPECIFIC TO GROUNDWATER EXTRACTION TRENCHES

A. The groundwater extraction trenches shall be excavated using the biopolymer slurry method or other approved method for trench shoring.

B. Elevation and Depth Measurements. The CONTRACTOR shall survey the elevation of each trench bottom at least every 20~~10~~ linear feet. All depth measurements shall be made from the working platform to the bottom of the trench. The CONTRACTOR shall generate and maintain on-site an as-built profile of each extraction trench.

C. Construction Equipment for Groundwater Extraction Trenches. The CONTRACTOR shall furnish all necessary equipment for use on this project. The CONTRACTOR shall obtain and maintain at the jobsite a supply of spare critical replacement parts or backup

equipment sufficient to allow the extraction trench~~barrier wall~~ construction to proceed with minimum loss of time due to mechanical breakdown or equipment failure

1. Trench Excava~~cua~~tion Equipment. Excavation of the groundwater extraction trench shall be accomplished by use of any suitable earth-moving equipment, or combination thereof, such as a hydraulic excavator~~backhoe~~ and/or clamshell, so the trench can be carried to its final depth of cut continuously along the trench alignment. The~~Special chopping, chiseling or other suitable~~ equipment ~~may be~~ used for~~as necessary to satisfactorily accomplish the required~~ excavation shall be capable of excavating to depths of at least 45 feet below the ground surface. The groundwater extraction trench shall be at least 3-feet wide.~~.~~ The width of the excavating tool shall be equal to or greater than the specified minimum width of the groundwater extraction trench.

2. Slurry Mixing Equipment. The plant for mixing the bio-polymer slurry shall include the necessary equipment including a mixer/reductor capable of producing a suspension of polymer in water plus any pumps, valves, hoes, supply lines, and all other equipment as required to adequately mix and supply slurry to the trench. The plant shall be equipped to accept additives in measured amounts. Storage tanks shall be provided (as needed) to store initially mixed slurry, and to retain a reserve in case substantial slurry loss. Slurry shall be recirculated in the storage tanks during working hours to maintain a homogeneous mix. All slurry for use in the trench shall be prepared using a suitable mixer and no slurry is to be made in the trench.

3. Backfill Placement Equipment.

   a. Equipment for handling and placing backfill may consist of any suitable material handling equipment, such as loaders, conveyors, elevators, or trucks that are capable of delivering the backfill to the trench. Placement of the backfill within the extraction trench shall occur using a tremmie pipe~~avoid methods that can segregate the backfill gradation~~ or other approved method~~add fine particles to the backfill~~.

   ~~b. Special methods including tremie placement, lowering to the bottom of the trench with a bucket, or placement on a slope may be necessary and will be required for some backfill gradations. The particular backfill material and placement method may also require additional equipment to pre-wet the backfill to permit placement through the tremie pipe and avoid suspending fine particles in the slurry.~~

4. Hauling Equipment. Earthwork related hauling equipment shall consist of pneumatic-tired vehicles with bodies suitable for the material being hauled.

5. Pipe Placement Equipment. Equipment for handling and placing the drain pipe shall operate from the surface of the working platform. The equipment shall develop a live load surcharge that will produce no significant contribution to the instability of the trench. The line and grade of the pipe shall be controlled and measured using survey, laser equipment and/or telltales. The pipe shall be centering between the trench walls using equipment or by special device. The pipe shall be fitted with ballast to ensure that buoyancy of the pipe is overcome and the final position of the pipe in the trench is fixed.

D. Excavation. Trench excavation shall be maintained in an open condition by the BP slurry method or other approved trench stabilization method.~~.~~ Excavation shall be conducted in a manner, which provides for a continuous minimum 3-foot wide~~width~~ trench to the required depth along the centerline of the excavation. The ENGINEER may direct the CONTRACTOR to deepen the trench based on examination of spoils and shall approve the depth of the trench immediately after completion of the excavation. The trench shall be constructed without undue interruption until complete.

E. Slurry Use and Trench Stability. Biopolymer slurry shall be prepared and used by the contractor to control trench width and stability. The level of the slurry shall always be maintained at least 3 feet above groundwater level and shall not be permitted to drop more than 2 feet below the surface of the working platform. The amount and quality of the slurry in the trench shall be maintained at a level sufficient to maintain trench stability. The contractor shall have sufficient personnel and equipment ready to raise the slurry level during construction and on call during nights and weekends. The quality of the slurry shall be maintained at all times until the backfill is in place and the slurry is degraded.

F. Backfilling.

1. Backfilling of the trench shall begin as soon as practical after completion~~and shall minimize the area~~ of excavation.~~trench supported only by slurry.~~ The backfill shall be placed into the trench from starting at the trench bottom and working in an upward direction using a tremmie pipe or other approved method. Placement shall occur in a manner that avoids inclusions~~segregation~~ of BP slurry in the backfill, backfill material segregation, or entrainment of~~ and contamination by~~ fine ~~soil~~ particles within the backfill. Backfill placement may also require additional equipment to pre-wet the backfill to permit placement through the tremie pipe and avoid suspending fine particles in the slurry.~~.~~ Backfill shall be placed in a uniform manner using controlled methods around wells/sumps and pipes so that the force of the backfill does not disturb their position. ~~Special means such as tremie, bucket placement or a backfill ramp shall be used as required by the gradation of the backfill~~

2. The CONTRACTOR shall place and tamp the drain sand in lift thicknesses of one foot.

~~2.~~ Once backfilling is complete, the drain~~In general, the backfill shall be placed continuously from the beginning of the trench in the direction of the excavation to the end of the trench. Initial backfill shall be placed by special means until it rises above the level of the slurry. Subsequent backfill shall be placed by allowing it to slide down the slope of previously placed backfill.~~

~~a. The CONTRACTOR shall place and tamp the drainage sand continuously from the beginning of the trench in the direction of excavation to the end of the trench. The minimum lift thickness shall be one foot. Compaction tests are not required on the drain sand. The drainage sand shall be placed in the trench in a manner that avoids displacement of the perforated drainage piping or segregation of the drainage sand. Free dropping of drainage sand shall not be permitted.~~

b. ~~The drainage~~ sand shall be covered with GCL as shown on the Drawings,~~by trimming~~ and ~~overlapping~~ the remainder of the trench~~GCL, and~~ shall be backfilled to top of grade. Uncontaminated native soil shall be used~~recompacted~~ to bring the trench to the finished grade elevation. Backfill overlying the GCL shall be placed in 12-inch maximum horizontal loose lifts and ~~The backfill material shall be~~ compacted by bucket tamping with a hydraulic excavator or

other approved methods in a manner that does not displace or damage the underlying GCL.~~to at least 95 percent of maximum density by the Modified Proctor test (ASTM D 1557), and shall have a moisture content not greater than ± 2 percent from optimum moisture as determined by ASTM D 1557. The maximum compacted lift thickness shall be 8 inches. In place density shall be measured using ASTM D 1556, at the rate of two tests per lift of backfill.~~

~~3. Cleanup - The CONTRACTOR shall continually clean up slurry wastes, debris and leftover materials resulting from the extraction trench construction process. Upon completion of the work, the site shall be cleared of debris which may have accumulated in the execution of the work. Spoils generated by the extraction trench construction shall be disposed of at location designated by the COMPANY.~~

G. ~~Drain Activation. After backfilling, the slurry shall be degraded to water and a minute amount of residual material. Slurry additives shall be used as necessary to destroy the viscosity of the slurry.~~ Drain Activation and Extraction Trench Development. After completion of drain sand placement and prior to placement of the GCL and soil cover layers, the BP slurry shall be broken down and water used to flushed through the drain sand in order to remove residual material and to ensure satisfactory permeability of the trench media. During breakdown, the BP slurry shall be degraded to water and a minute amount of residual material. Slurry additives shall be used as necessary to destroy the viscosity of the slurry. Broken-down BP slurry shall be made pH neutral. The CONTRACTOR shall pump and flush the extraction trench until at least five pore volumes of the trench have been circulated utilizing water from a source approved by the ENGINEER.

~~G. Broken slurry shall be made pH neutral. Water may be flushed through the backfill, if necessary. The pore volume of the trench shall be pumped and circulated at least two times to ensure activation of the drainage properties of the trench. Any excess broken slurry shall be encouraged to infiltrate into the subsurface or be removed from the trench prior to final backfilling.~~

H. Tolerances. The following tolerances shall apply to the groundwater extraction trench dimensions and construction. The tolerances may vary from the designed values if approved by the ENGINEER:

1. The groundwater extraction trench shall be essentially vertical. The working platform and/or excavating equipment may be leveled to be plumb within 1% of vertical.

2. The depth of the groundwater extraction trench shall be measured or surveyed to within 6 inches of the desired elevation.

3. The excavating tool shall be at least as wide as the design width (3 feet) of the groundwater extraction trench.

4. The groundwater extraction trench shall follow the designed alignment within 2 feet of the designated centerline.

5. Construction will not be permitted when the air temperature is below 20 °F or when severe weather conditions may compromise the quality of the work.

6. The pipe shall be installed in accordance with the manufacturer's recommendations. The elevation of drain pipe installed shall be within ± 6 inches of the plan elevation without kinks or bends and the elevation of the pipe and recorded at 10 ft intervals.

The grade of the pipe shall be continuously maintained without mounds or sharp bends~~sags~~ in the line of the pipe

I. As-Built Profile: An as-built profile of the extraction trench bottom, including descriptions of materials encountered in the trench bottom shall be continuously updated and maintained by the CONTRACTOR. This profile shall indicate extent of excavation and the barrier wall profile at the end of each work day. The profile shall include descriptions of materials encountered during excavation and the depth of the trench bottom. This profile shall indicate extent of excavation and the backfill profile at the beginning and end of each work day or shift, as determined from the soundings. The daily profile drawing shall prepared using AutoCAD or in another digital format as approved by the ENGINEER. The material encountered in the trench and bottom of the trench shall be included in the profile. The CONTRACTOR shall furnish profile drawings, individual and summary records of all observations, measurements, and tests performed, identified with the location and time of testing. These records shall be furnished no later than 24 hours after the tests, measurements and/or observations were made.

J. Treatment for Top of Backfill. After the trench is activated, a geosynthetic clay liner (GCL) shall be placed at the top of the Drain Sand backfill and the remaining trench shall be backfilled to the designated finished elevation. ~~A layer of geosynthetic clay liner shall be placed over the backfill to separate the backfill from subsequent soil layers.~~ A minimum of three feet of soil ~~from the trench excavation~~ shall be ~~recom~~placed over the GCL~~backfill~~ to bring the trench to the designated elevation. Prior to completion the working platform shall be regraded and/or resurfaced to promote drainage.

K. Trench Stability. The CONTRACTOR is responsible for maintaining the stability of the excavated trench for its full-length and depth. The trench will be open for a period of time to allow installation and testing of the piping. The CONTRACTOR shall control surcharges from the excavation and backfilling equipment, trench spoil containment and storage area construction, backfill stockpiles, and other loading situations that may affect trench stability. It is expressly understood that the CONTRACTOR is responsible to ensure that any stockpiles do not affect the stability of the open trench. In the event of failure of the trench prior to completion of backfilling, the CONTRACTOR shall re-excavate the trench and remove all material displaced into the trench and take the necessary corrective actions to prevent further deterioration at no additional expense.

L. Geosynthetic Clay Liner Installation. GCL will be installed as follows:

1. The GCL shall be installed in accordance with Section 02780 – Geosynthetic Clay Liner.

~~1.~~ Damage to ~~The GCL shall be installed over the trench with a minimum 2-foot overlap on all joints. The 2-foot overlap must be maintained throughout the backfilling operations. The GCL shall be installed free of large wrinkles. The GCL shall provide a continuous cover for the top of the trench. GCL shall be completely installed prior to placement of final backfill.~~

2. ~~Holes or tears in~~ the GCL shall be repaired in accordance~~by CONTRACTOR by overlapping~~ with Section 02780 – Geosynthetic Clay Liner~~additional panels or pieces of GCL~~.

M. Slotted~~Perforated~~ Drainage Piping Placement. Slotted~~Perforated~~ drainage piping shall be laid in a continuous line starting at the lowest elevation and proceeding to the highest elevation to the extent practical.~~.~~ All drainage piping and appurtenances shall be laid to

the lines and grades shown on the drawings. The pipe shall be bedded with six inches of drain~~age~~ sand. Drainage piping shall be placed to the design grade within a tolerance of plus or minus 0.2 foot of that shown on the drawings. ~~No reversal of grade shall be permitted.~~ The pipe shall be centered between the trench walls. The CONTRACTOR shall verify the elevation of the perforated drainage piping after placement by measur~~vey~~ing the crown elevation at~~every~~ 10-foot horizontal intervals ~~linear feet~~.

N. Extraction Trench Cleanout Placement. The cleanouts shall be placed in the trench in such a manner that displacement of the drain line will not occur. The cleanouts shall be constructed as shown on the drawings.

~~O.~~ Cleanup - The CONTRACTOR shall clean up slurry wastes, debris and leftover materials resulting from the extraction trench construction process on a daily basis or more frequently if necessary.~~Groundwater Extraction Trench Development. After completion of drainage sand placement and prior to lapping the GCL, water shall be flushed through the drainage sand in order to remove residual material and to ensure satisfactory permeability of the trench media. The CONTRACTOR shall pump and flush the extraction trench until at least five pore volumes of the trench have been circulated utilizing water from a COMPANY approved source.~~

O. Upon completion of the work, the site shall be cleared of debris which may have accumulated in the execution of the work. Spoils generated by the extraction trench construction shall be disposed of at location on within the Site boundary as designated by the ENGINEER.

3.3 EXECUTION SPECIFIC TO BARRIER WALL CONSTRUCTION

A. Construction Tolerances. Construction tolerances presented in the following table shall apply to the Barrier Wall dimensions shown on the drawings.

Table 3. Construction Tolerances

Item/Material	Allowable Tolerance
Horizontal deviation from Vertical[1]	≤2% of the depth of individual wall panels (0.02 times panel design depth in feet)
Note: 1. Deviations in excess of 2% will be cause for rejection for that portion of the slurry trench. Reconstruction of a slurry panel because of excess deviation from vertical shall not be the cause for additional compensation. The CONTRACTOR shall provide written description on method for verifying vertical tolerance and shall be accepted by the ENGINEER 60 days prior to starting the excavation.	

B. All other Barrier Wall construction shall be to tolerances as approved by the Engineer.

C. GENERAL

1. The Barrier Wall shall be constructed to the elevations, lines, grades, and cross sections shown in the drawings and in accordance with these specifications, unless otherwise directed by the Engineer.

2. Final acceptance of the Barrier Wall will be based on the results of laboratory tests of the samples and Barrier Wall measurements described in this Specification.

D. WORKING SURFACE

1. Barrier Wall construction shall be accomplished from the working platform surface as shown on the drawings. The working platform surfaces as shown on the drawings shall constitute the top of the Barrier Wall for the purpose of measurement and payment.

2. Prepare the temporary working platform surface from which Barrier Wall excavation will be performed. Form the working platform surface at least 4 feet above the groundwater table to facilitate constructability. The grade in direction of trenching is not to exceed 1 percent and the working platform surface shall be level in the direction perpendicular to the trench axis to facilitate excavation of a vertical trench.

3. Maintain control of gravity drainage along the working platform surface. Maintain the working platform surface free of excessive amounts of excavated soils and slurry. Maintain SWPPP BMPs in accordance with the Agency approved plan

E. SLURRY PREPARATION AND PLACEMENT

~~A. SLCB Slurry Preparation and Placement~~

1. Bentonite-water slurry must~~shall~~ be a homogenized, stable, colloidal suspension of bentonite in water. Allow freshly mixed slurry to hydrate in storage ponds or tanks. Agitate or recirculate slurry occasionally in the ponds or tanks until bentonite is fully hydrated, as indicated by stabilized Marsh funnel viscosity readings and homogeneous appearance of the slurry. A minimum of 12 hours is generally required for bentonite to be hydrated after it is mixed with water. ~~Mix no slurry in the trench.~~

2. Introduce slag-cement-bentonite ~~water~~ slurry into the trench when excavation begins. Maintain the slurry level in the trench at least 3 feet above the groundwater table and within 1 foot of the temporary working surface. Minimize dilution of the slurry by surface water. Maintain the slurry level in the trench at all times, including nights, weekends, and holidays.

3. Slurry in the trench must conform to specified requirements at all times. ~~Remove any slurry containing suspended solids in excess of specified requirements and use for preparing soil-bentonite backfill, or separate suspended solids and re-introduce the de-sanded slurry into the trench.~~

F. SLURRY TRENCH EXCAVATION

~~B. Slurry Trench Excavation~~

~~1. General~~

a. The excavation shall begin from the working platform surface and shall provide a vertical (within 2 percent) continuous 36-inch minimum width trench to the required depth along the centerline of the excavation. The equipment shall have a configuration and orientation that reduces live load and dead load surcharge to an amount that will produce no significant contribution to the instability of the trench.

b. No equipment travel over recently excavated and backfilled trench shall be permitted. The slurry trench shall be constructed using the panel method if construction cannot ~~. The CONTRACTOR shall plan each shift to have each panel worked on during the shift to~~ be completed prior to thickening and initial set~~by the end~~ of the slurry. The objective~~workday. This~~ will be to avoid

hardening of the S~~L~~CB slurry as defined below. ~~-~~If the CONTRACTOR elects to partially excavate any panel, then the hardened S~~L~~CB slurry shall be removed and disposed, and replaced with fresh S~~L~~CB slurry ~~being placed~~ in the trench. ~~When trench excavation overlaps into previously completed slurry trench panels, the excavation shall extend a minimum of 3 feet into the previously placed and hardened SLCB slurry at all depths. Any removed section of completed slurry trench panels shall be refilled with SLCB slurry at no additional expense to the COMPANY. Excavated hardened slurry shall be disposed at a location designated by the ENGINEER.~~ During excavation the CONTRACTOR shall rotate the excavator in a ~~landward~~ direction ~~(~~away from any surface water bodies~~)~~ to avoid spillage of slurry into surface water. ~~–~~During excavation, sufficient time shall be allowed for the excavator bucket to drain excess slurry to minimize slurry loss before loading excavated material into haul trucks.

2. Panel excavations shall be performed in a primary/secondary sequence unless otherwise approved by the Engineer. Unless otherwise approved by the Engineer, secondary panel excavation shall not commence until adjacent primary panels have achieved sufficient unconfined compressive strength to avoid displacement or damaged of the hardened slurry in the primary panels.

~~2. Vertical Tolerance. The Barrier Wall shall not deviate from vertical more than 2 percent of the depth of individual wall panels (0.02 X panel design depth in feet). Deviations from vertical of more than 2 percent will be cause for rejection for that portion of the slurry trench. Reconstruction of a slurry panel because of excess deviation from vertical shall not be the cause for additional compensation. The CONTRACTOR shall provide written description on method for verifying vertical tolerance and shall be accepted by the ENGINEER 60 days prior to starting the excavation.~~

~~3. Bottom Depth. The Barrier Wall shall be to the depth required to contact underlying very dense weathered quartz monzonite bedrock. The COMPANY may direct the CONTRACTOR to modify the depth based on examination of trench cuttings of foundation material.~~

~~4. Trench Stability and Slurry Loss~~

~~a. The CONTRACTOR shall be responsible for ensuring and maintaining the stability of the excavated trench at all times for its full length and depth and shall be responsible for maintaining slurry densities and levels within specified limits. The CONTRACTOR shall control surcharges from excavation and backfilling equipment, waste, berm construction, backfill stockpiles, and any other loading situations that may affect trench stability. It is the CONTRACTOR's sole responsibility to ensure that stockpiles and traffic do not affect the open trench stability. In the event of failure of the trench walls prior to completion of backfilling, the CONTRACTOR shall at his expense re-excavate the trench, remove all material displaced into the trench, and take corrective action to prevent further deterioration. The CONTRACTOR shall be aware of the possibilities of caving and sloughing of the trench and/or loss of slurry during excavation through the working platform and foundation soils. The CONTRACTOR shall monitor, control, and record slurry losses. The CONTRACTOR shall maintain adequate excess slurry storage to account for slurry losses and to maintain trench stability.~~

b.a. During excavation, slurry losses will be monitored by tracking slurry additions needed to maintain slurry levels for each panel. An estimate of slurry losses will be recorded for each panel in daily QC reports. Excess slurry losses (as indicated by unusually high slurry makeup requirements needed to maintain slurry levels in the trench) will immediately be brought to the attention of the ENGINEER.COMPANY. Visual monitoring of adjacent surface water bodies or other low-lying areas will commence immediately upon identifying excess slurry losses and be performed continuously throughout the remainder of the panel excavation or until slurry losses diminish to a normal level. If slurry discharge is observed on low-lying ground surfaces, stream banks, or in surface water bodies, the excavation will be discontinued immediately, the trench will be backfilled with native soil, and the slurry will be allowed to harden sufficiently prior to re-excavatingreexcavating the panel. In addition, sediment control measures will be installed immediately upon observing emerging slurry leaks to control migration of slurry and prevent slurry from reaching surface water bodies or other sensitive areas.

5. Continuity Between Panels

a. Panels started at the beginning of the work day shall be completed by the end of that work day before the SLCB slurry begins to harden. The CONTRACTOR shall plan the work and new panel lengths shall be based on experience, width and depth of panels, and completion of panels by the end of each shift. Panel lengths shall be included in the Slurry Trench Implementation Plan. Panel lengths shall not exceed 60 feet in length.

3. Bottom cleanout and all soundings for bottom acceptance and bottom cleanup shall be completed for each panel before the end of the work day.

b.a. SLCB slurry in completed panels shall be allowed to harden sufficiently to be self-supporting prior to starting excavation of adjacent panels. Panel joints shall be formed by overlapping the excavation of new panels into the hardened slurry of previously excavated panels by 3 feet at each end.

4. Depth measurements in completed panel excavations shall be made every 20 feet along the Barrier Wall alignment.

6. Discontinuities in the SLCB barrier wall may require grouting at the direction of the ENGINEER. When required by the ENGINEER, such grouting shall be conducted according to the methods submitted and accepted by the ENGINEER according to Paragraph 1.5 E.

7. Slurry Trench Bottom. The bottom of the slurry trench will be to the grade shown on the drawings or as directed by the ENGINEER. The ENGINEER may direct the according to field observation of foundation materials excavated from the trench bottom by the COMPANY and CONTRACTOR to modify. Following the trench bottom cleaning, the CONTRACTOR and the COMPANY shall jointly measure the depth based on examination of trench cuttings of foundation Material.to the bottom of the barrier wall panel.

a. Trench Bottom Cleaning. When the bottom of the wall panel is reached, the bottom surface shall be probed along the trench centerline, using a weighted tape, cable, or other approved device, to determine that the contract depth is obtained. Probing shall be used to determine if there is debris or excessive

sediment on the trench bottom that shall be removed prior to acceptance of the panel bottom.

8.5. Cleaning of the bottom of the trench shall be achieved by successive light passes of the excavation bucket over the bottom surface until the bucket returns free of debris or sediments. Removal of material from the walls of the trench shall be avoided during cleaning of the trench bottom.

9.6. Top of Slurry Trench. After completion of a panel, fill the barrier wall trench to within 1one foot of the ground surface. After initial setting of the slurry, any free water or disturbed slurry from the top of the wall shall be removed and fresh SLCB slurry added to the top of the slurry trench grade. Prior to placement of the trench cover, temporary cover shall be placed to protect the slurry wall and prevent desiccation. The cover shall prevent desiccation prior to the time when the slurry has hardened. If the desiccation requirement is not achieved with the cover materials then plastic sheeting may alsoshall be used to cover the trench. and prevent desiccation. Temporary cover material shall be placed over the top surface of a panel within two (2) days after the wall panel is completed. After a minimum time for the SLCB slurry to harden as established by testing (paragraph 2.2.1 Trial Mixes), the temporary trench cover shall be removed and permanent fill placed over the top of wall and graded to allow for equipment access. Heavy construction equipment and machinery shall not travel over or adjacent to the slurry trench until the SLCB has hardened, and the trench covered in such a manner to withstand such traffic without damage to the backfill.

10.7. Premature Hardening of SLCB Slurry: SLCB slurry shall be placed in the trench in a fluid, stable, colloidal state of suspension at the density and quality described in the above paragraphs. In the event that the slurry hardens prematurely, the hardened slurry shall be removed to the full depth and replaced with fresh slurry. Premature hardening resulting in re-excavation shall not be the basis for a claim of extra work and additional compensation. Trial mix results shall determine working time and slurry hardening time per paragraph 1.11B2.2.B Trial Mixes.

11.8. Trench Logging and Soil Sampling:

a. The trench logging shall be performed during excavation at both ends of each panel, or at 20 foot length intervals, whichever is less, by the slurry trench logger. The slurry trench logger shall be onsite during excavation operations and describe and classify the excavated soils in accordance with ASTM D2488D 2488.

b. Impervious Stratum: Samples of the low-permeability stratum at the base of the Barrier Wall (very dense weathered bedrock) shall be taken at minimum interval of 20 feet of excavation, or once per panel, whichever is shorter in length or as directed by the ENGINEER.COMPANY. The materials from the base of the wallow-permeability stratum shall be described and classified in accordance with ASTM D2488.D 2488. The date, time, station, depth, and panel number shall be recorded and the sample description and classification performed by the CONTRACTOR'S's Trench Logger and confirmed by the ENGINEER.COMPANY. After examining these results, the ENGINEERCOMPANY will either approve the termination of excavation at the minimum excavation shown on the Drawings or require additional or less excavation. If additional excavation is required, additional samples shall be furnished by the CONTRACTOR as specified above. All samples shall be

properly identified and labeled, placed in sealed plastic bags, and stored in a location designated by the OWNERCOMPANY.

12. Slurry Placement.

a. Slurry shall be introduced into the trench at the time excavation begins. The level of the slurry in open trenches shall be maintained a minimum of three feet above ground water level and no more than two feet below the top of the working surface until the required level of SLCB slurry is complete. The area around the trench shall be maintained such that slurry is not diluted by surface water. The slurry placement shall be performed such that free fall, and/or erosion and entrapment of soil within the SLCB slurry is prevented. The CONTRACTOR shall have sufficient personnel, equipment, slurry storage tanks, and prepared slurry material ready to raise the slurry level at any time in the excavated trench, weekends and holidays included. The day following completions of a panel, areas of surface settlement of the SLCB backfill shall be filled with fresh slurry brought to the working surface elevation. The dry surface crust of the harden slurry shall be removed prior to placing fresh slurry to fill any surface settlement.

b. Barrier Wall Protection - The CONTRACTOR shall take all necessary actions to protect the Barrier Wall from disturbance. No construction activity on top of the barrier wall will be permitted until the initial set of the backfill has occurred. A temporary non-compacted soil cover shall be placed within two days after completion of each. No activity on top of the barrier wall will be permitted for a minimum period for setting as demonstrated by mix design, and until the wall backfill has reached a minimum unconfined compressive strength of at least 30 psi. Heavy construction equipment and machinery shall only be driven over the barrier wall at approved equipment crossing points which are "bridged" with steel plates and additional cover material and transmit no loads to the barrier wall.

c. Cleanup: The CONTRACTOR shall continually clean up slurry wastes, debris and leftover materials resulting from the Barrier Wallbarrier wall construction process. Upon completion of the work, the site shall be cleared of debris which may have accumulated in the execution of the work. Spoils generated by the Barrier Wallbarrier wall construction shall be disposed of at a location designated by the OWNERCOMPANY.

G. AS-BUILT PROFILE

13.1. A recordedAs-Built Profile. An as-built profile of the Barrier Wallbarrier wall trench bottom, including descriptions of materials encountered in the trench bottom shall be continuously updated and maintained by the CONTRACTOR. This profile shall indicate extent of excavation and the barrier wall profile at the end of each work day. The profile shall include descriptions of materials encountered during excavation and the depth of the trench bottom. This profile shall indicate extent of excavation and the slag-cement-bentonite backfill profile at the beginning and end of each work day or shift, as determined from the soundings. The daily profile drawing shall prepared using AutoCAD or in another digital format as approved by the ENGINEER.COMPANY. The material encountered in the trench and bottom of the trench, as described by the approved Slurry Trench Logger, shall be included in the profile. The CONTRACTOR shall furnish profile drawings, individual and summary records of all observations, measurements, and tests performed, identified

with the location and time of testing. ~~-~~These records shall be furnished no later than 24 hours after the tests, measurements and/or observations a~~we~~re made.

3.4 QUALITY CONTROL AND QUALITY ASSURANCE

A. Quality Control and Quality Assurance Specific to Groundwater Extraction Trench Construction

1. Quality Control (Extraction Trench)

   a. General. The CONTRACTOR shall be responsible for Quality Control under the direction of the BP Slurry Specialist. Observations, tests, and measurements described in this Section shall be performed throughout the groundwater extraction trench construction.

   b. Trench Dimensions - The CONTRACTOR shall be responsible for demonstrating to the satisfaction of the ENGINEER that the trench is the proper width, continuous and excavated to the specified depth. The depth of the trench shall be sounded in horizontal increments no greater than 20~~at least every 10 lineal~~ feet.

   c. Slurry Materials - The CONTRACTOR shall test the slurry at least four times per day. Samples of the slurry shall be obtained from both the trench and the mixing plant for testing. The CONTRACTOR~~contractor~~ shall supply equipment and personnel for performing these tests.

   d. Drain Sand backfill material~~Backfill Materials~~ - The CONTRACTOR shall submit evidence that the Drain Sand backfill is the specified gradation and quality. Samples shall be obtained and tested at least every 500 tons and submitted to the ENGINEER.

   e. Discharge Header - The CONTRACTOR shall record the station and control the location and verticality of the headers until completely backfilled. The verticality of the headers shall be measured with a carpenter's level to ensure that the headers will permit unimpeded installation of pumps. If the alignment of the header is inadequate, the CONTRACTOR shall install a replacement header using well drilling methods, at no additional cost to the COMPANY.

   f. Drain Pipe - The CONTRACTOR shall verify and record the elevation of the pipe as it is installed. The line and grade of the pipe shall be maintained until completely backfilled.

   g. Records - All quality control records, tests, and inspections shall be documented by the CONTRACTOR and available for review by the ENGINEER. The CONTRACTOR shall record all measurements and test results for submittal to the ENGINEER each day.

2. **Quality Assurance (Extraction Trench)**

The ENGINEER may collect and perform quality assurance testing on the BP slurry using the laboratory and equipment furnished by the CONTRACTOR. The CONTRACTOR shall provide the equipment and laboratory space to ENGINEER on request and these services shall be considered a subsidiary obligation of the BP construction. Testing by the ENGINEER will in no way relieve the CONTRACTOR of the responsibility of performing tests necessary to meet the construction requirements. All routine testing procedures being conducted by the CONTRACTOR shall be available for inspection by the ENGINEER at any time.

B. **Quality Control and Quality Assurance Specific to Barrier Wall Construction**

1. **Quality Control Testing (Barrier Wall)**

a. General - The CONTRACTOR shall be responsible for Quality Control under the direction of the Barrier Wall Specialist. Observations, tests, and measurements described in this Section shall be performed throughout the barrier wall construction. Final acceptance of the Barrier Wall will be based on the trench measurements and from the results of tests performed on samples collected during the barrier wall work.

b. Daily Field Tests - The CONTRACTOR QC personnel shall sample and test the SLCB slurry density. ~~in accordance with ASTM D-4380.~~ All sampling and testing shall be performed on the production SLCB slurry, in accordance with the approved Preconstruction Testing Plan and Slurry Trench Implementation Plan. The density of the SLCB slurry shall be determined using a mud balance. Density results shall be measured at least twice per day at each wall panel and at the~~each~~ mixing plant

c. Barrier Wall Construction Records - The CONTRACTOR shall maintain daily construction records with results of visual inspections, measurements of progress and wall panel measurements, quantities of materials used, and all field tests. All records shall be incorporated into the Daily QC Report to be provided to the COMPANY by the following work day.

d. Access to Work Site. The CONTRACTOR shall allow time during the excavation cycle for inspection of the trench work by QC personnel and the ENGINEER. The CONTRACTOR shall provide:

1) Suitable means of access to the excavated trench for observation and depth measurement.

2) CONTRACTOR personnel to probe the depth of the trench and allow observation by the COMPANY.

3) A depth measuring device with prominent high visibility markers at 1/2-foot intervals.

e. Barrier Wall Measurements - Within four hours of placement of the SLCB slurry, the trench excavation to the head of the excavation will be sounded at a maximum horizontal interval of 20~~every 10~~ feet, or a at least two~~minimum of four~~ locations for each panel, whichever results in a greater number of soundings, unless otherwise specified along the trench centerline using a weighted tape, cable or other device approved by the COMPANY.

f. Elevation of Trench Bottom - The CONTRACTOR shall determine the elevation of the trench bottom after the trench has been cleaned in accordance with the specifications. This elevation is subject to approval by the ENGINEER.

g. Mixing Plant Testing - SLCB slurry shall be sampled at the mixing plant at least twice per day. At a minimum, sampling shall occur near the beginning, and near the end of the shift. SLCB slurry shall be sampled and tested in accordance with API RP 13B-1 for slurry density, Marsh funnel viscosity, filtrate loss, and other parameters as needed to verify conformance of the as-mixed slurry with the mix design.

~~g.~~ SLCB Slurry Trench Sampling- Sampling of the~~.~~

h. ~~The~~ SLCB slurry within the trench ~~properties~~ shall occur~~be sampled in the trench~~ two times per shift for each active panel. One set of ~~excavation, near the beginning and near the end of the shift. The~~ samples shall be obtained near the beginning and one set of samples shall be obtained near the end of the shift.

Samples shall be obtained from two ~~taken at three~~ different depths within the panel during each trench sampling event:~~,~~ one at a depth within ten~~five~~ feet below the slurry surface, one at a depth within ten~~five~~ feet above the bottom of the trench. Sampling shall be performed in accordance with API RP 13B-1.

1) Each slurry ~~, and one at mid depth of the~~ trench sample shall be tested in accordance with the test method and ~~. The SLCB slurry properties in the trench shall have the following properties measured at the cited~~ frequency requirements of Table 4 for Viscosity and density~~for each active excavation~~.

~~Property~~	~~Test Method~~	~~Requirement~~
~~Density~~	~~API RP 13B-1~~	~~69.6 lbs/ft3 to See Note 1~~
~~Viscosity~~	~~API RP 13B-1~~	~~40 sec to See Note 1~~
~~Sand Content~~	~~API RP 13B-1~~	~~See Note 1~~
~~Filtrate Loss~~	~~API 13A, 13B~~	~~Maximum based on Mix Design~~
~~Note 1: The maximum sand content used in the adopted mix design for meeting the strength and hydraulic conductivity requirements shall be the upper limiting value.~~		

2. Trench Sampling for Unconfined Compressive Strength and Hydraulic Conductivity Testing:

1) Two~~Three~~ bulk samples of the SLCB slurry will be taken from each panel upon the completion of excavation. The~~active excavation at least once per shift for Compressive Strength and Hydraulic Conductivity testing. The three~~ bulk samples shall be taken from a depth within ten~~five~~ feet below the slurry surface, a depth within ten~~five~~ feet above the bottom of the trench.

a.b. , and at mid-depth of the trench in each panel being actively excavated. For each bulk sample, plastic molds shall be used to cast cylindrical specimens that are at least 23 inches in diameter and 46 inches in height. The bulk samples shall be poured into the plastic molds and rodded or vibrated to remove trapped air pockets and then sealed. From each bulk sample, the CONTRACTOR shall cast six (6) cylindrical specimens for Quality Control purposes and threesix cylindrical specimens for the ENGINEER'SCOMPANY's Quality Assurance purposes. The bulk samples shall be poured into the plastic molds and rodded or vibrated to remove trapped air pockets and then sealed. Randomly selected (alternating depth) bulk samples representing a single batch shall be tested for hydraulic conductivity using three specimens and unconfined compressive strength using three specimens. The remaining six specimens from the same bulk sample shall be retained and properly stored for testing by the COMPANY. Twelve specimens from the remaining two bulk samples shall be retained and properly stored by the CONTRACTOR for possible future testing. The other twelve specimens shall be retained and properly stored for possible testing by the COMPANY. The CONTRACTOR shall store the COMPANY's specimens until they are transported by the COMPANY's Quality Assurance laboratory. The specimens shall be labeled and stored at a constant temperature (equivalent to average ground temperature), and damp environment, until tested or until otherwise directed by the COMPANY

b. Chain of Custody of Samples – The CONTRACTOR shall develop an approved chain of custody protocol for exchanging samples among the various parties used by the CONTRACTOR for the Quality Control program. At a minimum, the sample identification, location, heading, panel number, sampling date and time, depth, batch number, mixing plant, and person taking custody of the sample shall be entered into the chain of custody sampling form. Wherever the samples are exchanged between responsible parties, the transfer shall be noted by each party accepting and transferring the samples. The type of test, date and result of measurement shall be entered on the form once samples are used for laboratory testing. All samples stored for archive purposes shall be duly noted as to the location of the archive. The chain of custody form shall be available for inspection by the COMPANY at any time. Copies of the chain of custody form shall be given to the COMPANY on a weekly basis.

c. SLCB Slurry Testing

1) General – Each specimen prepared shall be labeled with the location, panel number, sampling date and time, depth, batch number, mixing plant, test type to be performed, and time to be cured before testing. Of three bulk samples obtained in accordance with paragraph "Trench Sampling for Compressive Strength and Hydraulic Conductivity", one bulk sample shall be selected in accordance with paragraph "Trench Sampling for Compressive Strength and Hydraulic Conductivity" for preparing three specimens to be tested for hydraulic conductivity and three specimens to be tested for unconfined compressive strength. Twelve specimens from the remaining two bulk samples shall be retained and properly stored by the CONTRACTOR for possible future testing. The other twelve specimens shall be retained and properly stored for possible testing by the COMPANY. All samples shall be cured at the equivalent average ground temperature until the test sample is selected for testing.

2) The CONTRACTOR shall then select one of the bulk samples from each panel for testing. The selected sample shall be from an alternate depth than the most recent selected bulk sample depth.

3) The CONTRACTOR shall test the selected Quality Control specimens from the selected bulk sample. Three of the samples shall be tested for hydraulic conductivity and three shall be tested for unconfined compressive strength testing. The three (3) Quality Assurance specimens from that sample shall then be retained and properly stored by the CONTRACTOR for Quality Assurance testing by the ENGINEER.

4) The CONTRACTOR shall store and retain the remaining Quality Control and Quality Assurance specimens from the remaining two bulk samples for possible future testing. The CONTRACTOR shall store the Quality Assurance specimens until they are transported by the ENGINEER's Quality Assurance laboratory.

5) All specimens shall be labeled and stored at a constant temperature (equivalent to average ground temperature), and in a damp environment, until tested or until otherwise directed by the ENGINEER.

c. Unconfined Compressive Strength and Hydraulic Conductivity Testing:

~~2)~~1) Testing Laboratory ~~–~~ An independent testing laboratory, approved by the OWNER~~COMPANY~~, shall perform the CONTRACTOR~~'~~'s laboratory testing including hydraulic conductivity and unconfined compressive tests. The independent Quality Control testing laboratory selected by the CONTRACTOR shall submit a ~~detailed~~ testing program and ~~followed with~~ information relating to equipment used for testing.

2) Unconfined Compressive Strength Testing

a) Unconfined compressive strength testing shall be performed on three of the QC specimens cast from each selected bulk sample.

~~3)~~ The specimens shall be removed from plastic cylinders ~~Hydraulic Conductivity Testing~~

b) ~~Three test specimens obtained in accordance with paragraph 3.8.H.2 shall be tested for hydraulic conductivity~~ in accordance with ASTM D4832.

c) Unconfined compressive strength testing shall be performed in accordance with ASTM D2166.~~D 5084.~~ Tests shall be performed on samples cured for 7 days, 14 days, and 28 days.

3) In the event a required specimen is damaged or test parameters are not met by the 28 day specimen, a reserve specimen may be tested at 35 days, or at another elapsed time interval as directed by the ENGINEER. In the event a bulk sample fails to meet testing requirements, testing of specimens from other samples may be required as directed by the ENGINEER. The compressive strength tests shall be performed on specimens from the same randomly selected bulk sample as the hydraulic conductivity test sample.

a) Testing shall be performed in accordance with the test method and frequency requirements of Table 4.

4) Hydraulic Conductivity Testing:

a) Hydraulic conductivity testing shall be performed on three of the QC specimens cast from each selected bulk sample.

b) The specimens shall be removed from plastic cylinders in in accordance with ASTM D4832.

Hydraulic conductivity testing shall be performed in accordance with ASTM D7100. Testing shall be performed on samples cured for 7 days, 14 days, and 28 days.– The tests shall be performed in a flexible-walled permeability cell. Testing shall be performed in accordance with the following parameters: Average effective confining stress = 5 pounds per square inch.

(1) Maximum hydraulic gradient = 10.

If samples have a permeability of less than 1×10^{-7} cm/sec such that testing at a hydraulic gradient of 10 is impractical, then a hydraulic gradient of up to 40 will be allowed with the ENGINEER'S review and approval.

a) Permeate shall be site groundwater provided by the OWNER or synthetically derived to simulate key components (pH and sulfate In the event a required specimen is damaged or test parameters are not met by the 28 day test specimens, a reserve specimen may be tested at 35 days, or at another elapsed time interval as directed by the COMPANY. In the event a bulk sample fails to meet testing requirements, testing of specimens from other samples may be required as directed by the COMPANY. The test parameters are as follows:

(1) Average effective confining stress = 10 pounds per square inch.

(2)(1) Maximum hydraulic gradient = 10.

(3) ENGINEER.Permeate shall be site groundwater provided by the COMPANY or synthetically derived to simulate key components (pH and sulfate concentration) of the site groundwater.

(4) Test backpressure sufficient to ensure a Skempton's pore pressure parameter greater or equal to 0.95.

Note: The hydraulic conductivity tests shall be continued until inflow-outflow measurements or flow rates demonstrate that steady state seepage conditions have been reached.

4)1) Compressive Strength Testing Three test specimens obtained in accordance with paragraph 3.8.H.2 shall be removed from plastic cylinders in in accordance with ASTM D 4832, and ASTM D 2166 for testing of the specimens. The tests shall be performed on samples cured for 7 days, 14 days, and 28 days. In the event a required specimen is

~~damaged or test parameters are not met by the 28-day specimen, a reserve specimen may be tested at 35 days, or at another elapsed time interval as directed by the ENGINEER.~~ In the event a bulk sample fails to meet testing requirements, testing of specimens from other samples may be required as directed by the ENGINEER.~~ The compressive strength tests shall be performed on specimens from the same randomly selected bulk sample as the hydraulic conductivity test sample.~~

5) Testing shall be performed in accordance with the test method and frequency requirements of Table 4.

Table 4
Minimum Required QC Field and Laboratory Testing Methods and Frequencies – Barrier Wall SLCB Trench Properties

Material	Test Name	Testing Method	Minimum QC Testing Frequency	Additional Requirements
SLCB Slurry				
SLCB Mixing Plant Samples[1]	Density (Unit Weight)	API RP 13B-1 ASTM D 4380	Twice per shift minimum	See Section 3.4.B.1.g
	Viscosity	API RP 13B-1		
	Filtrate Loss	API 13A, 13B		
SLCB Slurry Trench Samples	Density (Unit Weight)	API RP 13B-1 ASTM D 4380	1 test per sample (2 sampling events per shift with three samples per event)	See Section 3.4.B.1.i
	Viscosity	API RP 13B-1		
	Sand Content	API RP 13B-1		
	Filtrate Loss	API-13A 13B		
	Unconfined Compressive Strength	ASTM D 2166 ASTM D4832	1 set of 3 tests (at 7, 14 and 28 days) per sample (1 sampling event per shift)	See Section 3.4.B.1.j
	Hydraulic Conductivity	ASTM D7100	1 test (at 28 days) per sample (1 sampling event per shift)	
Note 1: Other testing to be performed as needed to verify conformance of the as-mixed slurry with the mix design.				

~~5) Construction Log - The CONTRACTOR shall maintain a construction log of daily activities which shall include delays encountered during construction, causes of delays, locations of affected areas, and extent of delays relating to barrier wall construction. The log shall also record excavation problems, slurry losses and unusual conditions or problems encountered, and the dispositions made. The ENGINEER shall be immediately notified of unusual conditions or problems and followed by a written description.~~

3. **Quality Assurance (Barrier Wall)**. The ENGINEER~~COMPANY~~ may collect and perform quality assurance testing on the barrier wall using the laboratory and

equipment furnished by the CONTRACTOR. The CONTRACTOR shall provide the equipment and laboratory space to ENGINEER~~COMPANY~~ on request and these services shall be considered a subsidiary obligation of the Barrier Wall construction. Testing by the ENGINEER~~COMPANY~~ will in no way relieve the CONTRACTOR of the responsibility of performing tests necessary to meet the construction requirements. All routine testing procedures being conducted by the CONTRACTOR shall be available for inspection by the ENGINEER~~COMPANY~~ at any time.

- END OF SECTION -

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SECTION 02272 –GEOMEMBRANES

PART 1 -- GENERAL

1.1 SUMMARY

A. The CONTRACTOR shall supply all labor, equipment, materials, and appurtenances for the complete installation of geomembranes as per contract documents.

B. Sufficient geomembrane material shall be furnished to cover all lined areas, including seam overlaps and anchor trenches. One percent shall be added to the length of each panel to allow for shrink and wrinkles. The geomembrane shall be installed in a relaxed condition and shall be free of tension or stress upon completion of the installation.

1.2 SUBMITTALS

A. The submittals indicated below shall conform to Section 01300 – Contractor Submittals.

B. Prior to installation of geomembrane material, the CONTRACTOR shall submit the following for the ENGINEER's approval:

1. Resin Data, including a certification stating that the resin meets the specification requirements (see Paragraph 2.1.B).

2. Statement certifying that geomembrane materials have been tested and inspected in accordance with Paragraph 1.5.

3. Statement certifying no recycled polymer and no more than 10% rework of the same type of material is added to the resin (product run may be recycled).

4. Specification sheet stating that the geomembrane meets the specification requirements (see Paragraph 2.1.E)

5. Installation layout drawings showing the proposed panel layout to cover the lined area shown, with proposed size, number, position, and sequence of placing all sheets and indicating the location and direction of all field joints and penetrations. Installation layout drawings shall also show complete details and/or methods for anchoring, field joints, seals at existing structures, etc.

6. Four 8-inch x 10-inch samples of the material proposed for the lining

7. A Statement of Qualifications for the geomembrane manufacturer and installation contractor with sufficient detail to satisfy the experience requirements of Paragraph 1.3.

8. Installation Contractor's Quality Control Plan.

C. Placement of geomembrane material shall not commence until the submittals required in Paragraph 1.2 B have been approved by the ENGINEER.

D. Upon completion of geomembrane installation, the CONTRACTOR shall submit the following:

1. Certificate stating the geomembrane has been installed in accordance with the Contract Documents.

2. Material and installation warranties

3. As-built drawings showing actual geomembrane placement and seams including complete details.

1.3 QUALIFICATIONS

A. **Qualifications of Manufacturer:** The manufacturer shall have at least five years continuous experience in manufacturing polyethylene geomembrane and/or experience totaling not less than 5 million square feet of manufactured polyethylene geomembrane.

1. The following manufacturers are approved by the COMPANY:

a. Agru America

b. GSE Environmental

B. **Qualifications of Installation Contractor:** The installation contractor shall be the manufacturer, or shall be trained to install the manufacturer's material, and shall have experience of not less than 3 projects and not less than 1,000,000 square feet of successfully installed polyethylene geomembrane.

1. Field Installation Supervisor: Installation shall be performed under the constant direction of a Field Installation Supervisor who shall remain on site and be responsible, throughout the geomembrane installation, for layout, seaming, testing, repairs, and all other activities by the Installer. The Field Installation Supervisor shall have installed or supervised the installation of not less than 1,000,000 square feet of polyethylene geomembrane.

2. Master Seamer: Seaming shall be performed under the direction of a Master Seamer (who may also be the Field Installation Supervisor) who has seamed not less than 1,000,000 square feet of polyethylene geomembrane, using the same type of seaming apparatus specified for this project. The Field Installation Supervisor and/or Master Seamer shall be present whenever seaming is performed.

1.4 REFERENCE SPECIFICATIONS, CODES AND STANDARDS

ASTM D1004	Test Method for Initial Tear Resistance of Plastic Film and Sheeting
ASTM D1238	Standard Test Method for Flow Rates of Thermoplastics by Extrusion Plastometer
ASTM D1505	Test Method for Density of Plastics by the Density-Gradient Technique
ASTM D1603	Test Method for Carbon Black in Olefin Plastics
ASTM D3895	Standard Test Method for Oxidative-Induction Time of Polyolefins by Differential Scanning Calorimetry
ASTM D4218	Standard Test Method for Determination of Carbon Black in Polyethylene Compounds
ASTM D4833	Standard Test Method for Index Puncture Resistance of Geotextiles, Geomembranes, and Related Products

ASTM D5199	Standard Test Method for Measuring Nominal Thickness of Geotextiles and Geomembranes
ASTM D5397	Standard Test Method for Evaluation of Stress Crack Resistance of Polyolefin Geomembranes Using Notched Constant Tensile Load Test
ASTM D5596	Standard Test Method for Microscopic Evaluation of the Dispersion of Carbon Black in Polyolefin Geosynthetics
ASTM D5994	Standard Test Method for Measuring Core Thickness of Textured Geomembranes
ASTM D6392	Standard Test Method for Determining the Integrity of Nonreinforced Geomembrane Seams Produced Using Thermo-Fusion Methods
ASTM D6693	Standard Test Method for Determining Tensile Properties of Nonreinforced Polyethylene and Nonreinforced Flexible Polypropylene Geomembranes
ASTM D7240	Standard Practice for Leak Location using Geomembranes with an Insulating Layer in Intimate Contact with a Conductive Layer via Electrical Capacitance Technique (Conductive Geomembrane Spark Test)
GRI GM 13	Test Methods, Test Properties, and Testing Frequency for High Density Polyethylene (HDPE) Smooth and Textured Geomembranes
GRI GM 14	Standard Guide for Selecting Variable Intervals for Taking Geomembrane Destructive Seam Samples Using the Method of Attributes
GRI GM 17	Test Methods, Test Properties and Testing Frequency for Linear Low Density Polyethylene (LLDPE) Smooth and Textured Geomembranes

1.5 QUALITY CONTROL

A. All WORK shall be constructed, monitored and tested in accordance with the requirements of the Installation Contractor's Quality Control Plan (CQP), which shall be submitted in accordance with Paragraph 1.2 B.

B. The CONTRACTOR shall be aware of all activities outlines in the CQP, and the CONTRACTOR shall account for these activities in the construction schedule. No additional costs to the COMPANY shall be allowed by the CONTRACTOR as a result of the performance of the CQP activities.

1.6 QUALITY ASSURANCE

A. The COMPANY shall conduct quality assurance monitoring and testing of the geomembrane installation under the direction of the ENGINEER.

1.7 WARRANTY

A. The CONTRACTOR shall procure and provide copies of the manufacturer's warranty for the geomembrane system and all appurtenances. The warranty shall cover materials for a period of 5 years and workmanship for a period of 1 year from the date of the COMPANY's acceptance of the project. The warranty must specifically include effects of ultraviolet irradiation and the normal wear and aging associated with installation in the environmental conditions similar to eastern Washington. The warranty shall not be prorated, but shall be a full replacement value warranty. Should defects or premature loss of use within the scope of the above warranty occur, repair and/or replacement of damaged material shall be performed by the CONTRACTOR at no cost to the COMPANY.

PART 2 -- PRODUCTS

2.1 SCHEDULE OF GEOMEMBRANES

TABLE 1 – SCHEDULE OF GEOMEMBRANES

Application	Geomembrane
West Water Management Pond Primary and Secondary Liner	60-mil HDPE, Textured (Double Side)
South Water Management Pond Primary and Secondary Liner	60-mil HDPE, Textured (Double Side)
Decontamination Area Pond Liner	60-mil HDPE, Textured (Double Side)
Pit 3/Pit 4 Subwaste Liner	80-mil HDPE, Smooth
Pit 3/Pit 4 Cover Geomembrane	40-mil LLDPE, Textured (Double Side)
Area 5 Cover Geomembrane	40-mil LLDPE, Textured (Double Side)
Mine Waste Dewatering Risers	See Section 02575

2.2 APPROVED GEOMEMBRANE PRODUCTS

A. 60-mil HDPE, Textured (Double Side)

1. GSE HD Textured

2. Agru America HDPE Super Gripnet Liner

B. 80-mil HDPE, Smooth

1. GSE HD Smooth

2. Agru America Smooth HDPE Liner

C. 40-mil LLDPE, Textured (Double Side)

1. GSE UltraFlex Textured

2. Agru America LLDPE Super Gripnet Liner

2.3 "OR EQUAL" PRODUCTS

A. CONTRACTOR shall provide the COMPANY approved geomembrane products listed in Paragraph 2.2, or provide "or equal" products that meet the requirement indicated below.

B. **LLDPE Interface Shear Strength**: LLDPE geomembrane products shall have a minimum interface friction angle of 23 degrees between the LLDPE geomembrane and the geocomposite drainage layer. CONTRACTOR shall provide documentation of interface friction angle testing for review and approval by the ENGINEER.

C. **Materials:** The material shall be black, coextruded high-density polyethylene (HDPE) geomembrane or black, coextruded linear low density polyethylene (LLDPE) geomembrane as listed below and as shown on the Contract Drawings.

D. The geomembrane shall be manufactured from new, first quality resin produced in the United States and shall be compounded and manufactured specifically for producing geomembrane. Natural resin (without carbon black) shall meet requirements listed in Table 2:

TABLE 2 – RESIN PROPERTIES

Property	Test Method	HDPE Value	LLDPE Value
Density (g/cm3)	ASTM D 1505	≥0.932	≤0.926
Melt Flow Index (g/10 min)	ASTM D 1238 (190/2.16)	≤1.0	≤1.0
OIT (minutes)	ASTM D 3895 (1 atm/200^{0}C)	≥100	≥100

Reprocessed materials shall not be acceptable. No post-consumer resin of any type shall be added to the formulation.

E. **Fabrication:** The geomembrane shall have a minimum 20-foot seamless width. The geomembrane shall be supplied in rolls with labels identifying the thickness of material, the length and width of the roll, the lot and roll numbers, and the name of the manufacturer.

F. Properties:

1. The geomembrane shall not exceed a combined maximum total of 1 percent by weight of additives other than carbon black.

2. The geomembrane shall be free of holes, pinholes, bubbles, blisters, excessive contamination by foreign matter, and nicks and cuts on roll edges.

3. The finished product shall be uniform in color, thickness, and surface texture and shall meet the **minimum** average specifications listed in Table 3.

G. Manufacturer Quality Control

1. All resins and additives used in the fabrication of the geomembrane shall be sampled, tested, and approved by the MANUFACTURER before being eligible for use.

2. All roll goods shall be inspected for defects and impurities. Geomembrane thickness shall be measured for each roll.

3. All geomembrane sheets produced at the factory shall be inspected prior to shipment for compliance with the physical property requirements listed in Paragraph 2.1.E and be tested by an acceptable method of inspecting for pinholes. If pinholes are located, identified and indicated during manufacturing, these pinholes may be corrected during installation.

4. The geomembrane shall be tested by the MANUFACTURER for the listed properties provided in the tables in Part 2. A log shall be maintained showing the testing date, time and results. Any rolls not meeting the visual inspection or requirements of the specification shall be rejected.

5. Certification that the material has been inspected, tested, and meets all requirements shall be submitted to the ENGINEER. Test results shall be made available to the ENGINEER upon request.

TABLE 3 – GEOMEMBRANE PROPERTIES

Tested Property	Test Method	Frequency	Minimum Average Value		
			Textured HDPE	Smooth HDPE	Textured LLDPE
Thickness, (minimum average) mil (mm); Lowest individual reading (-10%)	ASTM D 5994	every roll	60 (1.50) 54 (1.35)	80 (2.00) 72 (1.80)	40 (1.00) 36 (0.90)
Density, g/cm^3	ASTM D 1505	200,000 lb	0.94	0.94	0.94
Tensile Properties (each direction) Strength at Yield, lb/in-width (N/mm) Strength at Break, lb/in-width (N/mm) Elongation at Yield, % Elongation at Break, %	ASTM D 6693, Type IV Dumbell, 2 ipm G.L. 1.3 in (33 mm) G.L. 2.0 in (51 mm)	20,000 lb	126 (22) 90 (16) 12 100	168 (29) 304 (53) 12 700	N/A 60 (11) N/A 250
Tear Resistance, lb (N)	ASTM D 1004	45,000 lb	42 (187)	56 (249)	22 (100)
Puncture Resistance, lb (N)	ASTM D 4833	45,000 lb	90 (400)	144 (640)	44 (200)
Carbon Black Content, % (Range)	ASTM D 1603*/4218	20,000 lb	2.0 - 3.0	2.0 - 3.0	2.0 - 3.0
Carbon Black Dispersion	ASTM D 5596	45,000 lb	Note(1)	Note(1)	Note(1)
Asperity Height, mil (mm)	ASTM D 7466	second roll	18 (0.45)	N/A	18 (0.45)
Notched Constant Tensile Load(2), hr	ASTM D 5397, Appendix	200,000 lb	300	300	N/A
Oxidative Induction Time, min	ASTM D 3895, 200° C; O_2, 1 atm	200,000 lb	>100	>100	>100

NOTES:
(1)Dispersion only applies to near spherical agglomerates. 9 of 10 views shall be Category 1 or 2. No more than 1 view from Category 3.
*Modified

PART 3 -- EXECUTION

3.1 STORAGE

A. After delivery, all roll goods shall be stored so as to be protected from puncture, dirt, grease, moisture and excessive heat. Damaged material shall be stored separately for repair or replacement. The rolls shall be stored on a prepared smooth surface and should not be stacked more than two rolls high.

3.2 INSTALLATION

A. **General:** The geomembrane shall be installed in accordance with the following specifications and approved procedures submitted with the shop drawings.

B. Subgrade Preparation and Inspection:

1. Surfaces to be lined shall be smooth and free of all rocks, stones, sticks, roots, sharp objects, or debris of any kind. The surface shall provide a firm, unyielding foundation for the membrane with no sudden, sharp, or abrupt changes or break in grade.

2. The CONTRACTOR shall, on a daily basis, approve the surface on which the geomembrane shall be installed. The surface shall be smooth, clean and free of foreign material, sharp objects, frost, standing water or excessive moisture. Installation shall proceed only if the surface conditions are found satisfactory.

C. Equipment:

1. Welding equipment and accessories shall meet the following requirements:

a. Gauges showing temperatures in apparatus such as extrusion welder or fusion welder shall be present.

b. An adequate number of welding apparati shall be available to avoid delaying work.

c. Power source must be capable of providing constant voltage under combined line load.

D. Deployment:

1. Each panel shall be assigned a simple and logical identifying code.

2. The coding system shall be subject to approval by the ENGINEER and shall be determined at the job site.

3. The CONTRACTOR shall visually inspect the geomembrane during deployment for imperfections and mark faulty or suspect areas.

4. Deployment of geomembrane panels shall be performed in a manner that shall comply with the following guidelines:

a. Geomembranes shall be installed according to site-specific specifications and MANUFACTURER recommendations.

b. The geomembrane shall be placed in such a manner as to assure minimum handling.

c. Only those sheets of material which can be anchored and sealed together that same day shall be unpackaged and placed in position.

d. Deployment of the geomembrane shall proceed between ambient temperatures of 32° F and 104° F. Placement can proceed below 32° F only after it has been verified by the ENGINEER that the material can be seamed according to the specification. Placement shall not be done during any precipitation, in the presence of excessive moisture (fog, rain, dew) or in the presence of excessive winds. In areas where wind is prevalent, installation should be started at the upwind side of the project and proceed downwind. The leading edge of the geomembrane shall be secured at all times with sandbags or other means sufficient to hold it down during high winds.

e. Geomembrane shall be unrolled using methods that shall not damage geomembrane and shall protect underlying surface from damage (spreader bar, protected equipment bucket).

f. Ballast (commonly sandbags) which shall not damage geomembrane shall be placed on geomembrane to prevent wind uplift.

g. Personnel walking on geomembrane shall not engage in activities or wear shoes that could damage it. Smoking shall not be permitted on the geomembrane.

h. Heavy vehicular traffic shall not be allowed directly on geomembrane. Rubber-tired ATV's and trucks are acceptable if wheel contact is less than 8 psi.

i. Geomembrane shall be protected in areas of heavy traffic by placing protective cover over the geomembrane

5. Sufficient material (slack) shall be provided to allow for thermal expansion and contraction of the material.

E. Lining sheets shall be closely fitted and sealed around inlets, outlets, and other projections through the lining. Lining to concrete seals shall be made with a mechanical anchor or as approved by the ENGINEER. All piping, structures, and other projections through the lining shall be sealed with approved sealing methods.

F. Field Seams:

1. Seams shall meet the following requirements:

a. To the maximum extent possible, seams shall be oriented parallel to line of slope, i.e., down and not across slope.

b. The number of field seams in corners, odd-shaped geometric locations and outside corners shall be minimized.

c. Slope seams (panels) shall extend a minimum of five-feet beyond the grade break into the flat area.

d. Be designated using a sequential seam numbering system compatible with panel numbering system, and that is agreeable to the ENGINEER.

e. Seam overlaps shall be aligned to be consistent with the requirements of the welding equipment being used.

2. During welding operations provide at least one Master Seamer who shall provide direct supervision over other welders as necessary.

3. Extrusion Welding

a. Hot-air tack adjacent pieces together using procedures that do not damage the geomembrane.

b. Clean geomembrane surfaces by disc grinder or equivalent.

c. Purge welding apparatus of heat-degraded extrudate before welding.

4. Hot Wedge Welding

a. Welding apparatus shall be a self-propelled device equipped with an electronic controller which displays applicable temperatures.

b. Clean seam area of dust, mud, moisture and debris immediately ahead of hot wedge welder.

c. Protect against moisture build-up between sheets.

5. ~~E.~~ Trial Welds

a. Perform trial welds on geomembrane samples to verify welding equipment is operating properly.

b. Make trial welds under the same surface and environmental conditions as the production welds, i.e., in contact with subgrade and similar ambient temperature.

c. Minimum of two trial welds per day, per welding apparatus, one made prior to the start of work and one completed at mid shift.

d. Cut four, one-inch wide by six-inch long test strips from the trial weld.

e. Quantitatively test specimens for peel adhesion, and then for shear strength.

f. Trial weld specimens shall pass when the results shown in the Table 3 are achieved in both peel and shear test:

TABLE 4 – SEAM PROPERTIES

Property	Test Method	Minimum Values		
		60-mil HDPE	80-mil HDPE	40-mil LLDPE
Peel Strength (fusion) ppi (kN/m) (1), (2)	ASTM D6392	98 (17.2)	130 ()	48 ()
Peel Strength (extrusion) ppi (kN/m) (1), (2)	ASTM D6392	78 (13.7)	104 ()	50 ()
Shear Strength (fusion and ext.) ppi (kN/m)	ASTM D6392	121 (21.2)	162 ()	60 ()

Notes:
1) The break, when peel testing, occurs in the geomembrane material itself, not through peel separation (FTB).
2) The break is ductile.

g. Repeat the trial weld, in its entirety, when any of the trial weld samples fail in either peel or shear.

h. No welding equipment or welder shall be allowed to perform production welds until equipment and welders have successfully completed trial weld.

i. Seaming shall not proceed when ambient air temperature or adverse weather conditions jeopardize the integrity of the geomembrane installation. CONTRACTOR shall demonstrate that acceptable seaming can be performed by completing acceptable trial welds.

j. Defects and Repairs

1) Examine all seams and non-seam areas of the geomembrane for defects, holes, blisters, undispersed raw materials, and any sign of contamination by foreign matter.

2) Repair and non-destructively test each suspect location in both seam and non-seam areas. Do not cover geomembrane at locations that have been repaired until test results with passing values are available.

G. **Anchor Trench:** The geomembrane shall be placed and secured in an earth anchor trench as indicated in the Contract Drawings. The installer shall coordinate with the earthwork contractor regarding excavation and backfilling of the anchor trench. Care shall be taken when backfilling the trenches to prevent any damage to the geomembrane. If damage occurs, it shall be repaired prior to backfilling.

3.3 SEAM TESTING

A. Field Destructive Testing

1. Destructive seam tests shall be performed to evaluate bonded seam strength. The frequency of sample removal shall be one sample per 500 linear feet of seam. Location of the destructive samples shall be selected by the ENGINEER. Field testing shall take place as soon as possible after completion of the seam.

    a. At the sole discretion of the ENGINEER, destructive seam tests may be reduced in frequency by following the procedures of GRI GM 14.

2. Sample labeling shall be the responsibility of the ENGINEER and shall include test number, seam number, seaming machine number, job number, date welded, and welding tech number.

3. The samples shall be approximately 12 inches x 25 inches. The samples shall then be cut into two samples approximately 12 inches x 12 inches: one for field testing and one for archiving or independent testing.

4. The sample for field testing shall have ten coupons cut and be tested with a tensiometer adjusted to a pull rate as shown below. The strength of four out of five specimens shall meet or exceed the values below, and the fifth value must meet or exceed 80% of the value below.

    a. Seam must exhibit film tear bond (FTB). Welds shall have less than 25% incursion into the weld.

    b. Peel and shear values shall meet or exceed the values in Table 4 (at 2 inches/minute)

5. All destructive weld test data shall be logged by the ENGINEER.

6. If a test fails, additional samples shall be cut, approximately ten feet on each side of the failed test, and retested. This procedure shall be repeated until a sample passes. Then the area of the failed seam between the two tests that pass shall be capped or reconstructed.

B. Non-Destructive Testing

1. The CONTRACTOR shall non-destructively test all seams their full length for continuity using an air pressure or vacuum test.

2. Air Pressure Testing

    a. Air pressure testing shall be performed on all seams welded with a double seam fusion welder.

    b. The equipment used for air pressure testing shall consist of an air tank or pump capable of producing a minimum of 35 psi and a sharp needle with a pressure gauge attached to insert into the air chamber.

    c. Both ends of the seam to be tested shall be heated and squeezed together.

    d. The needle with gauge shall be inserted into the air channel and the channel shall be pressurized to 30 psi.

    e. If the pressure in the air channel drops by more than 3 psi over a period of five minutes, then the seam has failed.

f. If the seam fails the air pressure test, the leak shall be located and the area cut away. Air pressure testing shall be performed on the remaining portions of the seam until all portions of the seam pass the test.

g. The area cut away shall be repaired with a patch. The patch shall be tested according to the procedures outlined below for vacuum testing.

3. Vacuum Testing

a. Vacuum testing shall be performed on all seams welded with an extrusion welder.

b. The equipment used for vacuum testing shall consist of a vacuum pumping device, a vacuum box, and a foaming agent in solution.

c. The section of seam to be tested shall be wetted with a foaming agent and the vacuum box shall be placed over the wetted area. Air shall be evacuated from the vacuum box until a seal between the box and the geomembrane has been formed.

d. The minimum vacuum shall be equivalent to 5 psi (10 inches of mercury).

e. If fusion welded seams are being tested, the overlap flap must be cut off prior to testing.

f. The seam shall be observed through the viewing window for bubbles emitting from the seam.

g. If no bubbles are observed, the box shall be moved on to the next area for testing. If bubbles are observed, the area of the leak shall be marked for repair.

h. After completion of repairs, the repair seam shall be retested according to the requirements of paragraph 3.3B.

3.4 INSPECTION AND REPAIR

A. **Field Inspection:** All seals to penetrations as well as all seams and non-seam areas of the geomembrane shall be inspected for defects, holes, blisters, undispersed raw materials, and any sign of contamination by foreign matter. The surface of the geomembrane shall be clean at the time of inspection. Each suspect location shall be non-destructively tested as appropriate and repaired accordingly.

B. Repair Procedures:

1. Remove damaged geomembrane and replace with acceptable geomembrane materials if damage cannot be satisfactorily repaired.

2. Repair any portion of unsatisfactory geomembrane or seam area failing a destructive or non-destructive test.

3. CONTRACTOR shall be responsible for repair of defective areas.

4. Agreement upon the appropriate repair method shall be decided between ENGINEER and CONTRACTOR by using one of the following repair methods:

a. Patching- Used to repair large holes, tears, undispersed raw materials and contamination by foreign matter.

b. Abrading and Re-welding- Used to repair short section of a seam.

c. Spot Welding- Used to repair pinholes or other minor, localized flaws or where geomembrane thickness has been reduced.

d. Capping- Used to repair long lengths of failed seams.

e. Flap Welding- Used to extrusion weld the flap (excess outer portion) of a fusion weld in lieu of a full cap.

f. Remove the unacceptable seam and replace with new material.

5. The following procedures shall be observed when a repair method is used:

a. All geomembrane surfaces shall be clean and dry at the time of repair.

b. Surfaces of the polyethylene which are to be repaired by extrusion welds shall be lightly abraded to assure cleanliness.

c. Extend patches or caps at least 6 inches for extrusion welds and 4 inches for wedge welds beyond the edge of the defect, and around all corners of patch material.

6. Repair Verification

a. Number and log each patch repair (performed by ENGINEER).

b. Non-destructively test each repair using methods specified in this Specification.

7. The CONTRACTOR shall also keep detailed record drawings showing the location, size, type, and frequency of all repairs made during the installation of the geomembrane. These record drawings shall be updated by the CONTRACTOR on a daily basis and submitted to the COMPANY upon completion of the project. Inspection of these record drawings shall be made available to the ENGINEER or the COMPANY for verification and review at any time during the construction period.

3.5 ACCEPTANCE

A. The CONTRACTOR shall retain all ownership and responsibility for the geomembrane system until acceptance by the ENGINEER. Final acceptance shall occur when the following conditions are met:

1. Installation is finished.

2. Verification of the adequacy of all field seams and repairs is complete.

3. Submittals required in Paragraph 1.2 D have been accepted by the ENGINEER.

- END OF SECTION –

SECTION 02273 – RIPRAP

PART 1 -- GENERAL

1.1 SUMMARY

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

ASTM D 5240	Standard Test Method for Testing Rock Slabs to Evaluate Soundness of Riprap by use of Sodium Sulfate or Magnesium Sulfate
ASTM D 5519	Standard Test Methods for Particle Size Analysis of Natural and Man-Made Riprap Materials
ASTM D 6825	Standard Guide for Placement of Riprap Revetments
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. Proposed source of riprap and riprap bedding.

C. Test Certifications 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 TEMPORARY RIPRAP AND FILTER IN CONTAMINATED AREAS

A. Riprap and filter for temporary use within contaminated areas may be processed material from the Hillside Waste Rock Pile or from other suitable sources.

1. South Pond Spillway riprap and filter layers.

2. Other temporary erosion protection within contaminated areas

~~2.1~~2.2 PARTICLES FOR RIPRAP

A. Particles shall be graded in size to produce a reasonably dense mass. Riprap shall consist of dense, natural rock fragments. Rock pieces shall be angular or sub-angular rock fragments with at least 90 percent of the face area freshly broken. Particles 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 particles with shale seams are not acceptable.

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

~~1.~~ Type 0 (3~~-inch Average Size):~~

~~D-*sizes* Percent Passing~~	~~Minimum Diameter (in)~~	~~Maximum Diameter (in)~~
d_{15} 15% Passing	1.0	2.0
d_{50} 50% Passing	3.0	3.5
d_{85} 85% Passing	3.5	4.0
d_{100} 100% Passing	N/A	5.0

~~2.~~1. Type I (6-inch Average Size):

D-*sizes* Percent Passing	**Minimum Diameter (in)**	**Maximum Diameter (in)**
d_{15} 15% Passing	2.5	3.0
d_{50} 50% Passing	5.5	8.0
d_{60} 60% Passing	6.0	9.5
d_{85} 85% Passing	8.0	12.5
d_{100} 100% Passing	NA	14.5

~~3.~~2. Type II (9-inch Average Size):

D-*sizes* Percent Passing	Minimum Diameter (in)	Maximum Diameter (in)
d_{15} 15% Passing	4.7(5)	5.6(6)
d_{50} 50% Passing	9.0	10.8(11)
d_{60} 60% Passing	10.2(10)	12.3(12.5)
d_{85} 85% Passing	13.3(13.5)	16.0
d_{100} 100% Passing	NA	18.2(18)

~~4.~~3. Type III (12-inch Average Size):

D-*sizes* Percent Passing	Minimum Diameter (in)	Maximum Diameter (in)
d_{15} 15% Passing	6.3 (6)	7.5(8)
d_{50} 50% Passing	12.0	14.4 (14.5)
d_{60} 60% Passing	13.6(13.5)	16.4(16.5)
d_{85} 85% Passing	17.7(18)	21.3(21.5)
d_{100} 100% Passing	NA	24.2(24)

4. ~~Type IV (18~~-inch Average Size):

D-*sizes* Percent Passing	Minimum Diameter (in)	Maximum Diameter (in)
~~d_{15} 15% Passing~~	~~11.0~~	~~16.0~~

~~d_{50}~~ ~~50% Passing~~	~~17.0~~	~~21.0~~
~~d_{60}~~ ~~60% Passing~~	~~19.0~~	~~22.5~~
~~d_{85}~~ ~~85% Passing~~	~~23.0~~	~~28.0~~
~~d_{100}~~ ~~100% Passing~~	~~NA~~	~~36.0~~

5. Type V (24-inch Average Size):

D-*sizes* Percent Passing	**Minimum Diameter (in)**	**Maximum Diameter (in)**
d_{15} 15% Passing	15.0	23.0
d_{50} 50% Passing	23.0	28.0
d_{60} 60% Passing	25.0	30.0
d_{85} 85% Passing	31.0	37.0
d_{100} 100% Passing	NA	48.0

~~6. Type VI (30-inch Average Size):~~

~~**D-*sizes* Percent Passing**~~	~~**Minimum Diameter (in)**~~	~~**Maximum Diameter (in)**~~
~~d_{15}~~ ~~15% Passing~~	~~18.0~~	~~26.0~~
~~d_{50}~~ ~~50% Passing~~	~~28.5~~	~~34.5~~
~~d_{60}~~ ~~60% Passing~~	~~31.5~~	~~37.5~~
~~d_{85}~~ ~~85% Passing~~	~~39.0~~	~~46.0~~

~~d_{100}~~ ~~100% Passing~~	~~NA~~	~~60~~

~~7. Type VII (36-inch Average Size)~~

~~**D-*sizes* Percent Passing**~~	~~**Minimum Diameter (in)**~~	~~**Maximum Diameter (in)**~~
~~d_{15}~~ ~~15% Passing~~	~~22.0~~	~~31.0~~
~~d_{50}~~ ~~50% Passing~~	~~34.0~~	~~41.5~~
~~d_{60}~~ ~~60% Passing~~	~~38.0~~	~~45.0~~
~~d_{85}~~ ~~85% Passing~~	~~47.0~~	~~55.5~~
~~d_{100}~~ ~~100% Passing~~	~~NA~~	~~72.0~~

~~8. Type VIII (42-inch Average Size)~~

~~**D-*sizes* Percent Passing**~~	~~**Minimum Diameter (in)**~~	~~**Maximum Diameter (in)**~~
~~d_{15}~~ ~~15% Passing~~	~~26.0~~	~~36.5~~
~~d_{50}~~ ~~50% Passing~~	~~40.0~~	~~48.0~~
~~d_{60}~~ ~~60% Passing~~	~~44.0~~	~~52.5~~
~~d_{85}~~ ~~85% Passing~~	~~55.0~~	~~65.0~~
~~d_{100}~~ ~~100% Passing~~	~~NA~~	~~84.0~~

~~9. Type IX (48-inch Average Size)~~

~~**D-*sizes* Percent Passing**~~	~~**Minimum Diameter (in)**~~	~~**Maximum Diameter (in)**~~
~~d_{15} 15% Passing~~	~~29.0~~	~~42.0~~
~~d_{50} 50% Passing~~	~~46.0~~	~~55.0~~
~~d_{60} 60% Passing~~	~~51.0~~	~~60.0~~
~~d_{85} 85% Passing~~	~~62.0~~	~~74.0~~
~~d_{100} 100% Passing~~	~~NA~~	~~96.0~~

~~10. Type X - Drain Rock (2-inch Average Size)~~

~~**D-*sizes* Percent Passing**~~	~~**Minimum Diameter (in)**~~	~~**Maximum Diameter (in)**~~
~~d_{15} 15% Passing~~	~~1.0~~	~~1.5~~
~~d_{50} 50% Passing~~	~~1.8~~	~~2.2~~
~~d_{60} 60% Passing~~	~~2.5~~	~~2.8~~
~~d_{85} 85% Passing~~	~~3.0~~	~~3.8~~
~~d_{100} 100% Passing~~	~~NA~~	~~4.0~~

C. The greatest dimension of 50 percent of the particles 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. Particles shall consist of durable, sound, hard, angular rock meeting the following requirements for durability absorption ratio, soundness test, and abrasion test:

Characteristics Test	Criterion	Standard
Sodium Sulfate Soundness	<10% weight loss after 5 cycles	ASTM D5240
Bulk Specific Gravity	≥2.5	ASTM C127
Absorption	≤ 2%	ASTM C127
Durability Index	≥ 51	ASTM C127
Durability Adsorption Ratio	≥ 10	ASTM C127
Hardness	Hardest available (comparative)	ASTM D5873
LA Abrasion Durability	≤ 20% loss	ASTM C535
Point Load Index Strength	Hardest available (comparative)	ASTM D5731

E. 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.

F. The acceptability of the stones and gradation will be determined by the ENGINEER prior to placement. Any difference of opinion between the ENGINEER and the CONTRACTOR shall be resolved by dumping and checking the gradation of two random truckloads of particles. Arranging for and the costs of mechanical equipment, a sorting site, and labor needed in checking particles and gradation shall be the CONTRACTOR's responsibility.

2.3 RIPRAP FILTER FABRIC

~~2.2~~ RIPRAP FILTER FABRIC ~~GEOCOMPOSITE DRAINAGE LAYER~~

~~A. Geocomposite drainage layer shall conform to the requirements of Section 02275 – Geonet.~~

~~2.3 GEOMEMBRANE~~

~~A. Geomembrane shall conform to the requirements of Section 02272 – Geomembranes.~~

~~2.4 GEOTEXTILE~~

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

~~2.5~~2.4 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 uniformly graded and shall conform to the following gradation:

1. Type I

Size	Percentage Passing
¼-inch	70-100
No. 4	50-100
No. 7	25-55
No. 16	0-15

2. Type II

Size	Percentage Passing
2-inch	80 – 100
1 1/4-inch	35-100
1-inch	20-70
¾-inch	5-45
½-inch	0-15

3. Type III

Size	Percentage Passing
3-inch	70-100
2-inch	40-70
½-inch	0-15

~~2.6~~2.5 SURFACE PREPARATION

A. Surfaces to receive riprap shall be smooth and firm, free of brush, trees, stumps, and other objectionable material identified by the ENGINEER, 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 geomembrane, the surface shall be prepared to a smooth condition free of debris, depressions, or obstructions which may damage the geomembrane. The geomembrane 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 geomembrane

shall be anchored using key trenches or aprons at the crest and toe of the slope. In no instance shall the geomembrane be left exposed to sunlight longer than 7 –days. Overexposed geomembrane shall be removed and replaced.

~~2.7~~2.6 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 relative density. The finished grade shall be even, self-draining, and in conformance with the slope of the finished grade.

B. Filter material shall be placed, spread, and compacted in lifts of a minimum of 6-inches. Where filter material is indicated to be 12-inches thick or greater, lift placement shall not 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.

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

~~2.8~~2.7 PLACEMENT OF RIPRAP

A. Placement of riprap shall begin at the toe of the slope and proceed up the slope. The particles may be placed by dumping and may be spread by bulldozers, excavators, or other suitable equipment as long as the underlying material is not displaced. Particles shall be placed so as to provide a minimum of voids. Smaller particles 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. Provide laborers during placement for rearrangement of loose rock fragments, ”chinking” of void spaces and hand placement as necessary to create a well-keyed and stable layer of rock riprap.

C. Where riprap is placed over a GCL or Geotextile, the riprap shall be placed so as to avoid damage to the GCL or Geotextile. Particles shall not be dropped from a height greater than 3-feet, nor shall large particles be allowed to roll downslope.

~~2.9~~2.8 GROUTED RIPRAP

A. After wetting the riprap, the remaining volume of the interstices shall be filled with a well-mixed, relatively high slump grout composed of 1 part Portland cement and 3 parts of sand, mixed to a workable consistency. The grout shall be injected using a grout pipe. 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 -

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SECTION 02274 - GEOTEXTILES

PART 1 -- GENERAL

1.1 SUMMARY

A. The CONTRACTOR shall provide and install geotextiles as shown on the Drawings.

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 4354	Standard Practice for Sampling of Geosynthetics for Testing ASTM D 4595 Standard Test Method for Tensile Properties of Geotextiles by the Wide-Width Strip Method
ASTM D 4632	Standard Test Method for Grab Breaking Load and Elongation of Geotextiles

ASTM D 4751	Standard Test Method for Determining Apparent Opening Size of a Geotextile
ASTM D 4759	Standard Practice for Determining the Specifications Conformance of Geosynthetics
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)
ASTM D 5261	Standard Test Method for Measuring Mass per Unit Area of Geotextiles

1.3 CONTRACTOR SUBMITTALS

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

B. Prior to material delivery to project site, the CONTRACTOR shall provide the ENGINEER with a written certification or manufacturers quality control data which displays that the geotextile meets or exceeds minimum average roll values (MARV) specified herein.

PART 2 -- PRODUCTS

2.1 NONWOVEN GEOTEXTILE

A. 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.

B. 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.

C. **Minimum Nominal Weight per Square Yard:**

Application	**Geotextile~~Geomembrane~~**
Liner Cushion (Pit 3 ~~Subwaste~~ and Pit 4)~~Sump Liner Cushions~~	32 oz/sy
Riprap Filter Fabric and Drainage Channel Applications~~Pit 4 Subwaste Sump and Liner Cushions~~	16~~24~~ oz/sy
~~Waste Rock Dewatering Sump~~ Drain Gravel/Overliner Protection Separation Fabric (Pit 3 and Pit 4 Waste Rock Dewatering Sump)	8 oz/sy

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

E. **Unseamed Sheet Width:** Minimum 12-feet.

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

Tested Property	Test Method	Frequency	MARV		
			32 oz/sy	16~~24~~	8 oz/sy
Mass per Unit Area, oz/sy	ASTM D 5261	90,000 sf	32	16~~24~~	8
Grab Tensile Strength	ASTM D 4632	90,000 sf	600	390~~500~~	220
Grab Elongation, %	ASTM D 4632	90,000 sf	50	50	50
CBR Puncture Strength, lb	ASTM D 6241	90,000 sf	2,287	1,125~~720~~	575
Trapezoidal Tear Strength, lb	ASTM D 4533	90,000 sf	270	150~~200~~	90
UV Resistance, % retained after 500 hrs	ASTM D4355	90,000 sf	70	70	70
Apparent Opening Size, Sieve No. (mm)	ASTM D 4491	540,000 sf	N/A	100 (0.150)~~N/A~~	80 (0.180)
Water Flow Rate, gpm/sf	ASTM D 4491	540,000 sf	N/A	45~~N/A~~	95
Permitivity, sec^{-1}	ASTM D 4491	540,000 sf	N/A	0.60~~N/A~~	1.30

2.2 SEWING THREAD

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

2.3 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. Geotextile shall not be placed prior to obtaining ENGINEER's approval of the underlying surface.

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 the 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 approval of the geotextile installation from the ENGINEER.

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. Place geotextile in a way that will completely envelop granular drain 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.

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

3.8 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.

3.9 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. Secure patches with pins and washers, as indicated above for securing geotextile, or by other means approved by ENGINEER.

3.10 REPLACING CONTAMINATED GEOTEXTILE

A. Protect geotextile from contamination that would interfere with its intended function. Remove and replace contaminated geotextile with clean geotextile as directed by ENGINEER.

- END OF SECTION –

SECTION 02280 – GEOCOMPOSITE DRAINAGE LAYERS

PART 1 -- GENERAL

1.1 THE REQUIREMENT

A. The CONTRACTOR shall supply all labor, equipment, materials, and appurtenances for the complete installation of geocomposite drainage layers (GDL) as per contract documents.

B. Sufficient GCDL material shall be furnished to cover all lined areas, including seam overlaps and anchor trenches as shown on the Drawings. One percent shall be added to the length of each panel to allow for shrink and wrinkles. The GCDL shall be installed in a relaxed condition and shall be free of tension or stress upon completion of the installation.

1.2 SUBMITTALS

A. Prior to ordering geonet material, the CONTRACTOR shall submit the following for the ENGINEER's approval:

1. Certification stating that the geonet meets the specification requirements.

2. Certification or manufacturers quality control data which displays that the geotextile meets or exceeds minimum average roll values (MARV) specified herein.

3. Four 8-inch x 10-inch samples of the material proposed.

4. A Statement of Qualifications for the manufacturer and installation contractor with sufficient detail to satisfy the experience requirements of Paragraph 1.3.

B. Placement of geocomposite material shall not commence until the submittals required in Paragraph 1.2 A have been approved by the ENGINEER.

C. Upon completion of installation, the CONTRACTOR shall submit the following:

1. Certificate stating the GDL has been installed in accordance with the Contract Documents.

2. Material and installation warranties

1.3 QUALIFICATIONS

A. **Qualifications of Manufacturer:** The manufacturer shall have at least five years continuous experience in manufacturing polyethylene geocomposite materials and/or experience totaling not less than 10 million square feet of manufactured polyethylene geonet.

1. The following manufacturers are approved by the COMPANY:

a. GSE Environmental

B. **Qualifications of Installation Contractor:** The installation contractor shall be the manufacturer or a dealer trained to install the manufacturer's material and shall have

experience of not less than 3 projects and not less than 200,000 square feet of successfully installed polyethylene geocomposite materials.

1.4 REFERENCE SPECIFICATIONS, CODES AND STANDARDS

ASTM D 1238	Standard Test Method for Melt Flow Rates of Thermoplastics by Extrusion Plastometer
ASTM D 1505	Standard Test Method for Density of Plastics by the Density-Gradient Technique
ASTM D 1603	Standard Test Method for Carbon Black in Olefin Plastics
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 D4716	Standard Test Method for Determining the (In-Plane) Flow Rate Per Unit Width and Hydraulic Transmissivity of a Geosynthetic Using a Constant Head
ASTM D 4751	Standard Test Method for Determining Apparent Opening Size of a Geotextile
ASTM D 4759	Standard Practice for Determining the Specifications Conformance of Geosynthetics
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)
ASTM D 5261	Standard Test Method for Measuring Mass per Unit Area of Geotextiles

A. Relevant publications from the Environmental Protection Agency (EPA):

Daniel, D.E. and R.M. Koerner, (1993), Technical Guidance Document: Quality Assurance and Quality Control for Waste Containment Facilities, EPA/600/R-93/182.

1.5 QUALITY ASSURANCE

A. All resins and additives used in the fabrication of the geonet shall be sampled, tested, and pass a pre-approval process before being eligible for use. All roll goods shall be inspected for defects and impurities. A log shall be maintained showing the testing date,

time and results. Any rolls not meeting the visual inspection or requirements of the specification shall be rejected. Certification that the material has been inspected, tested, and meets all requirements as well as test results shall be made available to the ENGINEER upon request.

1.6 WARRANTY

A. The CONTRACTOR shall procure and provide copies of the manufacturer's warranty for the geocomposite. The warranty shall cover materials for a period of 5 years and workmanship for a period of 1 year from the date of the COMPANY's acceptance of the project. The warranty must specifically include effects of ultraviolet irradiation and the normal wear and aging associated with installation in the environmental conditions similar to eastern Washington. Unless otherwise stated, the warranty shall not be prorated but shall be a full replacement value warranty. Should defects or premature loss of use within the scope of the above warranty occur, repair and/or replacement of damaged material shall be performed at no cost to the COMPANY.

PART 2 -- PRODUCTS

2.1 GEOCOMPOSITE

A. The geocomposite shall be double geotextile sided and shall meet the following requirements:

PROPERTY	TEST METHOD	TESTING FREQUENCY	VALUE
Transmissivity, gal/min/ft (m^2/sec)	ASTM D4716	1/1,000,000 ft^2	4.3 (9 x 10^{-4})
Melt Flow Index (g/10 min)	ASTM D1238	Once Per Resin Lot	≤ 1.0

2.2 GEONET CORE

A. **Materials:** The material shall be high-density polyethylene (HDPE) geonet as shown on the Drawings.

B. The geonet shall be manufactured from new first quality, compounded polyethylene resin. Natural resin (without carbon black) shall meet the following requirements:

PROPERTY	TEST METHOD	TESTING FREQUENCY	VALUE
Density (g/cm3)	ASTM D1505	Once Per Resin Lot	>0.94
Melt Flow Index (g/10 min)	ASTM D1238	Once Per Resin Lot	≤ 1.0

C. **Properties:**

1. The geonet shall be manufactured by extruding two crossing strands to form a bi-planar drainage net structure.

2. The geonet shall have properties that meet or exceed the values listed in the following table:

PROPERTY	TEST METHOD	MINIMUM FREQUENCY	MINIMUM AVERAGE VALUE
Transmissivity, gal/min/ft (m^2/sec)	ASTM D4716	1/1,000,000 ft^2	38.6 (8 x 10^{-3})
Density g/cm^3	ASTM D1505	1/50,000 ft^2	0.94
Tensile Strength (MD), lb/in (N/mm)	ASTM D5035/7179	1/50,000 ft^2	75 (13.3)
Carbon Black Content, %	ASTM D1603/4218	1/50,000 ft^2	2.0

2.3 GEOTEXTILE

A. 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.

B. 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.

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

Tested Property	Test Method	Frequency	MARV
			8 oz/sy
Mass per Unit Area, oz/sy	ASTM D 5261	90,000 sf	8
Grab Tensile Strength	ASTM D 4632	90,000 sf	220
Grab Elongation, %	ASTM D 4632	90,000 sf	50
CBR Puncture Strength, lb	ASTM D 6241	90,000 sf	575
Trapezoidal Tear Strength, lb	ASTM D 4533	90,000 sf	90
UV Resistance, % retained after 500 hrs	ASTM D4355	90,000 sf	70
Apparent Opening Size, Sieve No. (mm)	ASTM D 4491	540,000 sf	80 (0.180)
Water Flow Rate, gpm/sf	ASTM D 4491	540,000 sf	95
Permitivity, sec^{-1}	ASTM D 4491	540,000 sf	1.30

2.4 APPROVED PRODUCTS:

1. GSE, FabriNet 300 mil, double sided

2. Agru America 300-mil Geocomposite

~~2.~~3. Or Equal.

PART 3 -- EXECUTION

3.1 STORAGE

A. After delivery, all roll goods shall be stored so as to be protected from puncture, dirt, grease, moisture and excessive heat. Damaged material shall be stored separately for repair or replacement. The rolls shall be stored on a prepared smooth surface and should not be stacked more than two rolls high.

3.2 INSTALLATION

A. **General:** The geocomposite shall be installed in accordance with the following specifications and approved procedures submitted with the shop drawings.

B. **Inspection:**

1. Prior to implementing any of the work in the Section to be covered with geocomposite, the CONTRACTOR shall carefully inspect the installed work of all other Sections and verify that all work is complete to the point where the installation of the Section may properly commence without adverse impact.

2. If the CONTRACTOR has any concerns regarding the installed work of other Sections, he shall notify the ENGINEER.

C. **Material Placement:**

1. The geonet roll shall be installed in the direction of the slope and in the intended direction of flow unless otherwise specified by the ENGINEER.

2. If the project contains long, steep slopes, special care should be taken so that only full length rolls are used at the top of the slope.

3. In the presence of wind, all geocomposites shall be weighted down with sandbags or the equivalent. Such sandbags shall be used during placement and remain until installation of geomembrane liner necessitates removal of the sandbags.

4. The geocomposite shall be properly anchored to resist sliding. Anchor trench compacting equipment shall not come into direct contact with the geocomposite.

D. **Seams and Overlaps:**

1. Each component of the geocomposite shall be secured to the like component at overlaps.

2. Adjacent edges along the length of the geocomposite roll shall be placed with the edges of each geonet butted against each other.

3. The overlapped edges shall be joined by tying the geonet structure with plastic cable ties. These ties shall be spaced every 5 feet along the roll length.

4. Adjoining rolls across the roll width should be shingled down in the direction of the slope, with the geonet portion of the top overlapping the geonet portion of the bottom geocomposite a minimum of 12-inches across the roll width and joined together with cable ties spaced every 6-inches along the roll width.

E. **Anchor Trench:** The geocomposite net shall be placed and secured in an earth anchor trench as shown on the Drawings. Care shall be taken when backfilling the trenches to prevent any damage to the geocomposite. If damage occurs, it shall be repaired prior to backfilling.

3.3 INSPECTION AND REPAIR

A. **Repair Procedures:**

1. Prior to covering the deployed geocomposite, the geocomposite shall be inspected for damage resulting from construction and approved by the ENGINEER.

2. Any rips, tears or damaged areas on the deployed geocomposite shall be removed and patched. The patch shall be secured to the original geocomposite by tying every 6 inches with the approved tying devices. If the area to be repaired is more than 50 percent of the width of the panel, the damaged area shall be cut out and the two portions of the geocomposite shall be joined in accordance with Paragraph 3.2.D.

- END OF SECTION –

SECTION 02567 - CORRUGATED PIPE

PART 1 -- GENERAL

1.1 SUMMARY

A. The CONTRACTOR shall provide corrugated metal and HDPE pipe and appurtenant WORK, complete in place, in accordance with the Contract Documents.

B. Corrugated ~~metal~~ pipe shall include round pipe, round stand-pipe, pipe arch, and underdrain pipe, ~~corrugated HDPE, corrugated steel and corrugated aluminum, coated and uncoated,~~ with or without a paved invert, and including fittings, couplings, stand-pipe lids, and related accessories

~~B.~~C. Corrugated metal pipe shall include corrugated steel.

1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. The following standards are referenced in this Section:

AASHTO M-36	Specification for Corrugated Steel Pipe, Metallic-Coated
~~AASHTO M-196~~	~~Specification for Corrugated Aluminum Pipe~~ for Sewers and Drains
AASHTO M-252 Type C	Specification for Corrugated High Density Polyethylene (3" - 10") single wall w/ plain ends for downdrains
AASHTO M-252 Type S	Specification for Corrugated High Density Polyethylene (3" - 10") double wall, w/ plain end "soil tight" or bell/spigot "water tight" ends for sewers and drains
AASHTO M-294 Type C	Specification for Corrugated High Density Polyethylene (12" - 24") single wall w/ plain ends for downdrains
AASHTO M-294 Type S	Specification for Corrugated High Density Polyethylene (12" - 48") double wall, w/ plain end "soil tight" or bell/spigot "water tight" ends for sewers and drains
ASTM D2321	Installation of HDPE
ASTM D3212	Water-tight Joint Testing Specification
ASTM D3350	HDPE Resin Specification
ASTM F477	Gasket Specification

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

A. Corrugated steel pipe and coupling bands and fittings for each type, shall conform to the requirements of AASHTO M-36, and shall be fabricated from zinc-coated steel sheet with nominal size as indicated in the Drawings.

B. Requirements: Unless otherwise indicated, Corrugated metal pipe shall meet the following requirements:

1. Type of pipe: Circular

2. Pipe material: Steel

3. If steel, type of coating: Zinc

4. Size: As Indicated

5. Wall thickness: 0.064-inch (16 gage) ~~diameter~~

6. Corrugation dimension: 2-2/3" x ½" for pipe less than 48-inch diameter; 3"x1" for pipe 48-inch diameter or greater,"~~,~~ or as otherwise indicated

7. Fittings and bends shall be manufacturer standard products.

2.2 CORRUGATED HDPE PIPE

A. M252 Type C and Type S Pipes

1. Corrugated Polyethylene drain pipe, couplings and fittings shall meet the requirements of AASHTO M 252 Type C (Single Wall - corrugated both inside and outside w/ plain ends) or Type S (Double Wall - corrugated outer wall and smooth inner liner). The maximum size pipe shall be 10" in diameter.

2. HDPE pipe with plain ends and split couplers shall meet the requirements of "soil tight".

3. HDPE pipe with Bell & Spigot ends shall meet the requirements of ASTM D3212 water tight joint testing specification (10.8 psi).

4. Fittings and bends shall be manufacturer standard products.

B. M294 Type C and Type S Pipes

1. Corrugated Polyethylene drain pipe, couplings and fittings shall meet the requirements of AASHTO M 252 Type C (Single Wall - corrugated both inside and outside w/ plain ends) or Type S (Double Wall - corrugated outer wall and smooth inner liner). Pipe diameter shall be 12" through 48".

2. HDPE pipe with plain ends and split couplers shall meet the requirements of "soil tight".

3. HDPE pipe with Bell & Spigot ends shall meet the requirements of ASTM D3212 water tight joint testing specification (10.8 psi).

4. Fittings, ~~and~~ bends, and end sections shall be manufacturer standard products.

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 6~~8~~ inches under the pipe, unless otherwise indicated.

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. Pipe bends shall be located and installed as to not produce excessive strain on connected sections. 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. 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.

G. End sections shall be installed in a careful workmanship like manner. The strap or rod shall be securely tightened around the pipe. The toe wall shall be placed in narrow trench. The invert of the end section shall be supported evenly by the bedding. The alignment of the end section shall match that of the pipe. The installation shall be completed by proper compaction of the backfill around the end section.

- END OF SECTION –

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SECTION 02594 – HIGH DENSITY POLYETHYLENE PIPE

PART 1 -- GENERAL

1.1 SUMMARY

A. The CONTRACTOR shall provide high density polyethylene (HDPE) pressure and non-corrugated drain pipe, complete and in place, in accordance with the Contract Documents.

B. Pipe sizing and pressure rating were calculated based on the final alignments. Contractor shall verify that sizing shown in the drawings is adequate for the temporary system throughout the project.

1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

PPI	Handbook of Polyethylene Pipe – 2009 (2ndEdition)
PPI TR 33	Generic Butt Fusion Joining Procedure for Field Joining of Polyethylene Pipe
PPI TN-42	Recommended Minimum Training Guidelines for PE Pipe Butt Fusion Joining Operators for Municipal and Industrial Projects (2009)
AWWA C906	Polyethylene (PE) Pressure Pipe and Fittings, 4 In Through 63 In, for Water Distribution and Transmission
AWWA M55	Manual of Water Supply Practices, PE Pipe–Design and Installation
ASTM F 2620	Heat Fusion Joining of Polyethylene Pipe and Fittings
ASTM D 3350	Polyethylene Plastics Pipe and Fittings Materials

1.3 CONTRACTOR SUBMITTALS

A. CONTRACTOR shall provide initial system layout and sizing to the ENGINEER for review and modifications shall be reviewed by the field engineer.

~~A.~~B. Furnish Shop Drawings of pipe, fittings, and appurtenances in accordance with Section 01300 - Contractor Submittals.

~~B.~~C. **Certifications:** Furnish a certified affidavit of compliance for pipe and other products or materials furnished under this Section:

1. Hydrostatic proof test reports.
2. Sustained pressure test reports.
3. Burst strength test reports.

~~C.~~D. Expenses incurred in making samples for certification of tests shall be borne by the CONTRACTOR as part of the WORK.

~~D.~~E. CONTRACTOR shall submit field fusing reports at the end of each week.

~~E.~~F. CONTRACTOR shall submit in writing a pipeline pressure testing plan and schedule, including methods for water source, water conveyance, sequence, control, and disposal. The testing plan shall be subject to review and approval by the ENGINEER.

~~F.~~G. CONTRACTOR shall submit a Marine Installation Plan for marine installation of the effluent pipeline outfall in Lake Roosevelt in accordance with Section 01XXX – Marine Installation Requirements. This plan shall be submitted a minimum of 60 days in advance of commencement of any excavation or work adjacent to or within Lake Roosevelt.

~~G.~~H. CONTRACTOR shall submit a Construction Dewatering Plan in accordance with Section 02140 – Dewatering and Control of Water.

1.4 QUALITY ASSURANCE

A. Each manufacturer shall have an approved in-house QA/QC program for compliance to the testing specifications and requirements of AWWA C906 for both pipe and fittings.

B. **Inspection:** Pipe shall be subject to inspection at the staging area 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 start date not less than 14 calendar days prior to the start of any phase of manufacture.

C. During manufacture of the pipe, the ENGINEER shall be given access to areas where manufacturing is in process to confirm compliance with the Specifications.

D. **Tests:** Except as modified herein, materials used in the manufacture of the pipe shall be tested in accordance with the requirements of this Section and in the referenced standards, as applicable.

E. The CONTRACTOR shall perform said material tests in accordance with the requirements of the Contract Documents. The ENGINEER shall have the right to witness testing conducted by the CONTRACTOR, provided that the CONTRACTOR'S schedule will not be delayed for the convenience of the ENGINEER.

F. In addition to those tests specifically required, the ENGINEER may request additional samples of any material for testing by the COMPANY. The additional samples shall be furnished as part of the WORK.

PART 2 -- PRODUCTS

2.1 GENERAL

A. **Scope:** The pipe shall meet the specifications and requirements of AWWA C 906. Pipe shall be in iron pipe sizes (IPS).

B. **Materials:** 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.

C. **Non-Corrugated HDPE Drain Pipe** shall have a wall thickness of DR 19.0 or thicker. Pipe shall be provided in laying lengths of 40-ft standard. Perforations or slots shall conform to the design drawings.

D. **Pipe and Fittings:** Pipe supplied shall have the Iron Pipe Size (IPS) OD shown below and shall meet ASTM D 3350. Laying lengths shall be 40-ft standard. Molded and fabricated fittings shall have the same OD, pressure and SDR ratings as the pipe. All molded fittings shall be manufactured per ASTM D3261.

Pipe SDR Sizing	Minimum Pressure Rating (PSI)
9	200
11	160
17	100
26	65

E. **Joints:** The pipe shall be joined by the butt fusion procedure outlined in ASTM F 2620 or PPI TR-33. All fusion joints shall be made in compliance with the pipe or fitting manufacturer's recommendations. Fusion joints shall be made by qualified fusion technicians per PPI TN-42.

F. **Mechanical:** Mechanical connection of HDPE to auxiliary equipment such as valves, pumps, and fittings shall use mechanical joint adapters, HDPE flange adapters with stainless steel back-up rings, or other devices as specified on the drawings and shall be in conformance with the PPI Handbook of Polyethylene Pipe, Chapter 9 and AWWA Manual of Practice M55, Chapter 6. Mechanical coupling shall be made by qualified technicians. Qualification of the field technician shall be demonstrated by evidence of mechanical coupling training within the past year. This training shall be on the equipment and pipe components to be utilized for this project

G. **Marking:** Pipe and fittings shall be marked as prescribed by AWWA C906 and NSF. Pipe markings shall include nominal size, OD base (i.e.: 12-inch ductile iron pipe sizing, DIPS), dimension ratio, pressure class, AWWA C906, manufacturer's name, manufacturer's production code including day, month, and year extruded, manufacturer's plant and extrusion line, and NSF - pw logo.

2.2 PIPE MARKING

A. The pipeline shall be marked with detectable identification tape in accordance with Section 02200.

PART 3 -- EXECUTION

3.1 GENERAL

A. 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 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.

C. Excavation shall be performed prior to the preparation of Shop Drawings for connections and before the fabrication and installation of the pipe.

3.2 HANDLING AND STORAGE

A. **Handling:** Pipe, fittings, and accessories shall be carefully inspected before and after installation and those found defective will be rejected. Pipe and fittings shall be free from fins and burrs. Before placing in position, clean pipe, fittings, and accessories, and maintain them in a clean condition. Proper methods shall be used 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 the pipe. Pipe shall be stored in such a way as to prevent sagging or bending, and it shall be protected from exposure to direct sunlight by covering with an opaque material that allows 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 Section 02200 - Earthwork.

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, a COMPANY'S representative, the ENGINEER'S representative, and any other personnel chosen by the COMPANY. The 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.

C. The fusion machine used in the joining of the pipe shall incorporate a data logging device that records information related to each individual joint for the construction of the entire pipeline. The recorded information shall include at least the date and time of the fusion, the employee ID of the machine operator, the machine ID, the machine model, the piston area, pipe material, pipe size, the interfacial pressures (including heat, soak, fuse, cool), recommended gauge pressures (including heat, soak, fuse, cool), drag pressure, data logger probe temperature, and the external probe temperature.

3.5 INSTALLATION

A. Trench shall be graded in straight lines, taking care to avoid 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. Segments of pipe having cuts or gouges in excess of 10% of the wall thickness of the pipe shall be cut out and removed.

C. Pipe shall be cut by means of saws, power driven abrasive wheels, pipe cutters, or other manufacturer recommended methods that will produce a clean, square cut.

D. Pipe shall be supported uniformly and firmly at its proper elevation. Wood support blocking will not be permitted. The full length of each section of pipe and fittings shall rest solidly on the soil, with recesses to accommodate joints and couplings. Anchors and supports shall be provided where necessary and where indicated for fastening WORK into place. Fittings shall be independently supported.

E. 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 shall be replaced.

F. 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.

3.6 PNEUMATIC TESTING OF PIPELINES

A. Pneumatic (compressed air) leakage testing of pressure system HDPE piping is prohibited for safety reasons.

3.7 HYDROSTATIC TESTING OF PIPELINES

A. All pipelines shall be tested. All testing operations shall be performed in the presence of the ENGINEER.

B. All test equipment, plugs, temporary valves, bulkheads, and other water control equipment, shall be as determined by the CONTRACTOR to accomplish the testing. No materials shall be used which would be injurious to the WORK.

C. Water for testing pipelines shall be furnished by the CONTRACTOR:

1. Utilize treated effluent water from the on-site water treatment plant for pressure testing of pipelines.

D. Disposal of testing water shall be by methods acceptable to the ENGINEER and in accordance with all permit requirements.

E. Prior to hydrostatic testing, pipelines shall be flushed or blown out as appropriate.

F. The CONTRACTOR shall test pipelines in sections as defined by isolation valves or manholes. Where isolation valves or manholes do not exist, pipeline shall be tested in sections of 2500 LF maximum.

G. The CONTRACTOR shall install temporary bulkheads or plugs for the purpose of testing when isolation valves are not present. The test shall be made by closing valves, of placing bulkheads or plugs and filling the line slowly with water. The CONTRACTOR shall be responsible for ascertaining that test bulkheads are suitably restrained to resist the thrust of the test pressure without damage to or movement of the adjacent pipe. Unharnessed sleeve-type couplings, expansion joints, or other sliding joints shall be restrained or suitably anchored prior to the test to avoid movement and damage to piping and equipment. Remove or protect any pipeline-mounted devices that may be damaged by the test pressure. The CONTRACTOR shall provide sufficient temporary tappings in the bulkhead fittings to allow for trapped air to exit. Care shall be taken that air relief valves are open during filling.

H. The upper most test segment of the pipeline shall be filled and tested first. Water from the first test segment may be transferred to the next lowest test segment and so on until all segments have been tested. The CONTRACTOR shall be responsible for providing all temporary piping and valves necessary to transfer water from one test segment to another.

I. The pipeline shall be filled at a rate which will not cause any surges or exceed the rate at which the air can be released through the release valves at a reasonable velocity. The air within the pipeline shall be allowed to escape completely. Visible leaks that appear during filling shall be repaired in a manner acceptable to the ENGINEER.

J. **Initial Expansion Phase**: After the pipeline or section thereof has been filled, gradually pressurize the test section to test pressure, and maintain test pressure for three (3) hours. Add water to restore the test pressure if the pressure decreases 5 psi below test pressure during the initial expansion phase. It is not necessary to monitor the amount of water added during the initial expansion phase.

K. **Test Phase**: Immediately following the initial expansion phase, reduce test pressure by 10 psi, and stop adding test liquid. If test pressure remains within 5% of the target value for one (1) hour, no leakage is indicated.

L. The total time for initial pressurization and time at test pressure shall not exceed eight (8) hours. If the test is not completed within this time, the test section shall be depressurized for at least eight (8) hours before repeating the test.

M. In the case of pipelines that fail to pass the leakage test, the CONTRACTOR shall determine the cause of the leakage, shall take corrective measures necessary to repair the leaks, and shall again test the pipeline, repeating as necessary until the pipeline passes.

3.8 TEST PRESSURES

A. The test pressure for piping shall be as indicated measured at the lowest point of the pipeline section being tested.

B. Pressure pipelines shall be hydrostatically tested at 1.5 times the working pressure for a pressure system.

C. The test pressure for gravity draining pipe shall be at least 5 ft of head pressure above the highest point in the system. If the pipeline is tested in sections, then the test pressure in all sections shall equal 5 feet plus the differential elevation between the section being tested and the highest point in the system.

- END OF SECTION -

SECTION 02831 – CHAIN LINK FENCING AND GATES

PART 1 -- GENERAL

1.1 THE REQUIREMENT

The CONTRACTOR shall design, furbish,~~provide~~ and install chain link fencing, gates and appurtenances as indicated~~shown~~ on the Drawings in accordance with the Contract Documents.

Chain link fencing, gates, accessories, fittings, and fastenings shall be products of a single manufacturer.

1.2 CONTRACTOR SUBMITTALS

General: Furnish submittals in accordance with Section 01300 - Contractor Submittals.

Shop Drawings

Manufacturer's technical data, product specifications, standard details, certified product test results, installation instructions and general recommendations.

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.

PART 2 -- PRODUCTS

2.1 FENCE CONFIGURATIONS

Existing Site Perimeter Security Fence

New fence segments, replacement fence segments, and new gates shall match the height and configuration of the existing fence and gates.

New gates installed at access road and haul road locations shall provide an equivalent level of security from unauthorized vehicle and personnel access as the existing perimeter fence. Gate configurations shall be determined by the CONTRACTOR and approved by the ENGINEER.

CSZ Fencing

New fence installed for the CSZ shall have a height of 6 feet. Gates shall be chain-link, lockable, swing-gates conforming to the requirement of this section.

Barbed wire top is not required for new CSZ fencing.

Interim Fencing and Water Management Pond Fencing

Perimeter fencing for water management ponds shall have a height of 8 feet. Gates shall be chain-link, lockable, swing-gates, conforming to the requirements of this section.

Barbed wire top is not required for water management pond fencing.

~~2.1~~2.2 GENERAL

Dimensions indicated herein for roll-formed pipe and H-sections are outside dimensions, excluding coatings.

Fence fabric height shall be the same as existing chain link fence on the site.

Fencing materials shall be hot-dip galvanized after fabrication.

Fencing shall be topped with 3 lines of barbed wire on single supporting arms, sloped outward at a 45-degree angle.

~~2.2~~2.3 STEEL FABRIC

Fence fabric shall be No. 9 gauge steel wire, 2-inch mesh, with top selvages knuckled and bottom selvages twisted and barbed.

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.

~~2.3~~2.4 FRAMING AND ACCESSORIES

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 foot of coated surface.

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.

End, Corner and Pull Posts: Posts shall be one-piece without circumferential welds, 3-inch schedule 40 pipe, 5.79 pounds per linear foot.

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.

Gate Posts: Gate post dimensions shall be according to manufacturer recommendations or 4-inch schedule 40 pipe, 9.1-pounds per linear foot, whichever is greater.

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.

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.

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.

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.

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.

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.

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.

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.

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~~2.5 GATES

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.

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.

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.

Where barbed wire is indicated above gates, vertical members shall be extended and fabricated as required to receive barbed wire supporting arms.

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.

Hardware and accessories shall be provided for each gate, galvanized in conformance with ASTM A 153, and in accordance with the following:

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.

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.

Keeper: Keeper shall be provided which automatically engages the gate leaf and holds it in the open position until it is manually released.

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.

~~2.5~~2.6 RELATED ITEMS

Concrete: Concrete shall be provided according to Section 03300 - Cast-In-Place Concrete.

Nuts, bolts and screws shall be steel, minimum size 3/8-inch diameter, hot-dip galvanized after fabrication.

~~2.6~~2.7 MANUFACTURERS

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.

Installer's Qualifications: Installation of the chain link fence shall be by the manufacturer or by a firm accepted and licensed by the manufacturer.

Manufacturers, or equal

American Fence Corp.

Anchor Fence, Inc.

United States Steel

PART 3 -- EXECUTION

3.1 INSPECTION

Prior to commencing installation, the CONTRACTOR shall 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

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 to safely accommodate the loads to which they will be subjected.

Excavation: Holes for posts shall be drilled or hand excavated to the diameters and spacings indicated, in firm, undisturbed or compacted soil. Post foundations shall comply with the following:

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.

Excavated depth for holes shall be a minimum of 4-inches lower than the post bottom, with bottom of posts set not less than 36-inches below finish grade surface.

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.

Corner posts shall be installed where changes in the fence lines equal or exceed 15 degrees, as measured in a horizontal plane.

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.

Concrete

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.

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.

Concrete footings shall have a neat appearance and shall be extended 2-inches above grade and troweled to a crown to shed water.

A minimum of 7 days shall elapse after placing the concrete footings before the fence fabric or barbed wire is fastened to the posts.

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.

Braces shall be so installed that posts remain plumb when diagonal rod is under proper tension.

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.

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.

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.

Fabric

Chain-link fabric shall be fastened on the secured side of the posts.

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.

Fabric shall be stretched and anchored in such a manner that it remains in tension after the pulling force is released.

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 two full turns. Ends of wire shall be bent back to minimize hazard to persons or clothing.

Fabric shall be tied to line posts with tie wires spaced at 12-inches on center.

Fabric shall be tied to rails and braces with tie wires spaced at 24-inches on center.

Fabric shall be tied to tension wires, with hog rings spaced 24-inches on center.

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.

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.

Galvanized coating damaged during construction of the fencing shall be repaired by application of **Galvo-Weld**; **Galvinox**; or equal.

3.3 GROUNDING

Fences crossed by powerlines of 600 volts or more shall be grounded at or near the point of crossing and at distances not exceeding 150-feet on each side of the crossing.

Fences, gates and appurtenances enclosing electrical equipment areas, gas yards, or other hazardous areas shall be electrically continuous and grounded.

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.

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.

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 -

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SECTION 03300 - CAST-IN-PLACE CONCRETE

PART 1 - GENERAL

1.1 DESCRIPTION

A. The CONTRACTOR shall provide cast-in-place concrete, joints in concrete, reinforcement steel, formwork, and appurtenant work in accordance with the Drawings and these Specifications.

B. The following types of concrete are covered in this Section:

1. **Structural Concrete**: Concrete to be used for roof~~Roof~~, floor slabs, columns, walls, pavements, drainage channel cut-off walls, and other concrete items not indicated otherwise in the Contract Documents.

2. **Sitework Concrete**: Concrete to be used for anchor posts, curbs, gutters, catch basins, sidewalks, fence and guard post embedment, underground duct bank encasement, and other concrete appurtenant to electrical facilities, unless otherwise indicated.

3. **Fiber Reinforced~~Lean~~ Concrete**: Concrete to be used as ~~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 connections~~.

1.2 APPLICABLE CODES AND STANDARDS

A. The following standards are referenced in this Section:

1. American Concrete Institute (ACI):

ACI 117	Standard Specifications for Tolerances for Concrete Construction and Materials
ACI 211.1	Practice for Selecting Proportions for Normal, Heavyweight, and Mass Concrete
ACI 211.5R	Guide for Submittal of Concrete Proportions
ACI 301	Specifications for Structural Concrete
ACI 304R	Guide for Measuring, Mixing, transporting, and Placing Concrete
ACI 304.2R	Placing Concrete by Pumping Methods
ACI 306.1	Standard Specification for Cold Weather Concreting
ACI 306R	Guide to Cold Weather Concreting
ACI 315	Details and Detailing of Concrete Reinforcement
ACI 318/318R	Building Code Requirements for Structural Concrete and Commentary

ACI 347R	Guide to Formwork for Concrete
ACI 546.2R	Guide to Underwater Repair of Concrete

2. American Society for Testing and Materials (ASTM):

ASTM A 615	Standard Specification for Deformed and Plain Billet-Steel Bars for Concrete Reinforcement
ASTM A 706	Standard Specification for Low-Alloy Steel Deformed and Plain Bars for Concrete Reinforcement
ASTM C 29	Standard Test Method for Bulk Density (Unit Weight) and Voids in Aggregate
ASTM C 31	Standard Practice for Making and Curing Concrete Test Specimens in the Field
ASTM C 33	Standard Specification for Concrete Aggregates
ASTM C 39	Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens
ASTM C 94	Standard Specification for Ready-Mixed Concrete
ASTM C 143	Standard Test Method for Slump of Hydraulic Cement Concrete
ASTM C 150	Standard Specification for Portland Cement
ASTM C 172	Practice for Sampling Freshly Mixed Concrete
ASTM C 231	Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method
ASTM C 260	Standard Specification for Air-Entraining Admixtures for Concrete
ASTM C 309	Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete
ASTM C 311	Test Methods for Sampling and Testing Fly Ash or Natural Pozzolans for Use as a Mineral Admixture in Portland Cement Concrete
ASTM C 494	Standard Specification for Chemical Admixtures for Concrete
ASTM C 595	Specification for Blended Hydraulic Cements
ASTM C 618	Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use as a Mineral Admixture in Concrete
ASTM C 721	Test Method for Average Particle Size of Alumina and Silica Powders by Air Permeability

ASTM C 989	Specification for Ground Granulated Blast-Furnace Slag for Use in Concrete and Mortars
ASTM C 1077	Standard Practice for Laboratories Testing Concrete and Concrete Aggregates for Use in Construction and Criteria for Laboratory Evaluation
ASTM C 1116	Standard Specification for Fiber-Reinforced Concrete
ASTM C 1240	Specification for Silica Fume Used in Cementitious Mixtures
ASTM C 1260	Test Method for Potential Alkali Reactivity of Aggregates (Mortar-Bar Method)
ASTM C 1567	Standard Test Method for Determining the Potential Alkali-Silica Reactivity of Combinations of Cementitious Materials and Aggregate (Accelerated Mortar-Bar Method)
ASTM D 695	Standard Test Method for Compressive Properties of Rigid Plastics
ASTM D 2419	Standard Test Method for Sand Equivalent Value of Soils and Fine Aggregate
ASTM C 1602	Standard Specification for Mixing Water Used in the Production of Hydraulic Cement Concrete
ASTM C 1611	Test Method for Slump Flow of Self-Consolidating Concrete

3. Concrete Reinforcing Steel Institute (CRSI):

Manual of Standard Practice

1.3 DEFINITIONS

A. "Cementitious material" as used herein shall include all Portland cement, pozzolan, ground granulated blast furnace slag, silica fume, and fly ash.

B. "Defective Concrete": Concrete not conforming to required lines, details, dimensions, tolerances or specified requirements.

C. “Design strength” (f’c) is the specified compressive strength of concrete to meet structural design criteria.

1.4 CONTRACTOR SUBMITTALS

A. All submittals shall be made at least 30 Days in advance of initiation of work unless expressly indicated below. Any changes or revisions to previously approved submittals shall be submitted immediately. The CONTRACTOR shall submit the following for ENGINEER review and approval:

1. Shop Drawings

a. Shop bending diagrams, placing lists, and drawings of reinforcing steel prior to fabrication.

b. Details of reinforcing steel for fabrication and erection shall conform to ACI 315 and the requirements herein. 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. Placement diagrams shall show all embedded metals or pipes and all temporary blockouts shown or necessary to complete the WORK.

c. Where mechanical couplers are permitted to be used to splice reinforcing steel, 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 that show the location of each coupler with details of how they are to be installed in the formwork.

d. Manufacturer's information demonstrating compliance with requirements of the following:

1) Mill tests for reinforcing steel

2) Mill tests for cement

3) Admixture certification. Chloride ion content shall be included.

4) Aggregate gradation test results and certification

5) Grout materials

2. Mix Designs: Prior to beginning the Work, submit concrete materials and mix designs in accordance with the guidelines of ACI 211.5R. When a water reducing admixture is to be used, the CONTRACTOR shall furnish mix designs for concrete both with and without the admixture.

3. Concrete Placement Plan: If requested by the ENGINEER, the CONTRACTOR shall submit a Concrete Placement Plan detailing means and methods that the CONTRACTOR will use in placing concrete. Adequate numbers of personnel, equipment and supplies shall be on Site and dedicated to the concrete placement. The plan shall provide and discuss, but not be limited to, the following items, which shall be considered mandatory:

a. Detail equipment to be used, including backup equipment.

b. Detail how concrete requirements for slump, temperature, time of placement from time of batching, etc. will be monitored and how decisions will be made to enable field adjustments to the batching process to be made and how communication with the batch plant will be made.

c. Detail contingency plans to be used in the event of breakdowns or other untimely events.

d. Each lift described shall be identified with a unique identification number that is included in the construction CPM schedule (Section 01311).

e. Estimated volume of concrete included in each lift.

4. Delivery Tickets: Where ready-mix concrete is used, the 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 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 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.

1.5 QUALITY ASSURANCE

A. Testing of Materials

1. Tests on component materials and for compressive strength of concrete will be performed as indicated herein. Tests for determining slump will be in accordance with the requirements of ASTM C 143. Unless otherwise noted herein, test samples for compliance shall be taken at the point of placement.

2. Tests for determining the air content of concrete shall be in accordance with ASTM C 231.

3. Testing for aggregate shall include reactivity, organic impurities, abrasion resistance, and soundness in accordance with ASTM C 33 and sand equivalent value in accordance with ASTM D 2419. Testing of the cement-pozzolan-aggregate combination of materials proposed for the work shall be in accordance with ASTM C 1567.

4. The cost of laboratory tests on cement, aggregates and admixtures shall be arranged for and paid by the CONTRACTOR. The cost of laboratory tests on concrete as delivered to the Site will be arranged for and paid by the COMPANY. However, the CONTRACTOR shall pay the cost of any additional tests and investigations on Work that does not meet the Specifications. The laboratory will meet or exceed the requirements of ASTM C 1077.

5. Concrete for testing shall be supplied by the CONTRACTOR at no cost to the COMPANY, and the CONTRACTOR shall assist in providing access, obtaining samples, and disposal and cleanup of excess material.

B. Field Compression Tests

1. Compression test specimen sets will be taken during construction from the first placement of each class of concrete herein and for every 50 cubic yards thereafter to insure continued compliance with these specifications. Each set of test specimens will be a minimum of 4 cylinders.

2. Compression test specimens for concrete will be made in accordance with ASTM C 31. Specimens will be 6-inches diameter by 12-inches 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 at 28 Days. The remaining cylinder will be held to verify test results, if needed. The 7-Day cylinder will be used as an indication of normal strength gain and will not have associated acceptance criteria.

C. Evaluation and Acceptance of Concrete

1. Evaluation and acceptance of the compressive strength of concrete will be according to the requirements of ACI 301 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 subsequent batches of the type of concrete affected.

3. Concrete that fails to meet the ACI requirements and these Specifications is subject to removal and replacement at no additional cost to the COMPANY.

D. Construction Tolerances: The CONTRACTOR shall set and maintain concrete forms and perform finishing operations so that the concrete is within the tolerances herein. 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.

1. The variation from required lines or grades shall not exceed 1/4-inch in 10 feet and there shall be no offsets or visible waviness in the finished surface.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Refer to ACI 301 and Section 01600 - Products, Materials, Equipment and Substitutions for job site storage of materials. Protect materials from contaminants such as grease, oil, and dirt. Ensure materials can be accurately identified after bundles are broken and tags removed.

PART 2 -- PRODUCTS

2.1 FORM MATERIALS

A. Except as otherwise expressly accepted by the ENGINEER, lumber brought on the Site for use as forms and bracing shall be new material.

B. Unless otherwise indicated, exterior corners in concrete members shall be provided with 3/4-inch chamfers.

2.2 REINFORCEMENT STEEL

A. General: Reinforcement steel for cast-in-place reinforced concrete construction shall conform to the following requirements:

1. Bar reinforcement and anchor bars shall conform to the requirements of ASTM A 615, Grade 60.

B. Accessories

1. Accessories shall include all necessary chairs, 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.

2. Concrete blocks (dobies) used to support and position reinforcement steel shall have the same or higher compressive strength than required for the concrete in which they are located. Where concrete blocks are used on concrete surfaces exposed to view, the color and texture of the concrete blocks shall match that required for the finished surface. Wire ties shall be embedded in concrete block bar supports.

2.3 MECHANICAL COUPLERS

A. Mechanical couplers shall be provided where approved by the ENGINEER. Couplers shall be in accordance with ACI 318 and shall develop a tensile strength that exceeds 125 percent of the yield strength of the reinforcing bars being spliced at each splice.

2.4 CONCRETE MATERIALS

A. 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 for concrete shall conform to the following requirements:

1. Cement shall be standard brand portland cement conforming to ASTM C 150, Type I/II low alkali or Type V low-alkali. A single brand of cement shall be used throughout the Work, to the extent possible, and prior to its use, the brand shall be accepted by the ENGINEER. If, over the course of the Project, the cement becomes unavailable or is proposed to be substituted with a new cement, the CONTRACTOR shall provide submittals and certifications for the new cement in accordance with these Specifications. 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 for each shipment of cement to be used shall be submitted to the ENGINEER, if requested, regarding compliance with these Specifications.

2. Pozzolan shall conform to ASTM C 618, Class N or F, except that the maximum allowable loss on ignition shall be 6 percent. The minimum pozzolan content shall be at least 15 percent of the total cementitious material by mass. In lieu of adding pozzolan independently the cement type indicated 1 subparagraph 1 above may be substituted with cement Type IP conforming to ASTM C 595, which shall contain 15 percent pozzolan by mass. Testing of the cement and aggregate combination is required per ASTM C 1567.

3. Silica fume, if used, shall conform to ASTM C 1240 with a maximum loss of ignition of 6 percent. The material may be supplied in dry or slurry form. The water content in the slurry shall be included in the water-cement ratio. Silica fume shall not exceed 12 percent by weight of cement.

4. Ground Granulated Blast Furnace Slag (GGBFS) shall conform to ASTM C 989 Grade 100 or 120. GGBFS shall not exceed 50 percent by weight of cementitious materials

5. Water for mixing and curing shall be potable, clean, and free from objectionable quantities of silty organic matter, alkali, salts, and other impurities, and shall meet the requirements of ASTM C 1602. The water shall be considered potable, for the

purposes of this Section only, if it meets the requirements of the local governmental agencies.

6. Aggregates shall be obtained from a single source pit or quarry acceptable to the ENGINEER and shall conform to the requirements of ASTM C 33.

   a. Coarse aggregates shall be graded to comply with ASTM C 33 and consist of clean, hard, durable gravel, crushed gravel, crushed rock, or a combination thereof. The coarse aggregates shall consist of Size Number 67 (3/4 in. to No. 4) unless otherwise approved by the ENGINEER or specified.

   b. Fine aggregates shall be natural sand or a combination of natural and manufactured sand that is hard and durable and shall meet the requirements of ASTM C 33. When tested in accordance with ASTM D 2419, the sand equivalent value shall not be less than 75 for an average of 3 samples, nor less than 70 for an individual test.

   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.

   d. Aggregates shall not contain any substance that may be deleteriously reactive with the alkalis in the cement unless effective mitigating measures are taken to control reactivity.

   e. Aggregates shall show expansions less than 0.10 percent at sixteen (16) Days when tested in accordance with ASTM C 1260 using a cement with an alkali content above 0.8 percent (expressed as sodium oxide), and shall not possess properties or constituents that are known to have specific unfavorable effects in concrete when tested in accordance with ASTM C 295.

   f. If mitigating measures are required to control reactivity, submit satisfactory test results from ASTM C 1567 to determine if the combination of cementitious materials is adequate to mitigate deleterious reactivity.

7. All admixtures, if used, shall be compatible. Admixtures shall be used in accordance with manufacturers' recommendations. 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 the specified air content in the concrete, as placed in the Work, when tested in accordance with ASTM C 231 - Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method. The ENGINEER reserves the right, at any time, to sample and test the air-entraining agent received on the job by the CONTRACTOR. 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 ENTRAINING ADMIXTURE SHALL NOT BE USD FOR UNDERWATER PLACED CONCRETE

   b. Water reducing and set retarding admixture (WRA) shall conform to ASTM C 494, Types A, E or F. Water reducing and set retarding admixture shall be used in all concrete at the rate recommended by the admixture manufacturer based on the time from batching to delivery on Site.

   c. High Range Water Reducer (HRWRA - Superplasticizers) shall conform to ASTM C494 Types F or G, or ASTM C1017 Types 1 or 2.

d. Accelerating admixtures shall conform to ASTM C 494, Type C.

e. Retarding admixtures shall conform to ASTM C494, Types B, D, or G.

f. Anti-washout / Rheoplastic Admixture (AWA) shall be specially formulated and so indicated to be an anti-washout admixture to increase cohesion and to resist cement washout and concrete segregation and bleeding. AWA shall be compatible with other admixtures and so confirmed by the admixture manufacturers.

1) Rheoplastic concrete is concrete with a plasticity (slump) in the range of 8 to 11 inches, is non-segregating and exhibits little or no bleeding.

2) Use rheoplastic admixtures of the second or third generation type that control slump loss to within 3 inches for at least one and one half hours after batching for concrete temperatures up to 100 degrees F.

3) Second generation rheoplastic admixtures control the rise in concrete temperature for a minimum of one and one half hours from the time of batching.

4) Third generation rheoplastic admixtures will not, when compared to a reference concrete of equal slump, significantly retard the set of concrete throughout their recommended dosage range and at varying concrete temperatures.

5) Add rheoplastic admixtures at the batch plant unless specifically recommended by the manufacturer.

8. Ready-mix concrete shall conform to the requirements of ASTM C 94 - Ready-Mixed Concrete.

2.5 CURING COMPOUND

A. Curing compound shall conform to ASTM C 309, Type 1, Class B.

2.6 EPOXY GROUT

A. Grout for grouting anchor 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 be Epcon A7 Acrylic Adhesive as manufactured by ITW Ramset/Read Head, Power-Fast Epoxy Injection Gel as manufactured by Powers Fasteners, Five Star RS Anchor Gel manufactured by Five Star Industries, Pro-Poxy 400 manufactured by Unitex, or ENGINEER-approved equal.

2.7 NON-SHRINK GROUTS

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 shall be as 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 freeze/thaw environments.

B. Non-Shrink Grout – Class I

1. Unless otherwise indicated, Non-Shrink Grout – Class I shall be provided as listed below whether indicated on the Drawings or not:

   a. Filling blockout spaces for embedded items such as railing posts, gate frame guides, etc. Where placement time exceeds 20 minutes use Non-Shrink Grout – Class II.

   b. 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.

   c. Storage tanks and other non-motorized equipment and machinery under 30 horsepower.

   d. Repair of holes and defects in concrete members which are not water bearing and not in contact with soil or other fill materials.

   e. Any application not listed in this Section, where grout is indicated.

2. Class I non-shrink grout shall have a minimum 28 Day compressive strength of 5000 psi when mixed at a fluid consistency.

3. 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.

4. 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.

5. 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.

6. Furnish certification that the non-shrink property of grout is not based on gas production or gypsum expansion.

7. Class I Non-Shrink Grout shall be Masterflow 713 Plus by MBT/Degussa Building Systems, 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 ENGINEER-approved equal.

C. Non-Shrink Grout – Class II

1. Unless otherwise indicated, Non-Shrink Grout – Class II shall be provided as listed below whether indicated on the Drawings or not:

   a. Filling blockout spaces for embedded items such as railing posts, gate frame guides, etc. where placement time exceeds 20 minutes.

   b. Under precast concrete elements.

   c. Repair of holes and defects in concrete members which are water bearing or in contact with soil or other fill materials.

2. 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.

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.

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.

5. 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.

6. 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.

7. The grout when tested shall not bleed or segregate at maximum allowed water content.

8. Provide certification that its non-shrink property is not based on gas production or gypsum expansion.

9. Class II non-shrink grout shall be Masterflow 928 by MBT/Degussa Building Systems, Five Star Fluid Grout 100 by Five Star Products, Crystex by L&M Construction Chemicals, or ENGINEER-approved equal.

2.8 CRYSTALLINE WATERPROOFING

A. Crystalline waterproofing shall be Krystol T1 and T2 as manufactured by Kryton International Inc. or equal.

2.9 CONCRETE DESIGN REQUIREMENTS

A. General

1. Concrete shall be composed of cement, admixtures, aggregates, and water of the qualities indicated. 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 proportions shall be changed whenever necessary or desirable to meet the required results at no additional cost to the COMPANY. Mix changes shall be subject to review by the ENGINEER.

2. The CONTRACTOR is cautioned that the limiting parameters below 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.

3. Concrete Properties: The specified compressive strength and other requirements shall be not less than the following tabulations:

   a. Structural Concrete:

Specified 28-Day Compressive Strength, psi	5,000
Max. Size Aggregate, inches	¾
Cement Content per cu. yd., pounds, minimum	600
Max. W/C Ratio (by weight)	0.40
Slump (inches) prior to addition of WRA and HRWRA	4 +/- 1
Air Entrainment (percent)	5 to 7.5

   b. Sitework Concrete:

   ~~b. Adjust Structural Concrete mix design to produce Lean Concrete with a 28-Day Compressive Strength of 3000 psi. Structural Concrete may be used for Lean Concrete.~~

   ~~c. Sitework Concrete:~~

Specified 28-Day Compressive Strength, psi	4,000
Max. Size Aggregate, inches	1
Cement Content per cu. yd., pounds, minimum	254
Max. W/C Ratio (by weight)	0.45
Slump (inches) prior to addition of WRA and HRWRA	4 +/- 1
Air Entrainment (percent)	5 to 7.5

   c. Fiber Reinforced Concrete: Adjust Structural Concrete mix design to produce Concrete with a 28-Day Compressive Strength of 2,500 psi.

      1. Fiber Reinforcing: Reinforcement shall be synthetic fiber reinforcements, Fibermesh 300, as manufactured by Propex.

2. Fiber reinforcing shall be batched at a rate of 1.5 pounds per cubic yard of concrete.

3. Material: 100% virgin homopolymer polypropolene fibrillated fibers, containing no reprocessed olefin materials.

4. Conformance: ASTM C1116, Type III

5 Fire Classifications: UL Report File No. R8534 11 and Southwest Certification Services (SWCS), Omega Point Laboratories No. 8662 1.

6. Fiber Length: 25 mm.

7. Alkali Resistance: Alkali proof.

8. Absorption: Nil.

9. Specific Gravity: 0.91.

10. Melt Point: 162°C.

4. Aggregate Reactivity: The cement-pozzolan-aggregate combination to be used in the proposed mix shall be tested as indicated herein. Mitigating measures shall be employed for all mixes using aggregates from pits with reactive aggregates.

5. **Cement shall be Type V Portland cement as specified in ASTM C150.**

2.10 CONSISTENCY

A. Consistency of the various classes of concrete in successive batches shall be determined by slump and air-content tests in accordance with ASTM C 143 and ASTM C 231, respectively.

2.11 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; provided that, where batches are so proportioned as to contain an integral number of conventional sacks of cement, and the cement is delivered at the mixer in the original unbroken sacks, the weight of the cement contained in each sack may be taken without weighing as 94 pounds.

2.12 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.

2.13 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, placing, the supplementary requirements as required herein, and is in accordance with ASTM C 94.

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. In hot weather, or under conditions contributing to quick stiffening of the concrete, or 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.

C. 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 revolutions of mixing.

D. Each batch of ready-mixed concrete delivered to the Work shall be accompanied by a delivery ticket furnished to the ENGINEER in accordance with Paragraph 1.4.A.4 entitled "Delivery Tickets."

E. 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 GENERAL FORMWORK REQUIREMENTS

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 forms, and any forms which are unsafe or inadequate in any respect shall promptly be removed from the Work and replaced at the CONTRACTOR's expense. 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 shall comply with applicable local, state and federal regulations. Design, construction, maintenance, preparation, and removal of forms shall follow the guidelines contained in ACI 347 and the requirements herein.

B. 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.

3.2 CONSTRUCTION

A. Vertical Surfaces: Vertical surfaces of concrete members shall be formed.

B. Construction Joints: Concrete construction joints will not be permitted at locations other than those indicated, except as may be approved by the ENGINEER.

C. Form Ties

1. Embedded Ties: 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, 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 or regular cement grout. Exposed faces of walls shall have at least 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.

3.3 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 exposed concrete surfaces. Exposed concrete surfaces are defined as surfaces which are permanently exposed to view.

3.4 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. Forms for vertical surfaces shall remain in place at least 48 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.

3.5 REINFORCEMENT 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, except as modified by the Drawings.

2. The CONTRACTOR shall fabricate reinforcement bars for structures in accordance with bending diagrams, placing lists, and placing drawings. Said drawings, diagrams, and lists shall be prepared by the CONTRACTOR.

3. Unless otherwise indicated, dowels shall match the size and spacing of the spliced bar.

B. Bending or Straightening: Reinforcement shall not be straightened or rebent in a manner which will damage the reinforcing bar. 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.

3.6 REINFORCEMENT 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 existing concrete, 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.

B. Tie wires shall be bent away from the forms and surfaces of concrete in order to provide the required concrete cover.

C. 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 his own expense.

D. Unless otherwise indicated, reinforcement placing tolerances shall be within the limits specified in ACI 117.

E. The minimum spacing requirements of ACI 318 shall be followed for reinforcing steel.

3.7 REINFORCEMENT SPLICING

A. General: 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 reviewed and accepted by the ENGINEER. Full lap splices will be allowed across construction joints (CJs) considering “top bar” and “other reinforcement” development length modification factors per ACI 318.

B. Splices of Reinforcement: The length of lap for reinforcement bars, unless otherwise indicated, shall be in accordance with ACI 318 for a Class B splice.

3.8 REINFORCEMENT 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 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, reinforcing shall be reinspected and, if necessary recleaned.

3.9 CONCRETE BATCHING, MIXING AND DELIVERY

A. Batching, mixing, and delivery of concrete shall conform to requirements of ASTM C 94, as specified otherwise herein, or as otherwise approved by the ENGINEER.

B. Retempering: Retempering of concrete, which has partially hardened, shall not be permitted.

3.10 PREPARATION OF SURFACES FOR CONCRETING

A. Moisture Conditioning: At least 24 hours prior to placement of concrete, existing concrete 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, debris and other matter that would be detrimental to bond at the time of placing concrete.

B. 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. Existing concrete against which concrete is to be placed shall be thoroughly cleaned of sediment, loose concrete and aggregates, and other materials that would affect bonding of the concrete to the existing substrate. Initial preparation shall be by one of the following methods:

1. High-Pressure Water Jetting: A stream of water under a pressure of not less than 6,000 psi.

2. Mechanical Methods: Mechanical methods, such as using “whirl-away” equipment or bush hammering.

C. Rock surfaces upon which concrete is to be placed shall be clean, free from drummy rock, debris, and loose, semidetached, unsound fragments and as specified in Section 02200 - Earthwork. Immediately before the concrete is placed, all rock surfaces shall be cleaned thoroughly by the use of water jets.

D. 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.

E. Embedded Items

1. No concrete shall be placed until all formwork, 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 that have become encrusted with dried grout from previous usage shall be cleaned before the surrounding or adjacent concrete is placed.

2. Reinforcement and anchor bars shall be set and secured in the forms at locations indicated on the Drawings or by Shop Drawings and shall be acceptable to the ENGINEER before any concrete is placed. Accuracy of placement is the responsibility of the CONTRACTOR.

F. No concrete shall be placed 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 damage 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.

3.11 HANDLING, TRANSPORTING, AND PLACING OF CONCRETE

A. General: Placing of concrete shall conform to the applicable requirements of ACI 301, the CONTRACTOR’s Concrete Placement Plan, and the requirements of this Section. Concrete will not be allowed to be placed until the CONTRACTOR’s Placement Plan has be reviewed and accepted by the ENGINEER. 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 Specifications, or which is of inferior quality, shall be removed and replaced.

C. Unauthorized Placement: No concrete shall be placed except in the presence of the ENGINEER. The CONTRACTOR shall notify the ENGINEER in writing at least 24-hours in advance of placement of any concrete.

D. 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 so designed and arranged 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 required 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.

E. Temperature of Concrete: The temperature of concrete when it is being placed shall be not more than 90 degrees F nor less than 40 degrees F in moderate weather, and not less than 50 degrees F in weather during which the mean daily temperature drops below 40 degrees F. 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 required minimum temperature. 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, as it is placed, below 90 degrees F. The CONTRACTOR shall not be entitled to additional compensation on account of the foregoing requirements.

F. Cold Weather Placement

1. Placement of concrete shall conform to ACI 301 and the following.

   a. Foundations shall be free from snow, frost or ice when concrete is placed upon or against them.

   b. Maintain the concrete temperature above 50 degrees F for at least 72-hours after placement.

3.12 PUMPING OF CONCRETE

A. General

1. 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.

2. Pumping Equipment

   a. The pumping equipment shall have 2 cylinders and be designed to operate with one cylinder only 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.

   b. The minimum diameter of the hose conduits shall be in accordance with ACI 304.2R - Placing Concrete by Pumping Methods.

c. Pumping equipment and hoses conduits that are not functioning properly shall be replaced.

d. Aluminum conduits for conveying the concrete shall not be permitted.

3.13 CONCRETE CONSOLIDATION

A. As concrete is placed, 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 high-speed power vibrators (8,000 to 12,000 rpm) of an immersion type in sufficient number and with at least one standby unit.

3.14 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. Unformed Surfaces: After proper and adequate vibration and tamping, unformed top surfaces of slabs shall be brought to a uniform surface with suitable tools. After sufficient stiffening of the screeded concrete, surfaces shall be float finished with wood or metal floats. 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.

3.15 CURING OF CONCRETE

A. General: Concrete shall be cured for not less than 14 Days after placing. The surface shall be either (1) be covered with burlap mats, which shall be kept wet with water for the duration of the curing period or (2) have a liquid membrane-forming curing compound applied at the coverage rate specified by the manufacturer and shall not be used on surfaces to receive additional concrete or cementitious finishing materials.

B. The CONTRACTOR may submit alternate methods of curing which maintain the concrete in a continuously wet condition for acceptance by the ENGINEER.

3.16 PROTECTION OF CONCRETE

A. The CONTRACTOR shall protect concrete against injury until final acceptance.

B. Fresh concrete shall be protected from damage due to water immersion, dripping water or any other cause. The CONTRACTOR shall provide such protection until the concrete receives its initial set.

3.17 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 at the CONTRACTOR's expense.

3.18 GROUTING

A. General

1. Grout shall be stored in accordance with manufacturer's recommendations.

2. Grout shall not be placed until base concrete or masonry has attained its design strength, unless authorized otherwise by the ENGINEER.

3. 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.

4. Surface preparation, curing, and protection of cement grout shall be in accordance with the manufacturers' recommendations. The finish of the grout surface shall match that of the adjacent concrete unless otherwise indicated.

5. 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.

6. Shade the WORK from sunlight for at least 24 hours before and 48 hours after grouting.

B. Grouting Procedures

1. Structural, equipment, tank, and piping support bases shall be grouted, unless indicated otherwise.

2. 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 other thickness if indicated.

3. 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.

4. Concrete equipment pads for equipment bases that will be epoxy-grouted shall be sized so that, when the equipment base is fully grouted, the epoxy grout is stopped not less than 4 inches from the edge of the pad.

C. Grouting of Anchor Bars and Bolts

1. Prepackaged Grouts: Surface preparation, mixing, handling, placing, consolidation, curing, and other means of execution for epoxy grout shall be done according to the instructions and recommendations of the manufacturer.

2. Holes for anchor bars shall be drilled with percussion equipment and shall be of the diameter as indicated on the Drawings or to the hole diameter specifically recommended in writing by the manufacturer of the grout.

3. Holes shall be thoroughly cleaned with bursts of air and water and all water shall be removed from the holes after cleaning.

4. Grout shall be placed in such a manner and at the consistency necessary to assure that the space to be grouted is completely filled.

5. Insert, rotate and vibrate the anchor bars as required to obtain full coating of the bar with grout to aid in corrosion protection and bonding.

6. Do not disturb the anchor bars for 5 Days or until such a time as recommended in writing by the manufacturer of the grout.

D. Consolidation

1. 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.

3.19 ENGINEER NOTIFICATION

A. The ENGINEER will inspect the placement area during preparatory phases of the Work, during concrete placements and during subsequent work. CONTRACTOR shall notify the ENGINEER 24 hours in advance of each concrete placement.

3.21 APPLICATION OF CRYSTALLINE WATERPROOFING

A. Crystalline waterproofing shall be applied to the exterior walls of all precast vaults and manholes and to cast-in-place concrete walls as indicated on the Drawings. Application of the two part system indicated in Paragraph 2.8 shall include two coats of the initial coating and a single coat of the outer coating, both mixed and applied in accordance with the manufacturer's written recommendations.

3.22 CLEANUP

A. Concrete trucks will be washed/cleaned only in area(s) so designated by the ENGINEER. The ENGINEER shall provide lighting at the cleanup area if so requested one week in advance of such need. Such solidified concrete shall be removed from the site at completion of the Work.

B. Upon completion of the Work each area shall be thoroughly cleaned of debris and foreign material, as acceptable to the ENGINEER, and such material shall be removed from the Site.

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SECTION 03495 - PRECAST CONCRETE MANHOLES, DROP INLETS, 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

CI 318/318R	Building Code Requirements for Structural Concrete and Commentary
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 890	Standard Practice for Minimum Structural Design Loading for Monolithic or Sectional Precast Concrete Water and Wastewater Structures
ASTM C 913	Standard Specification for Precast Concrete Water and Wastewater Structures
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 professional engineer in the State of Washington.

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 watertight 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 (IF NEEDED)

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. 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. Axial length of sections shall be selected to provide the correct total height with the fewest joints.

D. Conical sections shall be designed to support cast iron frames and covers under an H-20 loading, unless indicated otherwise.

E. 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.

F. **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 130 pcf located above all portions of the manhole.

3. Lateral soil pressure based on saturated soil producing 126 pcf acting on an empty manhole.

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 one-half of the diameter of the smaller penetration, whichever is greater.

~~G.~~ Joints shall be sealed with butyl-rubber sealants, **ConSeal CS-102, Ram-Nek RN101, or equal**, conforming to ASTM C 990-91 – Standard Specification for Joints in Concrete Pipe, Manholes, and Precast Box Sections Using Preformed Flexible Joint Sealants.

~~H.~~ Concrete for base and channel formation shall be 4000 psi concrete conforming to Section 03300 - Cast-In-Place Concrete. Cement shall be Type V portland cement as specified in ASTM C 150.

~~I.~~ Barrel section to pipe connections shall be sealed with resilient connectors, **Z-Lok connector by A-Lok Products, Inc., Kor-N-Seal I by Trelleborg (npc), or equal**, complying with ASTM C 923 – Standard Specification for Resilient Connectors Between

Reinforced Concrete Manhole Structures, Pipes and Laterals. Mechanical devices shall be stainless steel.

~~J.~~ Manhole steps shall be comprised of ½-inch grade 60 steel reinforcement rod encased in polypropylene copolymer plastic. Steps shall have tread width of 14-inches with a minimum 6-inch projection from the wall. Furnish test results demonstrating step capability to resist a pull out force of 400 pounds. Provide **PS2-PF Manhole Step by M.A. Industries**, or equal.

~~K. Manhole~~ Manufacturers, or Equal

1. **Oldcastle Precast**
2. **Panhandle Concrete Products, Post Falls, ID**
3. **Wilbert Precast, Inc., Yakima, WA**

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. Frame and cover shall be designed for H-20 traffic loading.

B. Castings Manufacturers, or Equal

1. **Neenah Foundry Co.**
2. **East Jordan Iron Works**
3. **D & L Supply**

2.3 DROP INLETS

A. Drop inlets shall be Type 2 Grate Inlet, as defined by W.S.D.O.T Standard Specification, Standard Plan B-35.40-00 and shall conform to WSDOT Specification 9-05.50(4) – Pre-Cast Concrete Inlets.

C. VAULTS

D. The CONTRACTOR shall provide precast vaults designed for the indicated applications and of the sizes indicated.

E. 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.

F. Design Loading: Vaults in areas subject to vehicular traffic shall be designed for H-20 traffic loading. Vaults in other areas shall be designed for a vertical live load of 300 psf. Lateral loads on vaults in all areas shall be calculated from:

$$L = 90\ h, \text{ plus surcharge of 240 psf in areas of vehicular traffic}$$

Where L = loading in psf

and h = depth of fill in feet

~~G.~~ 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.

~~H.~~ 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.

~~I.~~ 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.

~~J.~~ 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.

~~K.~~ Warning Signs

1. The entrance to every manhole and vault shall be fitted with a permanently affixed, plastic warning sign, located above and centered on the top step. Each sign shall be in accordance with the design drawings.

2. Sign Manufacturer, or Equal

   a. **W. H. Brady Company**

   b. **Seton Nameplate Corporation**

~~2.3~~2.4 CRYSTALLINE WATERPROOFING

A. Crystalline waterproofing shall be as indicated in Section 03300 – Cast-In-Place Concrete.

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. 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 vaults and manholes shall have a crystalline waterproofing applied to their exterior surfaces in accordance with Section 03300 – Cast-In-Place Concrete and the manufacturer's application instructions.

C. Buried pre-cast concrete vaults shall be assembled and placed in excavations on properly compacted soil foundations as indicated. Pre-cast concrete vaults shall be set to grade and oriented to provide the required dimensions and clearances from pipes and other structures.

D. Prior to backfilling, all cracks and voids in pre-cast concrete vaults shall be filled with non-shrink grout or polyurethane sealant, or both.

~~D.~~E. Unless otherwise indicated, around~~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.

~~E.~~F. Steps shall be driven into tapered holes formed in the concrete by inserts from the step manufacturer or 1-inch holes drilled 3-3/4-inches deep into the manhole wall in the field. No more than 6-1/8 inches of plastic arm, measured on the inside of the step, shall be exposed outside the concrete.

~~F.~~G. Steps shall be installed 12-inches on centers vertically, not more than 1/2 inch out of plumb. The top step shall be no more then 12-inches below the manhole cover.

- END OF SECTION –

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SECTION 05500 - MISCELLANEOUS METALWORK

PART 1 -- GENERAL

1.1 THE REQUIREMENT

A. Provide miscellaneous metalwork and appurtenances, complete and in place, as indicated 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-PRF-907F	Antiseize Thread Compound, High Temperature

B. Codes

OSHA 1927.10	Fixed Ladders

C. 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 the requirements of Section 01300 – Contractor Submittals.

B. Shop Drawings

1. Shop Drawings shall conform to AISC recommendations and specifications, and shall show holes, and the like, as may be required for other parts of the WORK.

2. Shop Drawings shall include complete details of members and connections, anchor bolt layouts, schedules for fabrication procedures, and diagrams for the sequence of erection.

3. Grating

a. Submit 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.

b. Submit load and deflection tables for each style and depth of grating used.

4. Anchors

a. Submit an ICBO report listing the ultimate load capacity in tension and shear for each size and type of concrete anchor.

b. Submit manufacturer's recommended installation instructions and procedures for adhesive anchors.

c. Upon review by the ENGINEER, these instructions shall be followed specifically.

d. 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 indicated otherwise
HSS	ASTM A 500 Grade B

B. Corrosion Protection

1. Unless otherwise indicated, fabricated steel metalwork which will be used in a corrosive environment and/or will be submerged in water or wastewater shall be coated in accordance with the requirements of Section 09800 – Protective Coating, and shall not be galvanized prior to coating.

2. Other miscellaneous steel metalwork shall be hot-dip galvanized after fabrication.

C. Stainless Steel

1. Unless otherwise indicated, stainless steel metalwork and bolts shall be fabricated from Type 316 stainless steel.

D. Aluminum

1. Unless otherwise indicated, aluminum metalwork shall be fabricated from Alloy 6061-T6.

2. Aluminum in contact with concrete, masonry, wood, porous materials, or dissimilar metals shall have contact surfaces coated in accordance with the requirements of Section 09800 – Protective Coating.

E. Cast Iron

1. Unless otherwise indicated, iron castings shall conform to the requirements of ASTM A 48, Class 50B, or better.

2.2 ALUMINUM RAILINGS

A. General

1. Aluminum handrails and railings shall be component systems, complete with anchors, attachments, balusters, brackets, caps, fasteners, gates (swing with self-latching hardware or be removable), posts, sleeves, trim, and any other related items as required or necessary for a complete installation.

2. Gates and removable rail sections shall be complete with hardware such as self-closing hinges, self-latching latches, hasps, and the like.

3. Railings shall conform to Building Code and OSHA requirements, General Industry Occupational Safety and Health Standards (29CFR1910).

B. Materials shall conform to the following requirements:

1. Aluminum

a. Aluminum shall be U.S. Alloy 6063 T-5 or T-6.

b. Aluminum pipe rail shall not be less than 1-1/2-inch diameter Schedule 40 pipe.

2. Electrolysis protective material shall be in accordance with the requirements of Section 09800 – Protective Coating.

3. Sleeves shall be of galvanized steel or PVC.

4. Grout for handrail posts shall consist of an inorganic, non-shrink, non-metallic premixed grout in accordance with the requirements of Section 03315 – Grout, with a minimum 28-Day compressive strength of 4,000 psi.

5. Fasteners, screws, and bolts shall be concealed and shall be fabricated from stainless steel or aluminum.

6. Aluminum welding rods shall be of a type recommended by the aluminum manufacturer for anodized finished products.

7. Kickplates shall be provided on railings and not set in curbs.

C. Pipe railing systems, including handrails, railings, tube caps, and other miscellaneous parts of the rails, shall be provided with a clear anodized finish, AA-M32C22A41.

D. Manufacturers or Equal

1. C-V Pipe Rail by Crane Veyor Corp.

2. Connectorail by Julius Blum and Co.

2.3 METAL STAIRS

A. Metal Stairs

1. Metal stairs shall be composed of steel or aluminum stringers and supports, shall be fabricated in accordance with the standard practice of the National Association of Ornamental Metal Manufacturers, and shall be as indicated.

2. Steel stair members shall be hot-dip galvanized after fabrication.

2.4 GRATING STAIR TREADS

A. Grating stair treads shall be designed to support a live load of 100 psf or a concentrated load at mid-span of 300 pounds, whichever creates the higher stress.

B. The maximum deflection due to the uniform live load shall be as required for metal grating, below.

C. Grating stair treads shall be provided with an integral non-slip nosing.

2.5 SAFETY STAIR NOSINGS

A. Safety stair nosing shall be provided on concrete stairs and other locations as indicated.

B. The nosing shall be 3 inches wide and fabricated from extruded aluminum with cast-in abrasive strips and integral extruded anchors.

C. The color of the cast abrasive shall be as selected by the ENGINEER from among the manufacturer's standard colors.

D. The nosing shall be Amstep Products Style 231-A, Grating Pacific XRS-3, Robertson Grating Products Type 9511, or equal.

2.6 LADDERS

A. Materials

1. Ladders which may be partially or wholly submerged or which are located inside a hydraulic structure shall be fabricated entirely of Type 316 stainless steel.

2. Other ladders shall be fabricated from aluminum materials as indicated.

B. Pop-Up Extension

1. Every ladder that does not have an exterior handhold shall be equipped with a pop-up extension.

2. The pop-up extension device shall be manufactured of the same material and finish as the ladder, and shall be provided with a telescoping tubular section that locks automatically when fully extended.

3. Upward and downward improvement shall be controlled by stainless steel spring balancing mechanisms.

4. The units shall be completely assembled with fasteners for securing to the ladder rungs in accordance with the manufacturer’s instructions.

2.7 METAL GRATING

A. General

1. Metal grating shall be of the indicated design, size, and type.

2. Grating shall be supported around an opening by support members.

3. Where grating is supported on concrete, unless otherwise indicated provide embedded support angles that match the grating material and are mitered and welded at their corners.

4. Banding

   a. The grating shall be completely banded at edges and cutouts.

   b. The banding material and cross-section shall be equivalent to the bearing bars.

   c. The banding shall be welded to each cut bearing bar.

5. The grating pieces shall be fastened to each support in 2 locations.

6. 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 with a width equal to that of the stairway.

7. Where the grating depth is not indicated, provide grating within allowable stress levels and which shall not exceed a deflection of 1/4 inch or the span divided by 180, whichever is less.

8. Design Loading

   a. 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.

   b. For heavy-duty grating, the loading used for determining stresses and deflections shall be in accordance with AASHTO HS-20.

B. Material

1. Except where indicated otherwise, bar grating shall be fabricated entirely of:

   a. aluminum

      1) Bearing and Banding Bars: Alloy 6061-T6

      2) Cross Bars: Alloy 6063-T5

2. Grating that may be partially or wholly submerged shall be fabricated entirely of Type 316 stainless steel.

C. Standard-Duty Grating

1. No single piece of grating shall weigh more than 80 pounds, unless indicated otherwise.

2. Standard duty grating shall be composed of serrated bar grating.

3. Cross bars shall be welded or mechanically locked tightly into position such that there is no movement between the bearing and cross bars.

D. Safety Grating

1. Safety grating shall be fabricated from sheet metal punched into an open serrated diamond pattern and be formed into plank sections.

2. The open diamond shapes shall be approximately 1-7/8 inches by 11/16-inch in size.

3. Safety grating shall be Grip Strut by Metal Products Division, United States Gypsum Company, Deck Span by IKG Industries, or equal.

E. Heavy-Duty Grating

1. Heavy-duty grating shall be fabricated from welded steel, galvanized after fabrication.

2.8 METAL DECKING

A. Metal decking shall be of the indicated size and gauge, and shall meet the requirements of the AISI specification for the "Design of Light Gauge, Cold-formed Steel Structural Members."

B. The steel shall be hot-dip galvanized after fabrication.

2.9 BOLTS AND ANCHORS

A. Standard Service (Non-Corrosive Application)

1. Unless otherwise indicated, bolts, anchor bolts, washers, and nuts shall be fabricated from steel as indicated.

2. 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.

3. Except as otherwise indicated, steel for bolt material, anchor bolts, and cap screws shall be in accordance with the following requirements:

a. Structural Connections: ASTM A 307, Grade A or B, hot-dip galvanized

b. Anchor Bolts: ASTM A 307, Grade A or B, or ASTM A 36, hot-dip galvanized

c. High-Strength Bolts, where indicated: ASTM A 325

d. Pipe and Equipment Flange Bolts: ASTM A 193, Grade B-7

B. Corrosive Service

1. Bolts, nuts, and washers in the locations listed below shall be fabricated from stainless steel as indicated.

a. all water management pond applications

~~a.~~b. buried locations

~~b.~~c. submerged locations

~~c.~~d. locations subject to seasonal or occasional flooding

~~d.~~e. inside hydraulic structures below the top of the structure

~~e.~~ inside buried vaults, manholes, and structures ~~that do not drain through a gravity sewer or to a sump with a pump~~

f. chemical handling areas

g. inside trenches, containment walls, and curbed areas

h. locations indicated 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 fabricated from Type 316 stainless steel, Class 2, conforming to ASTM A 193 for bolts and to ASTM A 194 for nuts.

D. Buried pipe flange bolts and nuts on pipe of Class 275 and greater shall be in accordance with ASTM A193/A194, Grade B7.

E. Coating

1. Threads on stainless steel bolts shall be protected with an antiseize lubricant suitable for submerged stainless steel bolts, meeting government specification MIL-A-907E.

2. Buried bolts in poorly drained soil shall be coated the same as the buried pipe.

3. Antiseize lubricant shall be classified as acceptable for potable water use by the NSF.

4. 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.

F. 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.

3. Threads shall be Coarse Thread Series conforming to the requirements of the American Standard for Screw Threads.

4. Bolts and cap screws shall have hexagon heads and nuts shall be Heavy Hexagon Series.

5. Bolts and nuts shall be installed with washers fabricated from material matching the base material of bolts, except that hardened washers for high-strength bolts shall conform to the requirements of the AISC Specification.

6. Lock washers fabricated from material matching the bolts shall be installed where indicated.

7. The length of each bolt shall be such that the bolt extends at least 1/8 inch beyond the outside face of the nut before tightening, except for anchor bolts which shall be flush with the face of the nut before tightening.

G. Adhesive Anchors

1. General

   a. Unless otherwise indicated, drilled concrete or masonry anchors shall be adhesive anchors.

   b. No substitutions will be considered unless accompanied with an ICBO report verifying strength and material equivalency.

2. Epoxy Anchors

   a. Epoxy adhesive anchors are required for drilled anchors for outdoor installations, in submerged, wet, splash, overhead, and corrosive conditions, and for anchoring handrails and reinforcing bars.

   b. Epoxy shall be in accordance with the requirements of Section 03315 – Grout.

   c. Threaded rod shall be galvanized for general purpose applications and fabricated from Type 316 stainless steel for use in corrosive applications.

   d. 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.

   e. Epoxy anchors shall not be used where anchors are subject to vibration or fire.

   f. Embedment depth shall be as the manufacturer recommends for the load to be supported.

3. Unless otherwise indicated, glass capsule, polyester resin adhesive anchors will be permitted in locations not included above, and shall be **Hilti HVA**, **Cobra Anchors**, or equal.

4. Threaded rod shall be fabricated from galvanized steel.

H. Expanding-Type Anchors

1. Expanding-type anchors, if indicated or permitted, shall be fabricated from galvanized steel, shall be of the expansion type, and shall be **ITW Ramset/Redhead Trubolt** anchors, **Hilti Kwik-Bolt TZ,** or equal.

2. Lead caulking anchors will not be permitted.

3. Size shall be as indicated.

4. Embedment depth shall be as the manufacturer recommends for the load to be supported.

5. Expansion-type anchors that are to be embedded in grout may be fabricated from steel.

6. Non-embedded buried or submerged anchors shall be fabricated from stainless steel.

I. Non-Shrink Grouted Anchors

1. Anchors, if indicated or permitted, shall be grouted with a non-shrink cementitious grout in accordance with the manufacturer's recommendations.

2. Embedment depth shall be as the manufacturer recommends for the load to be supported.

3. Non-shrink grout material shall be Class B or C in accordance with Section 03315 – Grout.

2.10 POWDER-DRIVEN PINS

A. Powder-driven pins for installation in concrete or steel shall be fabricated from heat-treated steel alloy.

B. 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.

C. Pins shall have capped or threaded heads capable of transmitting the loads the shanks are required to support.

D. Pins that are connected to steel shall be provided with longitudinal serrations around the circumference of the shank.

2.11 IMPACT ANCHOR

A. Impact anchors shall be an expansion-type anchor in which a nail-type pin is driven to produce the expansive force.

B. The pin shall be provided with a zinc sleeve with a mushroom-style head and stainless steel nail pin.

C. 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

1. 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

1. Aluminum railing fabrication and installation shall be performed by craftsmen experienced in the fabrication of architectural metalwork.

2. Exposed surfaces shall be free from defects or other surface blemishes.

3. Dimensions and conditions shall be verified in the field.

4. Joints, junctions, miters, and butting sections shall be precision fitted with no gaps occurring between sections, and with surfaces flush and aligned.

5. Electrolysis protection of materials shall be provided.

C. Unless otherwise indicated, provide a 1/2-inch drain line to the nearest floor drain for floor hatches.

D. Powder-Driven Pins

1. Powder-driven pins shall be installed by a craftsperson certified by the manufacturer as being qualified to install the manufacturer's pins.

2. Pins shall be driven in one initial movement by an instantaneous force that has been carefully selected to attain the required penetration.

3. Driven pins shall conform to the following requirements where "D" is equal to the pin 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	See DRAWINGS

3.2 WELDING

A. Method

1. Welding shall be performed by the metal-arc method or gas-shielded arc method as described in the American Welding Society "Welding Handbook" as supplemented by other pertinent standards of the AWS.

2. The qualification of the welders shall be in accordance with the AWS Standards.

B. Quality

1. In assembly and during welding, the component parts shall be adequately clamped, supported, and restrained in order to minimize distortion and for control of dimensions.

2. Weld reinforcement shall be as indicated by the AWS Code.

3. Upon completion of welding, remove weld splatter, flux, slag, and burrs left by attachments.

4. Welds shall be repaired in order to produce a workmanlike appearance, with uniform weld contours and dimensions.

5. 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.

B. Any galvanized part that becomes warped during the galvanizing operation shall be straightened.

C. Bolts, anchor bolts, nuts, and similar threaded fasteners, after being properly cleaned, shall be galvanized in accordance with the requirements of ASTM A 153.

D. Field Repairs

1. Field repairs to damaged galvanizing shall be performed by preparing the surface and applying a coating.

2. 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.

3. The coating shall be applied to at least 3 mils dry film thickness, and shall be **Zinc-Clad XI** by **Sherwin-Williams**, **Galvax** by **Alvin Products**, **Galvite** by **ZRC Worldwide**, or equal.

3.4 DRILLED ANCHORS

A. Drilled anchors and reinforcing bars shall be installed in strict accordance with the manufacturer's instructions.

B. Holes shall be roughened with a brush on a power drill, and then cleaned and dried.

C. Drilled anchors shall not be installed until the concrete has reached the required 28-day compressive strength.

D. Adhesive anchors shall not be loaded until the adhesive has reached its indicated strength in accordance with the manufacturer's instructions.

- END OF SECTION -

SECTION 11000 - EQUIPMENT GENERAL PROVISIONS

PART 1 -- GENERAL

1.1 THE REQUIREMENT

A. The CONTRACTOR shall provide equipment and appurtenant WORK, complete and operable, in accordance with the Contract Documents.

B. The provisions of this Section shall apply to equipment throughout the Contract except where otherwise indicated.

C. **Equipment Arrangement:** Unless specifically indicated otherwise, the arrangement of equipment indicated is based upon information available at the time of design and is not intended to show exact dimensions particular to a specific manufacturer. Some aspects of the Drawings are diagrammatic and some features of the illustrated equipment arrangement may require revision to meet the actual equipment requirements. Structural supports, foundations, piping and valve connections, and electrical and instrumentation connections indicated may have to be altered to accommodate the equipment provided. No additional payment will be made for such revisions and alterations. Substantiating calculations and drawings shall be submitted prior to beginning the installation of equipment.

1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. Equipment shall be in accordance with the following standards, as applicable and as indicated in each equipment specification:

1. American Society for Testing and Materials (ASTM).

2. American National Standards Institute (ANSI).

3. American Society of Mechanical Engineers (ASME).

4. American Water Works Association (AWWA).

5. American Society of Heating, Refrigerating, and Air Conditioning Engineers (ASHRAE).

6. American Welding Society (AWS).

7. National Fire Protection Association (NFPA).

8. Federal Specifications (FS).

9. National Electrical Manufacturers Association (NEMA).

10. Manufacturer's published recommendations and specifications.

11. General Industry Safety Orders (OSHA).

B. The following standards are referenced in this Section:

ASME B16.1 Cast Iron Pipe Flanges and Flanged Fittings, Class 25, 125, 250, and 800

ASME B16.5	Pipe Flanges and Flanged Fittings, Steel, Nickel Alloy and other Special Alloys
ASME B46.1	Surface Texture
ANSI S12.6	Method for the Measurement of the Real-Ear Attenuation of Hearing Protectors
ASME B1.20.1	General Purpose Pipe Threads (Inch)
ASME B31.1	Power Piping
AWWA C206	Field Welding of Steel Water Pipe
AWWA C207	Steel Pipe Flanges for Waterworks Service - Sizes 4 In. Through 144 In. (100 mm through 3,600 mm)
AWWA D100	Welded Steel Tanks for Water Storage
ASTM A 48	Gray Iron Castings
ASTM A 108	Steel Bars, Carbon, Cold-Finished, Standard Quality

1.3 CONTRACTOR SUBMITTALS

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

B. **Shop Drawings:** Furnish complete drawings and technical information for equipment, piping, valves, and controls. Where indicated or required by the ENGINEER, Shop Drawings shall include clear, concise calculations showing equipment anchorage forces and the capacities of the anchorage elements proposed by the CONTRACTOR.

C. **Spare Parts List:** The CONTRACTOR shall obtain from the manufacturer and submit at the same time as Shop Drawings a list of suggested spare parts for each piece of equipment. CONTRACTOR shall also furnish the name, address, and telephone number of the nearest distributor for each piece of equipment.

1.4 QUALITY ASSURANCE

A. **Costs:** Responsibility shall be the CONTRACTOR'S for performing and paying the costs of inspection, startup, testing, adjustment, and instruction services performed by factory representatives. The COMPANY will pay for costs of power and water. If available, the COMPANY'S operating personnel will provide assistance in the field testing.

B. **Inspection:** The CONTRACTOR shall inform the local authorities, such as building and plumbing inspectors, fire marshal, OSHA inspectors, and others, to witness required tests for piping and plumbing, and related items to obtain required permits and certificates, and shall pay inspection fees.

C. **Quality and Tolerances:** Tolerances and clearances shall be as shown on the Shop Drawings and shall be closely adhered to.

1. Machine WORK shall be of high-grade workmanship and finish, with due consideration to the special nature or function of the parts. Members without milled ends and which are to be framed to other steel parts of the structure may have a variation in the detailed length of not greater than 1/16-inch for members 30-feet or less in length, and not greater than 1/8-inch for members over 30-feet in length.

2. Castings shall be homogeneous and free from non-metallic inclusions and defects. Surfaces of castings which are not machined shall be cleaned to remove foundry irregularities. Casting defects not exceeding 12.5 percent of the total thickness and where defects will not affect the strength and serviceability of the casting may be repaired by approved welding procedures. The ENGINEER shall be notified of larger defects. No repair welding of such defects shall be carried out without the ENGINEER'S written approval. If the removal of metal for repair reduces the stress resisting cross-section of the casting by more than 25 percent or to such an extent that the computed stress in the remaining metal exceeds the allowable stress by more than 25 percent, then the casting may be rejected. Costs of casting new material shall be the CONTRACTOR'S responsibility as part of the WORK.

3. Materials shall meet the physical and mechanical properties in accordance with the reference standards.

D. **Machine Finish:** The type of finish shall be the most suitable for the application and shall be shown in micro-inches in accordance with ANSI B46.1. The following finishes shall be used:

1. Surface roughness not greater than 63 micro-inches shall be required for surfaces in sliding contact.

2. Surface roughness not greater than 250 micro-inches shall be required for surfaces in contact where a tight joint is not required.

3. Rough finish not greater than 500 micro-inches shall be required for other machined surfaces.

4. Contact surfaces of shafts and stems which pass through stuffing boxes and contact surfaces of bearings shall be finished to not greater than 32 micro-inches.

E. **Manufacturer's Experience:** Equipment manufacturer shall have a record of at least 5 years of successful, trouble-free operation in similar applications and size equal or larger than the equipment in this Contract.

PART 2 -- PRODUCTS

A. **Drive Trains and Service Factors:** Service factors shall be applied in the selection or design of mechanical power transmission components. Components of drive train assemblies between the prime mover and the driven equipment shall be designed and rated to deliver the maximum peak or starting torque, speed, and horsepower. All of the applicable service factors shall be considered, such as mechanical (type of prime mover), load class, start frequency, ventilation, ambient temperature, and fan factors. Drive train components include couplings, shafts, gears and gear drives, drive chains, sprockets, and V-belt drives. Unless otherwise indicated, the following load classifications shall apply in determining service factors:

B.

Type of Equipment	Service Factor	Load Classification
Pumps centrifugal or rotary	1.0	Uniform

C. Mechanical Service Factors

	Mechanical Service Factors	
	Electric Motor	**Internal Combustion Engine**
Uniform	1.25	1.50
Moderate Shock	1.50	1.75
Heavy Shock	2.00	2.25

D. For thermal rating adjustments such as start frequency, ambient temperature, and hourly duty cycle factor, ventilation factor, and fan factor, refer to gear manufacturer sizing information.

E. For service factors of electric motors, see Section 16460 - Electric Motors.

F. Where load classifications are not indicated, service factors shall be for standard load classifications and for flexible couplings.

G. **Welding:** Unless otherwise indicated, welding shall conform to the following:

1. Latest revision of AWWA D100.

2. Latest revision of AWWA C206.

3. Composite fabricated steel assemblies that are to be erected or installed inside a hydraulic structure, including any fixed or movable structural components of mechanical equipment, shall have continuous seal welds to prevent entrance of air or moisture.

4. 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.

5. 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 specified 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 are to be painted or coated shall be ground to a minimum of 1/32-inch on the flat.

H. **Protective Coating:** Stainless steel and thermoplastic surfaces~~Equipment~~ shall not be ~~painted or~~ coated. Ferrous surfaces shall be coated~~ in accordance~~ with the manufacturer's standard premium coating system.~~Section 09800 - Protective Coating, unless otherwise indicated.~~ Non-ferrous metal and corrosion-resisting steel surfaces shall be coated with grease or lubricating oil. Coated surfaces shall be protected from abrasion or other damage during handling, testing, storing, assembly, and shipping.

I. **Potable water contact**: Materials immersed in or exposed to potable water shall be listed as compliant with NSF Standard 61.

J. **Protection of Equipment:** Equipment shall be boxed, crated, or otherwise protected from damage and moisture during shipment, handling, and storage. Equipment shall be protected from exposure to corrosive fumes and shall be kept thoroughly dry. Pumps, motors, drives, electrical equipment, and other equipment having anti-friction or sleeve bearings shall be stored in weather tight storage facilities prior to installation. For extended storage periods, plastic equipment wrappers should be avoided to prevent accumulation of condensate in gears and bearings. In addition, motor space heaters shall be energized and shafts shall be rotated. Equipment delivered to the Site with rust or corroded parts shall be rejected. If equipment develops defects during storage, it shall be disassembled, cleaned, and recoated to restore it to original condition.

K. Identification of Equipment Items

1. At the time of shipping, each item of equipment shall have a legible identifying mark corresponding to the equipment number in the Contract Documents for the particular item.

2. After installation, each item of equipment shall be given permanent identification.

a. Pumps, compressors, and blowers of 150 horsepower or less shall receive acrylic plastic nametags in accordance with Section 10400 – Identifying Devices.

~~L. **Vibration Isolators:** Air compressors, blowers, engines, inline fans shall be provided with restrained spring-type vibration isolators or pads per manufacturer's written recommendations. Vibration isolations shall be provided with seismic restraint.~~

~~M.~~L. **Shop Fabrication:** Shop fabrication shall be performed in accordance with the Contract Documents and the Shop Drawings.

~~N.~~M. **Controls:** Equipment and system controls shall be in accordance with Division 17 - Instrumentation.

2.2 EQUIPMENT SUPPORTS AND FOUNDATIONS

A. **Equipment Supports:** Unless otherwise indicated, equipment supports, anchors, and restrainers shall be adequately designed for static, dynamic, wind, and seismic loads. The design horizontal seismic force shall be the greater of: that noted in the general structural notes or as required by the governing building code, or 10 percent of gravity. Submitted design calculations for equipment supports shall bear the signature and seal of an engineer registered in the State wherein the project is to be built, unless otherwise indicated. Calculations shall account for forces and distribution of forces on supporting structures resulting from normal operation, normal operation plus seismic loadings, and normal operation plus wind loadings.

1. Wall-mounted equipment weighing more than 250 pounds or which is within 18-inches above the floor shall be provided with fabricated steel supports. Pedestals shall be of welded steel. If the supported equipment is a panel or cabinet or is enclosed with removable sides, the pedestal shall match the supported equipment in appearance and dimensions.

2. Seismic requirements: Freestanding and wall-hung equipment shall be anchored in place by methods that satisfy the building code. Calculations shall be performed and signed and stamped for equipment weighing more than 400 pounds. Calculations shall analyze lateral and overturning forces and shall include a factor of safety against overturning equal to 1.5. Calculations shall include the distribution of forces imposed on the supporting structure and anchors, verifying that each anchor can develop the required resistance forces.

3. Wind requirements: Exterior freestanding equipment shall be anchored in place by methods that satisfy the building code.~~ Calculations shall be performed and signed and stamped, analyzing lateral and overturning forces and shall include a factor of safety against overturning equal to 1.5. Calculations shall include the distribution of forces imposed on the supporting structure and anchors, verifying that each anchor can develop the required resistance forces.~~

B. **Anchors:** Anchor bolts shall be in accordance with Section 05500 - Miscellaneous Metalwork. CONTRACTOR shall determine the size, type, capacity, location, and other placement requirements of anchorage elements. Anchoring methods and leveling criteria in the manufacturer's literature shall be followed. Submit methods and criteria with the Shop Drawings.

2.3 SHAFTING

A. **General:** Shafting shall be continuous between bearings and shall be sized to transmit the power required. Keyways shall be accurately cut in line. Shafting shall not be turned down at the ends to accommodate bearings or sprockets whose bore is less than the diameter of the shaft. Shafts shall rotate in the end bearings and shall be turned and polished, straight, and true.

B. **Design Criteria**: Shafts shall be designed to carry the steady state and transient loads suitable for unlimited number of load applications, in accordance with ASME B106.1M - Design of Transmission Shafting. Where shafts are subjected to fatigue stresses, such as frequent start and stop cycles, the mean stress shall be determined by using the modified Goodman Diagram. The maximum torsional stress shall not exceed the endurance limit of the shaft after application of the factor of safety of 2 in the endurance limit and the stress concentration factor of the fillets in the shaft and keyway. Stress concentration factor shall be in accordance with ASME Standard B17.1 - Keys and Keyseats.

C. **Materials:** Shafting materials shall be appropriate for the type of service and torque transmitted. Environmental elements such as corrosive gases, moisture, and fluids shall be taken into consideration. Materials shall be as indicated unless furnished as part of an equipment assembly.

~~1. Low carbon cold-rolled steel shafting shall conform to ASTM A 108, Grade 1018.~~

~~2. Medium carbon cold-rolled shafting shall conform to ASTM A 108, Grade 1045.~~

~~3. Other grades of carbon steel alloys shall be suitable for service and load.~~

~~4.~~1. Corrosion-resistant shafting shall be stainless steel or Monel, whichever is most suitable for the intended service.

2.4 BEARINGS

A. **General:** Bearings shall conform to the standards of the American Bearing Manufacturers Association, Inc. (ABMA).

B. To assure satisfactory bearing application, fitting practice, mounting, lubrication, sealing, static rating, housing strength, and lubrication shall be considered in bearing selection.

C. Re-lubricatable type bearings shall be equipped with hydraulic grease fittings in an accessible location and shall have sufficient grease capacity in the bearing chamber.

D. Lubricated-for-life bearings shall be factory-lubricated with the manufacturer's recommended grease to insure maximum bearing life and best performance.

E. **Anti-Friction Type Bearing Life:** Except where otherwise indicated, bearings shall have a minimum L-10 life expectancy of 5 years or 20,000 hours, whichever occurs first. Where so indicated, bearings shall have a minimum rated L-10 life expectancy corresponding to the type of service, as follows:

Type of Service	Design Life, years	L-10 Design Life, hours
	(whichever comes first)	
8-hour shift	10	20,000
16-hour shift	10	40,000
Continuous	10	60,000

F. Bearing housings shall be of cast iron or steel and bearing mounting arrangement shall be as indicated or as recommended in the published standards of the manufacturer. Split-type housings may be used to facilitate installation, inspection, and disassembly.

G. **Sleeve Type Bearings**: Sleeve-type bearings shall have a cast iron or ductile iron housing and Babbitt or bronze liner. Bearing housing shall be bolted and doweled to the lower casing half. These housings shall be provided with cast iron caps bolted in place and the bearing end caps shall be bored to receive the bearing shells. Sleeve bearings shall be designed on the basis of the maximum allowable load permitted by the bearing manufacturer. If the sleeve bearing is connected to an equipment shaft with a coupling, the coupling transmitted thrust will be assumed to be the maximum motor or equipment thrust. Lubricant, lubrication system, and cooling system shall be as recommended by the bearing manufacturer.

H. **Plate Thrust Bearings**: Thrust bearings shall be the **Kingsbury** Type, designed and manufactured to maintain the shaft in the fixed axial position without undue heating or the necessity of adjustment or attention. Bearings shall be oil lubricated to suit the manufacturer's standard method of lubrication for the specific bearing. If bearing cooling is required, manufacturer shall provide necessary piping, filters, and valves.

2.5 PIPING CONNECTIONS

A. **Pipe Hangers, Supports, and Guides:** Pipe connections to equipment shall be supported, anchored, and guided to avoid stresses and loads on equipment flanges and equipment. ~~Supports and hangers shall be in accordance with Section 15006 - Pipe Supports.~~

B. **Flanges and Pipe Threads:** Flanges on equipment and appurtenances shall conform to ASME B16.1, Class 125, or B16.5, Class 150, unless otherwise indicated. Pipe threads shall be in accordance with ASME B1.20.1 and Section 15000 - Piping, General.

~~C. **Flexible Connectors:** Flexible connectors shall be installed in piping connections to engines, blowers, compressors, and other vibrating equipment and in piping systems in accordance with the requirements of Section 15000. Flexible connectors shall be harnessed or otherwise anchored to prevent separation of the pipe where required by the installation.~~

~~D. **Insulating Connections:** Insulating bushings, unions, couplings, or flanges, as appropriate, shall be used in accordance with the requirements of the Section 15000.~~

2.6 GASKETS AND PACKINGS

A. Gaskets shall be in accordance with Section 15000.

B. Packing around valve stems and reciprocating shafts shall be of compressible material, compatible with the fluid being used. Chevron-type "V" packing shall be **Garlock No. 432, John Crane Everseal,** or equal.

C. Packing around rotating shafts (other than valve stems) shall be "O" rings, stuffing boxes, or mechanical seals, suitable for the fluid as recommended by the manufacturer and approved by the ENGINEER, in accordance with Section 11100 - Pumps, General.

2.7 NAMEPLATES

A. Equipment nameplates of stainless steel shall be engraved or stamped and fastened to the equipment in an accessible location with No. 4 or larger oval head stainless steel screws or drive pins. Nameplates shall contain the manufacturer's name, model, serial number, size, characteristics, and appropriate data describing the machine performance ratings.

2.8 TOOLS AND SPARE PARTS

A. **Tools:** The CONTRACTOR shall furnish one complete set of special wrenches and other special tools necessary for the assembly, adjustment, and dismantling of the equipment. Tools shall be of best quality hardened steel forgings with bright finish. Wrench heads shall have work faces dressed to fit nuts. Tools shall be suitable for professional work and manufactured by **Snap On, Crescent, Stanley,** or equal. The set of tools shall be neatly mounted in a labeled toolbox of suitable design provided with a hinged cover.

B. Spare parts shall be furnished as indicated in the individual equipment sections. Spare parts shall be suitably packaged in a metal box and labeled with equipment numbers by means of stainless steel or solid plastic nametags attached to the box.

2.9 EQUIPMENT LUBRICANTS

A. The CONTRACTOR shall provide lubricants for equipment during shipping, storage, and prior to testing, in accordance with the manufacturer’s recommendations. Lubricants that could come in contact with potable water shall be food grade lubricants. After successful initial testing, final testing, and satisfactory completion startup testing per Section 01660 - Equipment Testing and Plant Startup, the CONTRACTOR shall conduct one complete lubricant change on all equipment. In addition, the CONTRACTOR shall be responsible

for the proper disposal of used lubricants. The COMPANY will then be responsible for subsequent lubricant changes

PART 3 -- EXECUTION

3.1 SERVICES OF MANUFACTURER

A. **Inspection, Startup, and Field Adjustment**: Where required by individual sections, an authorized, experienced, and competent service representative of the manufacturer shall visit the Site for the number of Days indicated in those sections to witness or perform the following and to certify in writing that the equipment and controls have been properly installed, aligned, lubricated, adjusted, and readied for operation.

1. Installation of equipment

2. Inspection, checking, and adjusting the equipment and approving its installation

3. Startup and field testing for proper operation, efficiency, and capacity

4. Performing field adjustments during the test period to ensure that the equipment installation and operation comply with requirements

B. Instruction of the COMPANY'S Personnel

1. Where required by the individual equipment sections, an authorized training representative of the manufacturer shall visit the Site for the number of Days indicated in those sections to instruct the COMPANY'S personnel in the operation and maintenance of the equipment, including step-by-step troubleshooting with necessary test equipment. Instruction shall be specific to the models of equipment provided.

2. The representative shall have at least 2 years of experience in training. A resume of the representative shall be submitted.

3. Training shall be scheduled 3 weeks in advance of the scheduled session.

4. Proposed training material and a detailed outline of each lesson shall be submitted for review. Review comments from the ENGINEER shall be incorporated into the material.

5. The training materials shall remain with the trainees after the session.

6. The COMPANY may videotape the training for later use by the COMPANY'S personnel.

3.2 INSTALLATION

A. **General:** Equipment shall be installed in accordance with the manufacturer's written recommendations.

B. **Alignment**: Equipment shall be field tested to verify proper alignment.

3.3 PACKAGED EQUIPMENT

A. When any system is furnished as pre-packaged equipment, the CONTRACTOR shall coordinate space and structural requirements, clearances, utility connections, signals, and outputs with Subcontractors to avoid later change orders.

B. If the packaged system has any additional features (as safety interlocks, etc.) other than required by the Contract Documents, the CONTRACTOR shall coordinate such features with the ENGINEER and provide material and labor necessary for a complete installation as required by the manufacturer.

3.4 FIELD ASSEMBLY

A. Studs, cap screws, bolt and nuts used in field assembly shall be coated with **Never Seize** compound or equal.

3.5 WELDING

A. Welds shall be cleaned of weld-slag, splatter, etc. to provide a smooth surface.

3.6 FIELD TESTS

A. Where indicated by the individual equipment sections, equipment shall be field tested after installation to demonstrate satisfactory operation without excessive noise, vibration, or overheating of bearings or motor.

B. The following field testing shall be conducted:

1. Start equipment, check, and operate the equipment over its entire operating range. Vibration level shall be within the amplitude limits as indicated or as recommended by the reference applicable standards.

2. Obtain concurrent readings of motor voltage, amperage, capacity, vibration, and bearing temperatures.

3. Operate equipment indicated in Section 01660.

C. The ENGINEER shall witness field-testing. The CONTRACTOR shall notify the ENGINEER of the test schedule 3 Days in advance.

D. In the event that any equipment fails to meet the test requirements, the equipment shall be modified and retested until it satisfies the requirement.

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SECTION 11100 - PUMPS, GENERAL

PART 1 -- GENERAL

1.1 THE REQUIREMENT

A. Provide pumps and pumping appurtenances, complete and operable, as indicated in accordance with the Contract Documents.

B. The provisions of this Section shall apply to pumps and pumping equipment throughout the Contract Documents, except where otherwise indicated.

C. Unit Responsibility

1. The pump manufacturer shall be made responsible for furnishing the WORK and for the coordination of design, assembly, testing, and installation of the WORK of each specific pump Section.

2. The CONTRACTOR shall be responsible to the COMPANY for compliance with the requirements of each specific pump Section.

D. Single Manufacturer

1. Where 2 or more pump systems of the same type or size are required, provide pumps produced by the same manufacturer.

1.2 CONTRACTOR SUBMITTALS

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

B. Shop Drawings

1. Submit pump name, identification number, and specification Section number.

2. Performance Information

a. Submit performance data curves showing head, capacity, horsepower demand, NPSH required, and pump efficiency over the entire operating range of the pump.

b. Require the equipment manufacturer to indicate separately the head, capacity, horsepower demand, overall efficiency, and minimum submergence required at the design flow conditions and the maximum and minimum flow conditions.

c. Submit performance curves at intervals of 100 RPM from minimum speed to maximum speed for each centrifugal pump equipped with a variable speed drive.

3. Operating Range

a. Require the manufacturer to indicate the limits on the performance curves recommended for stable operation without surge, cavitation, or excessive vibration.

b. Provide a stable operating range as wide as possible, based on actual hydraulic and mechanical tests.

4. Submit assembly and installation drawings. including shaft size, seal, coupling, bearings, anchor bolt plan, part nomenclature, material list, outline dimensions, and shipping weights.

5. Submit data, in accordance with the requirements of Section 16460 – Electric Motors, for the electric motor proposed for each pump.

6. Submit an elevation of the proposed local control panel, showing panel-mounted devices, details of enclosure type, a single-line diagram of power distribution, current draw of the panel, and a list of all terminals required to receive inputs or to transmit outputs from the local control panel.

7. Submit a wiring diagram of field connections, with identification of terminations between local control panels, junction terminal boxes, and equipment items.

8. Submit a complete electrical schematic diagram.

C. Technical Manual

1. Submit a Technical Manual containing the required information indicated in Section 01300 – Contractor Submittals and each specific pump Section.

D. Spare Parts List

1. Submit a spare parts list containing the required information indicated in Section 01300 – Contractor Submittals and each specific pump Section.

E. Factory Test Data

1. Submit signed, dated, and certified factory test data for each pump system which requires factory testing.

2. Submit these data before shipment of equipment.

F. Certifications

1. Submit the manufacturer's certification of proper installation.

2. Submit the CONTRACTOR's certification of satisfactory field testing.

PART 2 -- PRODUCTS

2.1 GENERAL

A. Compliance with the requirements of the specific pump Sections may necessitate modifications to the manufacturer's standard equipment.

B. Performance Curves

1. Provide centrifugal pumps with a continuously rising curve or with the system operating range not crossing the pump curve at 2 different capacities or “dip region.”

2. Unless otherwise indicated, the required shaft horsepower for the entire pump assembly at any point on the performance curve shall not exceed the rated horsepower of the motor or engine or encroach on the service factor.

C. Compatibility

1. Provide entirely compatible components of each pump system provided under the specific pump Section.

2. In each unit of pumping equipment, incorporate basic mechanisms, couplings, electric motors or engine drives, variable speed controls, necessary mountings, and appurtenances.

2.2 MATERIALS

A. Provide materials suitable for the intended application.

B. For materials not indicated, provide high-grade, standard commercial quality, free from defects and imperfections that might affect the serviceability of the product for the purpose for which it is intended, and conforming to the following requirements:

1. Provide cast iron pump casings and bowls constructed of close-grained gray cast iron, conforming to ASTM A 48 - Gray Iron Castings, Class 30, or equal.

2. Provide bronze pump impellers conforming to ASTM B 62 - Composition Bronze or Ounce Metal Castings, or B 584 - Copper Alloy Sand Castings for General Applications, where dezincification does not occur.

3. Provide pump shafts constructed of Type 416 or 316 stainless steel.

4. Miscellaneous stainless steel parts shall be of Type 316.

5. Provide anchor bolts, washers, and nuts in standard service (non-corrosive application) of galvanized steel in accordance with the requirements of Section 05500 – Miscellaneous Metalwork.

6. Provide anchor bolts, washers, and nuts in corrosive service as defined in Section 05500 – Miscellaneous Metalwork, of stainless steel in accordance with Section 05500 – Miscellaneous Metalwork.

C. Materials in contact with potable water shall be listed as compliant with NSF Standard 61.

2.3 PUMP COMPONENTS - GENERAL

A. Flanges and Bolts

B. Provide suction and discharge flanges conforming to ASME B16.1 - Cast Iron Pipe Flanges and Flanged Fittings, Class 25, 125, 250, and 800 or ASME B16.5 - Pipe Flanges and Flanged Fittings dimensions.

C. Provide bolts shall be in accordance with the requirements of Section 05500 – Miscellaneous Metalwork.

D. Lubrication

1. Vertical pump shafts of clean water pumps shall be product water-lubricated, unless otherwise indicated.

2. Provide deep-well pumps and pumps with dry barrels with water- or oil-lubricated bearings and seals, and enclosed line shafts.

3. Pumps for sewage, sludge, and other process fluids shall be lubricated as indicated.

E. Hand holes

1. Provide hand holes on pump casings shaped to follow the contours of the casing in order to avoid any obstructions in the water passage.

F. Drains

1. Pipe gland seals, air valves, cooling water drains, and drains from variable speed drive equipment to the nearest floor sink or drain, using galvanized steel pipe or copper tube that is properly supported with brackets.

G. Grease Lubrication

1. For vertical propeller, mixed-flow, and turbine pumps, other than deep well pumps, of bowl sizes 10-inch and larger, provide a stainless steel tube attached to the column for grease lubrication of the bottom bearing.

H. Stuffing Boxes

1. Where stuffing boxes are indicated for the pump seal, provide stuffing boxes of the best quality, using the manufacturer's suggested materials best suited for the specific application.

2. For sewage, sludge, drainage, and liquids containing sediments, provide fresh-water-flushed seals, using lantern rings.

3. If fresh water is not available, the seal shall be flushed with product water cleaned by a solids separator as manufactured by **John Crane Co., Lakos (Claude Laval Corp.),** or equal.

4. Conventional Packing Gland Type Seal

   a. Unless otherwise indicated, provide packing material of Teflon braiding, containing 50 percent ultrafine graphite impregnation in order to satisfy the requirements listed in the table below.

   b. Acceptable ring materials are asbestos-free die-molded packing rings of braided graphite material free of PTFE, **Chesterton 1400R** or equal, for non-potable water service, and braided PTFE material, **Chesterton 1725** or equal, that is listed under NSF Standard 61 for potable water service.

c. Seal Requirements

Shaft speeds	up to 2500 fpm
Temperature	up to 500 deg F
pH range	0 - 14

5. Mechanical Seals (Conventional Non-Split-Type)

   a. Provide mechanical seals of the fresh water-flushed-type, unless otherwise indicated in which case use product water cleaned by a solids separator as indicated above.

   b. Provide mechanical seals as manufactured by the following, or equal:

Sewage, Sludge, or Wastewater Pumps	Double seals	John Crane Type 5620P, Flowserve Type ISCPP, Chesterton Type GDS or 255
Abrasives, Grit, or Lime Slurry Pumps	Double seals	John Crane Type 5620P (hard faces), Flowserve Type ISCPP or SLC (check with pump manufacturer), Chesterton Type GDS or 255
Chemicals or Corrosive Liquid Pumps	Single seals	John Crane Type 8-1 or 9, Flowserve Type ISCPX, or Chesterton Type UV, GSS, or 155
Water Pumps (hot and cold)	Single seals	John Crane Type 5610Q, Flowserve Type ISCPX, Chesterton Type UV, GSS, or 155

6. Where indicated, circulate a buffer fluid at a minimum 20 psi above discharge pressure, or as required by the manufacturer, in order to maintain reliable seal performance.

7. Equip mechanical seals with nonclogging, flexible–mounted seats with elastomer secondary seals.

8. Provide wetted metal parts constructed of Type 316 stainless steel, Alloy 20, or Hastelloy B or C, whichever has the best corrosion resistance to the pumped fluid.

9. Provide double-balanced dual cartridge seals in order to allow for seal integrity in case of flush water pressure reversal.

10. Provide springs in single and double seals, in the non-wetted end of the seal.

11. Deliver fresh water to the seals through appropriate size piping with plug valves, strainers, pressure regulators, electrically operated solenoid valves, and rotameters.

12. Wiring shall comply with the requirements of Division 16 – Electrical, and solenoid control shall comply with the requirements of Division 17 – Instrumentation and Control.

2.4 PUMP APPURTENANCES

A. Nameplates

1. Equip each pump with a stainless steel nameplate indicating serial number(s), rated head and flow, impeller size, pump speed, and manufacturer's name and model number.

B. Solenoid Valves

1. Require the pump manufacturer to provide solenoid valves on the water or oil lubrication lines and on cooling water lines.

2. Provide solenoid valve electrical ratings compatible with the motor control voltage.

C. Gauges

1. Equip~~Except for sample pumps, sump pumps, and hot water circulating pumps, equip~~ pumps with pressure gauges installed at the pump discharge lines.

~~2. Provide pump suction lines with compound gauges.~~

~~3.~~2. Located gauges in a representative location, where not subject to shock or vibrations, in order to achieve true and accurate readings.

~~4.~~3. Where subject to shock or vibrations, wall-mount the gauges or attach the gauges to galvanized channel floor stands and connect by means of flexible connectors.

4. Construction

   a. Diameter: 4-1/2 inches

   b. bottom connected

   c. white laminated dials and black graduations

   d. Windows: acrylic

5. Provide the ~~pressure and compound~~ gauges ~~in accordance~~ with a blowout disc, and encase in phenolic, steel, or cast iron.

6. The measuring element shall be a stainless steel bourdon tube with welded, stress-relieved joints.

7. Provide the socket with wrench flats.

8. Provide a rotary- geared movement and construct~~the requirements~~ of stainless steel.

9. Provide the gauges with a pulsation snubber constructed of Type 316 stainless steel, and an isolation valve.

10. Calibrate the gauges to read in applicable units.

11. Provide an accuracy of plus and minus 1/2-percent range to 150 percent of the working pressure or vacuum of the pipe or vessel to which the gauge is connected.

12. ~~Section 17122 –~~ Pressure Gauges Manufacturer, or Equal

    a. Ashcroft 1279

~~5.~~13. Ametek Solfrunt Series 1900~~.~~

2.5 FACTORY TESTING

A. Conduct the following tests on each indicated pump system:

1. Motors

    a. Test electric motors in accordance with the requirements of Section 16460 – Electric Motors.

    b. Furnish test results to the pump manufacturer prior to the pump test.

2. Factory Non-witnessed Test

    a. Test centrifugal pump systems with drives 10 hp up to and including 125 hp at the pump factory in accordance with the American National Standard for Centrifugal Pump Tests (ANSI/HI 1.6) acceptance Level "1U" or the American National Standard for Vertical Pump Tests (ANSI/HI 2.6) as approved by ANSI and published by the Hydraulic Institute.

    b. For sump pumps and sample pumps, acceptance shall be in accordance with Level "2" of ANSI/HI 1.6, unless otherwise indicated.

    c. Perform tests using the complete pump system to be furnished, including the Project motor and variable speed drive if equipped with variable speed drive.

    d. For pumps with motors smaller than 100 hp, the manufacturer's certified test motor will be accepted.

    e. Testing of prototype models will not be accepted.

    f. Conduct the following minimum tests and submit the test results:

        1) hydrostatic test;

        2) Performance Test:

            a) Conduct performance testing at maximum speed, obtain a minimum of 5 hydraulic test readings between shutoff head and 25 percent beyond the maximum indicated capacity, and record on data sheets as defined by the Hydraulic Institute standards;

            b) For variable speed driven pumps, test each pump between maximum and minimum speed at 100-RPM increments;

c) Submit pump curves showing head, flow, bhp, and efficiency results;

3) mechanical test;

4) NPSH

a) Perform a net positive suction head required test (NPSHr3), if required by the specific pump Section.

b) If not required by the specific pump Section, submit the published manufacturer-calculated NPSHr3 curve.

g. Submit certification signed by a senior official of the pump manufacturer that the pump shaft horsepower demand did not exceed the rated motor horsepower of 1.0 service rating at any point on the curve.

h. Submit test results to the ENGINEER for review prior to delivery to the Site.

3. Acceptance

a. In the event of failure of any pump to meet any of the requirements, make necessary modifications, repairs, or replacements in order to conform to the requirements of the Contract Documents, and re-test the pump until found satisfactory.

PART 3 -- EXECUTION

3.1 MANUFACTURER'S SERVICES

A. Inspection, Startup, and Field Adjustment

1. Where required by the specific pump Section, furnish an authorized service representative of the manufacturer at the Site continuously to supervise the following items and to certify in writing that the equipment and controls have been properly installed, aligned, lubricated, adjusted, and readied for operation:

a. installation of the equipment;

b. inspection, checking, and adjusting the equipment;

c. startup and field testing for proper operation; and

d. performance of field adjustments to ensure that the equipment installation and operation comply with the indicated requirements.

B. Instruction of COMPANY's Personnel

1. Where required by the individual pump Section, furnish an authorized training representative of the manufacturer at the Site for the number of Days indicated in the specific pump Section, to instruct the COMPANY's personnel in the operation and maintenance of the equipment, including step-by-step troubleshooting with necessary test equipment.

2. Furnish instruction specific to the model of equipment provided.

3. Qualifications

   a. Furnish a representative with at least 2 years of experience in training.

   b. Submit a resume for the representative.

4. Schedule the training a minimum of 3 weeks in advance of the first session.

5. Lesson Plan Review

   a. Submit the proposed training material and a detailed outline of each lesson for review.

   b. Incorporate review comments into the material.

6. The trainees will keep the training materials.

7. The COMPANY may videotape the training for later use with the COMPANY's personnel.

3.2 INSTALLATION

A. General

1. Install pumping equipment in accordance with the manufacturer's written recommendations.

B. Alignment

1. Field-test the equipment in order to verify proper alignment and freedom from binding, scraping, shaft runout, or other defects.

2. Measure the pump drive shafts just prior to assembly in order to ensure correct alignment without forcing.

3. Ensure that the equipment is secure in position and neat in appearance.

C. Lubricants

1. Provide the necessary oil and grease for initial operation.

3.3 PROTECTIVE COATING

A. Coat materials and equipment in accordance with the requirements of Section 09800 – Protective Coating.

3.4 FIELD TESTS

A. Field-test each pump system after installation in order to demonstrate:

1. satisfactory operation without excessive noise and vibration;

2. no material loss caused by cavitation;

3. no overheating of bearings; and,

4. indicated head, flow, and efficiency at the design point.

B. Conduct the following field testing:

1. Startup, check, and operate the pump system over its entire speed range.

2. If the pump is driven by a variable speed drive, test the pump and motor at 100-RPM increments.

3. If the pump is driven at constant speed, test the pump and motor at the maximum RPM.

4. Unless otherwise indicated, vibration shall be within the amplitude limits recommended by the Hydraulic Institute standards at a minimum of 4 pumping conditions defined by the ENGINEER.

5. Obtain concurrent readings of motor voltage, amperage, pump suction head, and pump discharge head for at least 4 pumping conditions at each pump rotational speed, at 100-RPM increments if equipped with a variable speed drive or at maximum RPM if equipped with a constant speed drive.

6. Check each power lead to the motor for proper current balance.

7. Bearing Temperatures

   a. Determine bearing temperatures by a contact-type thermometer.

   b. Precede this test with a run time sufficient to stabilize bearing temperatures, unless an insufficient liquid volume is available to furnish such a run time.

8. Ensure that electrical and instrumentation tests conform to the requirements of the Section under which that equipment is specified.

C. Witnessing

1. Field testing will be witnessed by the ENGINEER.

2. Furnish 3 Days advance notice of field testing.

D. If the pumping system fails to meet the indicated requirements, modify or replace the pump and re-test as indicated above until it satisfies the indicated requirements.

E. Certification

1. After each pumping system has satisfied the requirements, certify in writing that it has been satisfactorily tested and that final adjustments have been performed.

2. Certification shall include the date of the field tests, a listing of persons present during the tests, and the test data.

F. The CONTRACTOR shall be responsible for costs of field tests, including related services of the manufacturer's representative, except for power and water, which the COMPANY will bear.

G. If available, the COMPANY'S operating personnel will provide assistance in field testing.

- END OF SECTION -

SECTION 11155 - DEWATERING PUMPS

PART 1 -- GENERAL

1.1 GENERAL DESCRIPTION

A. Identification:

Pump Name	Equipment Number
Pit 3 Waste Rock Dewatering	P-0031
Pit 3 Underdrain	P-0035
Pit 4 Waste Rock Dewatering	P-0041
Pit 4 Underdrain	P-0045
Central Drainage Alluvial	TP~~P~~-0060
Western Drainage Alluvial	TP~~P~~-0070
Far East~~Eastern~~ Drainage Alluvial	TP~~P~~-0080
Alluvial Ground Water Controls Wet Well	TP~~P~~-0090
Seepage Collector Dewatering Wet Well	P-0101
South Pond East Cell	TP-0131
South Pond West Cell	TP-0132
West Pond	TP~~P~~-0105

B. **Operating Conditions:** The WORK of this Section shall be suitable for long term operation under the following conditions:

Duty	Constant
Drive	Full Voltage Non-Reversing
Ambient environment	Submerged /Outdoors
Ambient temperature, °F	0 to 100
Ambient relative humidity, percent	Submerged
Fluid service	Water
Fluid temperature, °F	Ambient
Fluid pH range	4.0-8.0
Fluid specific gravity	1.0
Project site elevation, msl	2350 to 3275
Maximum size spheres to pass~~, inches diameter~~	Sand
Pump removal method	Well casing/Pond riser
Pump Control	Water Level

~~C.~~ Performance Requirements:

~~Equipment Number~~	~~P-0031~~	~~P-0035~~	~~P-0041~~	~~P-0045~~	~~P-0060~~	~~P-0070~~	~~P-0080~~	~~P-0090~~	~~P-0101~~	~~P-0105~~
~~Design flow capacity, gpm~~	~~228~~	~~366~~	~~68~~	~~128~~	~~15~~	~~15~~	~~15~~	~~45~~	~~10~~	~~500~~
~~Design flow TDH, feet~~	~~425~~	~~455~~	~~245~~	~~315~~	~~37~~	~~51~~	~~22~~	~~205~~	~~250~~	~~55~~
~~Design flow~~	~~72~~	~~78~~	~~56~~	~~75~~	~~-~~	~~-~~	~~-~~	~~60~~	~~50~~	~~78~~

~~minimum hydraulic efficiency, percent~~										
~~Minimum motor size, hp~~	~~40~~	~~60~~	~~7.5~~	~~15~~	~~0.5~~	~~0.5~~	~~0.5~~	~~5~~	~~1~~	~~15~~
~~Power supply~~	~~480 VAC, 3 Ø, 60 Hz~~	~~480 VAC, 3 Ø, 60 Hz~~	~~480 VAC, 3 Ø, 60 Hz~~	~~480 VAC, 3 Ø, 60 Hz~~	~~230 VAC, 1 Ø, 60 Hz~~	~~230 VAC, 1 Ø, 60 Hz~~	~~230 VAC, 1 Ø, 60 Hz~~	~~230 VAC, 1 Ø, 60 Hz~~	~~230 VAC, 1 Ø, 60 Hz~~	~~480 VAC, 3 Ø, 60 Hz~~

Equipment Number	Design flow capacity, gpm	Design flow TDH, feet	Design flow minimum hydraulic efficiency, percent	Minimum motor size, hp	Power
P-0031	228	450	60	50	480 VAC, 3 Ø, 60 Hz
P-0035	366	500	75	60	480 VAC, 3 Ø, 60 Hz
P-0041	68	250	56	7.5	480 VAC, 3 Ø, 60 Hz
P-0045	128	315	75	15	480 VAC, 3 Ø, 60 Hz
TP-0060	15	37	-	0.5	230 VAC, 3 Ø, 60 Hz
TP-0070	15	51	-	0.5	230 VAC, 3 Ø, 60 Hz
TP-0080	15	42	-	0.5	230 VAC, 3 Ø, 60 Hz
TP-0090	45	205	60	5	230 VAC, 3 Ø, 60 Hz
P-0101	10	250	50	1	230 VAC, 3 Ø, 60 Hz
TP-0131	250	75	75	7.5	480 VAC, 3 Ø, 60 Hz
TP-0132	250	75	75	7.5	480 VAC, 3 Ø, 60 Hz
TP-0105	500	55	78	15	480 VAC, 3 Ø, 60 Hz

1.2 PUMP REQUIREMENTS

A. General

1. Each pump shall be capable of pumping mine tailing water. See mine water chemistry elsewhere in these specifications.

2. Each pump shall be capable of continuous operation at full load, without cavitation or overheating of the motor.

3. Each pump, with its cable and appurtenances, shall be able to withstand continuous maximum submergence, whether running or off, without leakage.

4. Each pump shall be supplied with a built-in check valve to prevent flow back through the pump.

B. Each pump shall be controlled by means of a level transducer or floats. The transducer shall be set to activate the pump at a maximum level and deactivate the pump at a minimum level above the invert of the pond sump invert. The floats shall have a high and a low level to deactivate and activate the pump, respectively. The float system shall also have a high, high level to indicate an alarm condition.

C. Pump Construction: Construction of submersible pumps shall conform to the following requirements:

Bowls	Type 316 stainless steel
Impeller (multi-stage vertical turbine)	Stainless steel, Type 316
Impeller seal ring	Stainless steel
Impeller shaft method of connection	Type 316 stainless steel impeller lock collet
Wear rings	Stainless steel, hard-faced, replaceable
Bowl shaft	Stainless steel, Type 410, 416, or 316
Suction case and strainer	Type 316 stainless steel
Motor Adaptor	Type 316 stainless steel
Suction case bearing	Stainless steel
Bowl bearing	Rubber with stainless steel
Pump to motor coupling	Stainless steel

D. Drive

1. Motor Design

a. Provide a squirrel cage induction motor designed for continuous underwater operation in conformance with NEMA standards.

b. Provide a bearing rated for a minimum of 130 percent of the maximum pump downthrust load.

c. Do not use oils or grease lubrication.

d. The shaft seal shall be a Nitrite rubber lip seal or a Nitrite, carbon, carbide or ceramic face seal.

e. A mercury-type shaft seal will not be accepted.

f. Provide exterior material construction of Type 316 or 316L stainless steel

g. The~~Do not exceed the~~ nameplate horsepower shall not be exceeded at any point on the pump curve.

h. See Specification 16460 for additional requirements.

2. Electrical Cable

a. Provide necessary cables for power connection, control wires, and overload protection, sheathed, coded, and suitable for submersible pumps, and of sufficient length for direct and continuous connection from the motor to the control panels located above ground.

b. Provide the surface plate with a power cable splice box that meets the requirements of the National Electrical Code.

c. If indicated, provide a junction box that meets the requirements of the National Electrical Manufacturer's Association (NEMA).

d. Connect cables to the pumps and test at the factory.

e. If the cables are not assembled in the factory, the field connection of the cable to the motor shall be supervised and certified by the pump manufacturer's representative.

f. Splicing of cable between the motor and the terminal box will not be accepted.

g. The size and type of cable shall be determined by the pump manufacturer, suitable for the application.

h. Fully contain the motor lead-to-electrical cable within the water-tight motor housing and conform to IEEE and NEC standards.

i. Provide an electrical wire of annealed, bare, 19-stranded copper conductors insulated with PVC.

j. Jacket the power conductors plus a ground conductor in a flat heavy-duty PVC jacketing.

k. Provide UL-listed cable in accordance with UL83 Type TW Construction A, as Deep Well Submersible Cable.

l. Size power conductors to allow no more than 5 percent voltage loss in the entire length.

m. Size the grounding conductor in accordance with Table 24.3 of UL83.

n. Strap the electrical cable to the discharge column with stainless steel bands.

3. Motor Rating

   a. Provide motors with a service factor of 1.10 or greater.

4. Provide the motor with a junction box capable of being sealed completely from the stator casing in order to prevent leakage through the junction box into the stator housing should a motor cable be damaged, or provide some other means to prevent leakage into the junction box under any condition.

5. Cable Entry

   a. Design the cable entry water seal such that it precludes specific torque requirements in order to ensure a watertight and submersible seal.

   b. It shall permit no entry of water into any high voltage area even if the cable is severed below the water level.

6. Motor Protection

a. Provide integral thermal sensors in the motors, one for each phase, to monitor stator temperatures.

b. Utilize these sensors in conjunction with and supplemented by external motor over-current protection located at the control panel.

c. Provide integral leak detection in the motors.

1.3 FACTORY TESTING AND SHIPMENT

A. In addition to the factory tests in Section 11100~~432000~~, perform the following procedures with the factory test prior to shipment:

1. Hydrostatically test the hydraulic end of pump assembled to the motor not less than 150 percent of the shutoff head of the pump.

2. Leak-Test

a. Leak-test the motor not less than 150 percent the maximum submergence at Site conditions.

b. If the motor is to be installed inside an artesian well, leak-test the motor at a test of pressure equal to at least 150 percent of the static pressure above the centerline of the motor.

3. Acceptance criteria for hydrostatic and leak test shall be zero leak.

4. Verify the pump characteristic curves by testing at shutoff head, 25, 50, 75, 100, and 125 percent of the indicated design flow, and at maximum "run-out" flow, and recording the measured head and motor current for each flow.

5. Verify cavitation-free service and absence of motor overheating during conditions simulating the actual operating conditions after installation.

6. Design the motor seals for complete water tightness at 150 percent of the actual maximum submergence at the Site for 30 minutes, and submit data on factory testing and quality control with the Shop Drawings.

7. Properly lubricate and protect parts such that no damage or deterioration will occur even during a prolonged delay from the time of shipment until installation is completed and the pumps are ready for operation.

8. Properly protect unpainted finished ferrous surfaces in order to prevent rust and corrosion.

9. Protect the finished surfaces of exposed flanges by strong wooden blind flanges.

10. Properly crate each pump to protect against damage during shipment.

1.4 PUMP CONTROLS

A. Equipment manufacturer shall be responsible for coordination of controls and control strategies with the ENGINEER.

1.5 SPARE PARTS

A. **General:** The pumps shall be backed by supplies of spare parts from stock, and after-sales service from a factory trained and authorized maintenance facility.

B. Parts to be Furnished

1. bearings, radial

2. valve seat

3. neck rings

4. seal ring

5. upthrust ring.

1.6 MANUFACTURERS, OR EQUAL

A. Grundfos

PART 2 -- PRODUCTS

2.1 THE REQUIREMENT

A. The CONTRACTOR shall provide dewatering pumps and appurtenances, complete and operable, in accordance with the Contract Documents.

B. The requirements of Section 11000 - Equipment General Provisions apply to this Section.

C. The Supplier shall examine the Site conditions, intended application, and operation of the pump system and recommend the pump which will best satisfy the indicated requirements.

D. This section covers submersible non-clog pumping units. Each pumping unit shall be complete with a closed-coupled, submersible, electric motor and all other appurtenances specified or otherwise required for proper operation.

2.2 SUBMITTALS

A. General. Submittals shall be prepared and transmitted in accordance with Section 01300 – Contract Submittals.

B. Shop Drawings. The following information shall be furnished with the Shop Drawings:

1. Fabrication, assembly, and installation drawings showing dimensions and materials of construction of the equipment components.

2. Equipment mounting drawings showing the weight and base dimensions.

3. Structural calculations, where required, for seismic analysis and/or equipment design.

4. Location and orientation of piping interconnections.

5. Pump performance information as specified in Section 11100 – Pumps, General

6. Provide complete electrical motor data in accordance with Section 16460– Electric Motors.

7. Wiring diagram of field connections with identification of terminations between equipment devices, instrumentation items, junction terminal boxes, local control panels, vender control panels, etc.

8. Instructions for delivery, handling, storage, and installation of the equipment.

9. List of spare parts to be furnished.

10. Describe any exceptions or deviations taken to the Contract Documents.

C. Technical Manuals. Operation and Maintenance Information and Equipment Maintenance Sheets as specified in Section 01300 – Contract Submittals.

D. Manufacturer's Certificate. A Manufacturer's Certificate of satisfactory installation is required for the equipment specified herein. The Manufacturer's Certificate shall be prepared and submitted as specified in Section 01300 – Contractor Submittals.

PART 3 – EXECUTION

3.1 INSTALLATION

A. Contractor shall provide fittings/reducers/increasers and pipe spools needed to connect pump discharge to field transmission pipeline

~~A.~~B. In addition to the requirements of Section 11100, the CONTRACTOR shall ensure that anchor bolts are set only after the discharge piping has been properly installed, to ensure exact fit with embedded piping components.

~~B.~~C. Each discharge base shall be leveled, plumbed, aligned, and wedged into position to fit connecting piping.

~~C.~~D. Field Startup and Testing: After installation, each pump and motor shall be tested with the process service fluid. Record the following each minute for one hour per pump:

1. Flow, discharge pressure, wet well level, amp draw, speed and winding temperatures.

2. Check instruments attached to the pump and motor and record conditions. Each instrument shall read normal readings. If any instrument indicates abnormal conditions, notify the ENGINEER, and have the manufacturer quickly resolve the problem.

3.2 SERVICES OF MANUFACTURER

A. **Inspection, Startup, and Field Adjustment:** The service representative of the manufacturer shall be present continuously at the Site to furnish the services required by Section 11100.

B. **Instruction of OWNER'S Personnel:** The training representative of the manufacturer shall be present at the Site for 1 Day to furnish the services required by Section 11100.

C. For the purposes of this paragraph, a Day is defined as an 8 hour period at the Site, excluding travel time.

D. The ENGINEER may require that the inspection, startup, and field adjustment services above be furnished in 2 separate trips.

- END OF SECTION -

SECTION 15000 - PIPING, GENERAL

PART 1 -- GENERAL

1.1 THE REQUIREMENT

A. Provide the piping systems indicated, complete and operable, in accordance with the Contract Documents.

B. The provisions of this Section shall apply to piping sections in Divisions 2 and 15.

C. The Drawings define the general layout, configuration, routing, method of support, pipe size, and pipe type.

D. The Drawings are not pipe construction or fabrication drawings.

E. Where pipe supports and spacing are indicated on the Drawings and are referenced to a Standard Detail, the CONTRACTOR shall use that detail.

F. Where pipe supports are not indicated on the Drawings, it is the CONTRACTOR's responsibility to develop the details necessary to design and construct mechanical piping systems to accommodate the specific equipment provided, and to provide spacers, adapters, and connectors for a complete and functional system.

G. The CONTRACTOR shall provide plumbing specialties in accordance with manufacturer's printed instructions.

H. Screwed joints shall be made with joint compound and be tight and leakproof. A sufficient number of brass to ferrous metal seat unions shall be placed in lines so that any pipe, valve, or piece of equipment may be easily disconnected.

I. Drainage and sanitary lines shall be properly run, trapped, and vented to conform to Code requirements. Changes in direction shall be made with "Y" branch fittings and shall be of the same size as the pipe. Changes in pipe size shall be made with reducing fittings. Minimum depth of cover shall be 4~~3~~ feet.

J. Horizontal soil, drain, and waste pipes shall be given a slope of at least 1/4-inch per foot unless indicated otherwise.

1.2 CONTRACTOR SUBMITTALS

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

B. Shop Drawings: Shop Drawings shall contain the following information:

1. Drawings: Layout drawings including necessary dimensions, details, pipe joints, fittings, specials, bolts and nuts, gaskets, valves, appurtenances, anchors, guides, and material lists. Fabrication drawings shall indicate spacers, adapters, connectors, fittings, and pipe supports to accommodate the equipment and valves in a complete and functional system.

~~2. Thermoplastic Pipe Joints: Submit solvent cement manufacturer's catalog indicating that the recommended product is suitable for each fluid service application.~~

~~3.~~2. Gasket Material: Submit gasket manufacturer's catalog indicating that the recommended product is suitable for each fluid service application.

~~4.~~3. Modular Seals for Pipe: Manufacturer's catalog sheet showing materials and installation procedures.

C. Samples: Performing and paying for sampling and testing as necessary for certifications are the CONTRACTOR'S responsibility.

D. Certifications

1. Necessary certificates, test reports, and affidavits of compliance shall be obtained by the CONTRACTOR.

2. A certification from the pipe fabricator that each pipe 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.

1.3 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.

B. Defective or damaged materials shall be replaced with new materials.

PART 2 -- PRODUCTS

2.1 GENERAL

A. Extent of Work: Pipes, fittings, and appurtenances shall be provided in accordance with the requirements of the applicable Sections of Divisions 2 and 15 and as indicated.

B. Pipe Supports: Pipes shall be adequately supported, restrained, and anchored in accordance with manufacturer's recommendations.

~~C. Lining: Application, thickness, and curing of pipe lining shall be in accordance with the applicable Sections of Division 2, unless otherwise indicated.~~

~~D. Coating~~

~~1. Pipes shall be coated in accordance with Section 09800 – Protective Coating, unless otherwise indicated.~~

~~E.~~C. Pressure Rating: Piping systems shall be designed for the maximum expected pressure as defined on the Piping Schedule.

~~F.~~D. Inspection

1. Pipe shall be subject to inspection at the place of manufacture.

2. During the manufacture, the ENGINEER shall be given access to areas where manufacturing is in progress and shall be permitted to make inspections necessary to confirm compliance with requirements.

~~G.~~E. Tests

1. Except where otherwise indicated, materials used in the manufacture of the pipe shall be tested in accordance with the applicable specifications and standards.

2. Welds shall be tested as indicated.

3. The CONTRACTOR shall be responsible for performing material tests.

~~H.~~F. Welding Requirements

~~1. Qualification of welding procedures used to fabricate pipe shall be in accordance with the provisions of AWS D1.1 - Structural Welding Code or the ASME Boiler and Pressure Vessel Code, Section 9, whichever is applicable.~~

~~2.~~1. Welding procedures shall be submitted for the ENGINEER's review.

~~I.~~G. Welder Qualifications

1. Welding shall be performed by skilled welders and welding operators who have adequate experience in the methods and materials to be used.

~~2. Welders shall be qualified under the provisions of AWS D1.1 or the ASME Boiler and Pressure Vessel Code, Section 9, whichever is applicable.~~

~~3.~~2. Machines and electrodes similar to those used in the WORK shall be used in qualification tests.

~~4.~~3. Qualification testing of welders and materials used during testing is part of the WORK.

2.2 PIPE FLANGES

A. General

B. Flanges shall be provided with flat faces and shall be attached with bolt holes straddling the vertical axis of the pipe unless otherwise indicated.

C. Attachment of the flanges to the pipe shall conform to the applicable requirements of AWWA C207.

D. Flanges fabricated from steel plate shall meet the requirements of ASTM A 516, Grade 70. Forgings shall meet the requirements of ASTM A 105. Castings shall meet the requirements of ASTM A 216 WCB.

E. Flange faces shall be perpendicular to the axis of the adjoining pipe.

F. Flanges for miscellaneous small diameter pipes shall be in accordance with the standards indicated for these pipes.

G. Flanges and pipe stub for HDPE pipe shall be machined from a single block of material that can be butt fused to pipe. Steel backer flanges shall be used at connections.

H. Pressure Ratings

1. 150 psig or less: Flanges shall conform to either AWWA C207 - Steel Pipe Flanges for Waterworks Service--Sizes 4 In. Through 144 In., Class D, or ASME B16.5 - Pipe Flanges and Flanged Fittings, 150 lb. class.

2. Selection Based on Test Pressure

   a. Do not expose AWWA flanges to test pressures greater than 125 percent of rated capacity.

   b. For higher test pressures, the next higher rated AWWA flange or an ANSI-rated flange shall be selected.

I. Blind Flanges

1. Provide blind flanges in accordance with AWWA C207, or as indicated for miscellaneous small pipes.

~~2. Blind flanges for pipe sizes 12-inches and greater shall be provided with lifting eyes in the form of welded or screwed eye bolts.~~

J. Flange Coating: Machined faces of metal blind flanges and pipe flanges shall be coated with a temporary rust-inhibitive coating to protect the metal until the installation is completed.

K. Flange Bolts

1. Bolts and nuts shall be Type 316 stainless steel Class 2, grade B8M conforming to ASTM A 193 for bolts and to ASTM A 194 for nuts~~conform to the requirements of Section 05500 – Miscellaneous Metalwork~~.

2. Use all-thread studs on valve flange connections where space restrictions preclude the use of regular bolts.

L. Insulating Flanges: Insulated flanges shall be provided with bolt holes 1/4-inch diameter greater than the bolt diameter.

M. Flange Gaskets

1. Gaskets for flanged joints used in general shall be full-faced type, with material and thickness in accordance with AWWA C207, suitable for temperatures to 700 degrees F, a pH of one to 11, and pressures to 1000 psig.

2. Blind flanges shall be provided with gaskets covering the entire inside face of the blind flange and shall be cemented to the blind flange.

3. Ring gaskets will not be accepted unless otherwise indicated.

4. Flange gaskets shall be: John Crane, Style 2160; Garlock, Style 3000; or equal.

5. Gaskets for flanged joints used in chemicals, air, solvents, hydrocarbons, steam, chlorine and other fluids shall be made of materials compatible with the service, pressure, and temperature.

2.3 THREADED INSULATING CONNECTIONS

A. General

1. Threaded insulating bushings, unions, or couplings, as appropriate, shall be used for joining threaded pipes of dissimilar metals and for piping systems where corrosion control and cathodic protection are involved.

B. Materials

1. Threaded insulated connections~~connecitons~~ shall be of nylon, Teflon, polycarbonate, polyethylene, or other non-conductive materials, and shall have ratings and properties~~properiteies~~ to suit the service and loading conditions.

~~2.4 SLEEVE-SPLIT TYPE COUPLINGS (Depend-O-Lok, or equal)~~

~~A. General: Provide sleeve-split type couplings where indicated.~~

~~B. Construction~~

~~1. Couplings shall be of the split-type, consisting of one- or 2-piece housing, gasket assembly, bolts and nuts, and end rings.~~

~~2. The double arch cross section that closes around the pipe ends shall be smooth in order to allow for expansion or contraction requirements.~~

~~3. The pipe ends with steel end rings affixed shall provide restraint requirements.~~

~~4. As the coupling closes, it shall confine the elastomeric gasket beneath the arches of the sleeve to create a radial seal.~~

~~5. The axial seal shall squeeze the closure plates as the bolts pull the coupling snug around the pipe.~~

~~6. The coupling shall permit angular pipe deflection, flexibility, contraction and expansion, as designed by the manufacturer.~~

~~7. The coupling housing shall be designed for internal pressure and external loads as determined by the design procedures of AWWA M-11.~~

~~8. The coupling shell thickness of the steel coupling shall be calculated using the formula:~~

$$\cancel{T = (P_w \times D_y) / (2 \times F_s)}$$

~~Where:~~

~~T = steel coupling thickness, inches~~

~~D_y = pipe outside diameter, inches~~

~~P_w = Design working pressure, psi~~

~~F_s = 50 percent of minimum yield point of steel, psi~~

9. Coupling design calculations shall be stamped and signed by a registered engineer and shall be included in the Shop Drawing submittal for couplings.

10. The sealing members shall be comprised of two O-ring gaskets and an elastomer sealing pad bonded to sealing plate.

11. Internal pressure shall not be required to make the seal.

C. Materials

1. Unless otherwise indicated, the coupling housing material shall be the same material as the piping.

2. Couplings

a. Carbon steel couplings shall be fabricated from ASTM A 36.

b. Stainless steel couplings shall be fabricated from ASTM A 240, T-304, 304L, 316, or 316L.

3. End Rings

a. Carbon steel end rings shall conform to ASTM A 108 Grade 1018.

b. Stainless steel end rings shall conform to ASTM A 276 T-316L.

4. Bolts and nuts shall be in conformance with the requirements of Section 05500 – Miscellaneous Metalwork.

5. Gaskets

a. Gaskets shall be composed of EPDM conforming to ASTM D 2000 for air service up to 240 degrees F.

b. Gaskets for general water or sewerage service within the temperature range of minus 20 to plus 180 degrees F shall be composed of isoprene or EPDM conforming to ASTM D 2000.

6. Carbon steel couplings shall be fusion bond epoxy-coated inside and outside of the coupling in accordance with the requirements of Section 09800 – Protective Coating.

7. Wrapping

a. Couplings installed underground shall be provided with Depend-O-Wrap tape or equal.

b. The application of wrapping material shall be in conformance with AWWA C209.

D. Pipe Preparation

1. Ends of pipes shall be prepared for the flexible split sleeve type couplings inspected and approved by the coupling manufacturer.

2. The pipe outside diameter and roundness tolerances shall comply with tolerances listed in AWWA C219.

3. Plain ends for use with couplings shall be smooth and round for a distance of 12 inches from the end of the pipe.

4. End Rings

a. Provide end rings with couplings when restraint is required.

b. Carbon steel end rings shall be constructed of ASTM A 108 Grade 1018.

c. Stainless steel end rings shall conform to ASTM A 276 T-316L.

5. Where the split-type coupling is used to take up thermal expansion or contraction (Depend-O-Lok F X E or equal) at the pipe joint, one end ring shall be fixed to one end of the pipe in order to keep the coupling in the proper location.

6. Fully-Restrained Joints

a. Where the split-type coupling is used for a fully-restrained pipe joint (Depend-O-Lok F X F or equal) at the pipe joint, one end ring shall be welded to each of the pipe ends to fit beneath the coupling and shall be protected by the coating.

b. Welding design and specification shall be in conformance with the coupling manufacturer's recommendations.

E. Sleeve-Split Type Couplings Manufacturer, or Equal: Depend-O-Lok

2.5 SLEEVE-TYPE COUPLINGS

A. General

1. Provide sleeve-type couplings where indicated.

2. The CONTRACTOR will not be allowed to substitute a sleeve-split coupling, or any other type in lieu of sleeve coupling unless approved by the ENGINEER.

B. Construction

1. Sleeve couplings shall be in accordance with AWWA C219 - Standard for Bolted Sleeve-Type Couplings for Plain-End Pipe.

2. Couplings shall be constructed of steel with steel bolts, without pipe stop.

3. Couplings shall be of sizes to fit the indicated pipe and fittings.

4. The middle ring shall be not less than 1/4-inch thick or at least the same wall thickness as the pipe to which the coupling is connected.

5. If the strength of the middle ring material is less than the strength of the pipe material, the thickness of the middle ring shall be increased to have the same strength as the pipe.

6. The coupling shall be either 5 or 7 inches long for diameters up to and including 30-inches, and 10 inches long for diameters greater than 30-inches, for standard steel couplings, and 16 inches long for long-sleeve couplings.

7. The followers shall be single-piece contoured mill sections welded and cold-expanded as required for the middle rings, and of sufficient strength to accommodate the number of bolts necessary to obtain adequate gasket pressures without excessive rolling.

8. The shape of the follower shall be of such design as to provide positive confinement of the gasket.

9. Bolts and nuts shall be in accordance with the requirements of Section 05500 – Miscellaneous Metalwork.

10. Buried sleeve-type couplings shall be epoxy-coated at the factory as indicated.

C. Pipe Preparation

1. Where indicated, prepare the ends of the pipe for flexible steel couplings.

2. Plain ends for use with couplings shall be smooth and round for a distance of 12 inches from the ends of the pipe, with an outside diameter not more than 1/64 inch smaller than the nominal outside diameter of the pipe.

3. The middle ring shall be tested by cold-expanding a minimum of one percent beyond the yield point, in order to proof-test the weld to the strength of the parent metal.

4. The weld of the middle ring shall be subjected to air test for porosity.

D. Gaskets

1. Gaskets for sleeve-type couplings shall be rubber-compound material that will not deteriorate from age or exposure to air under normal storage or use conditions.

2. Gaskets for wastewater and sewerage applications shall be composed of Buna N, Grade 60, or equivalent suitable elastomer.

3. The rubber in the gasket shall meet the following specifications:

a. Color: jet black

b. Surface: non-blooming

c. Durometer Hardness: 74, plus and minus 5

d. Tensile Strength: 1000 psi minimum

e. Elongation: 175 percent minimum

4. The gaskets shall be immune to attack by impurities normally found in water or wastewater.

5. Gaskets shall meet the requirements of ASTM D 2000 - Classification System for Rubber Products in Automotive Applications, AA709Z, meeting Suffix B13 Grade 3, except as indicated above.

6. Where sleeve couplings are used in water containing chloramine or other fluids which attack rubber materials, gasket material shall be compatible with the piping service and fluid utilized.

E. Restrained Joints

1. Sleeve-type couplings on pressure lines shall be harnessed unless thrust restraint is provided by other means.

2. Harnesses shall be designed by the pipe manufacturer in accordance with AWWA Manual M11, or as indicated.

3. Harness sets shall be designed for the maximum test pressure of the pipe in which they are installed.

F. Sleeve-Type Couplings Manufacturer, or Equal

1. Dresser, Style 38

2. Ford Meter Box Co., Inc., Style FC1 or FC3

3. Smith-Blair, Style 411

2.62.4 EXPANSION JOINTS

A. Piping subject to expansion and contraction shall be provided with sufficient means to compensate for such movement without exertion of undue forces to equipment or structures, accomplished with expansion loops, bellow-type expansion joints, or sliding-type expansion joints.

B. Dual-wall pipe has the potential for unique expansion between the outer and inner walls of the pipe. Details on any above-grade dual-wall pipe expansion considerations shall be submitted.

B. Expansion joints shall be provided with flanged ends and constructed of stainless steel, Monel, rubber, or other materials best suited for each individual service.

C. Submit detailed calculations and manufacturer's Shop Drawings of proposed expansion loopsjoints, piping layouts, and anchors and guides, including information on materials, temperature, and pressure ratings.

2.72.5 PIPE THREADS

A. Pipe threads shall be in conformance with ASME B1.20.1 - Pipe Threads, General Purpose (inch), and be made up with Teflon tape unless otherwise indicated.

2.82.6 MODULAR MECHANICAL SEALS FOR PIPING PENETRATIONS

A. Where indicated and where required in order to prevent flow of water or air, the passages of piping through wall sleeves and cored openings shall be sealed with modular interlocking link mechanical closures.

B. Individual links shall be constructed of EPDM rubber, be suitable for temperatures between minus 40 and plus 250 degrees F, and be shaped to fill the annular space between the outside of the pipe and the inside of the wall sleeve or cored opening.

C. Assemble the links using Type 316 stainless steel bolts and nuts to form a continuous rubber belt around the pipe.

D. Pressure plates under each bolt and nut shall be fabricated of a corrosion-resistant composite material.

E. After the seal assembly is positioned in the sleeve, tighten the bolts against the pressure plates to expand the rubber links and form the watertight seal.

F. Sizing and installation of sleeves and assemblies shall be in accordance with the manufacturer's recommendations.

G. Modular Mechanical Seals Manufacturer, or Equal: Thunderline Corporation, Link-Seal.

PART 3 -- EXECUTION

3.1 GENERAL

A. Install piping, fittings, and appurtenances in accordance with the requirements of applicable Sections of Division 2 and Division 15.

B. Proprietary manufactured couplings shall be installed in accordance with the coupling manufacturer's recommendation.

C. Care shall be taken to insure that piping flanges, ~~mechanical-type couplings, sleeve-type couplings~~, flexible connectors, and expansion joints are properly installed as follows:

1. Gasket surfaces shall be carefully cleaned and inspected prior to making up the connection.

2. Each gasket shall be centered properly on the contact surfaces.

3. Connections shall be installed to prevent inducing stress to the piping system or the equipment to which the piping is connected.

4. Contact surfaces for flanges, couplings, and piping ends shall be aligned parallel, concentric, and square to each axis at the piping connections.

5. Flange Bolts

a. Flange bolts shall be initially hand-tightened with the piping connections properly aligned.

b. Bolts shall be tightened with a torque wrench in a staggered sequence to the AISC-recommended torque for the bolt material.

6. Harness, Thrust Restraint, and Tie Rod Bolts

   a. Harness, thrust restraint, and tie rod bolts used for sleeve couplings, flange coupling adapters, or flexible joints shall be tightened gradually and equally at diametrically opposite sides until snug, in order to prevent misalignment and to insure that all studs carry equal loads.

   b. In order to prevent induced stress or misalignment, do not over-torque connections to adjoining pump or equipment.

7. Groove ends shall be clean and free from indentations, projections, and roll marks in the area from the pipe end to the groove.

8. After installation, joints shall meet the indicated leakage rate.

9. Flanges shall not be deformed nor cracked.

~~D. Lined Piping Systems~~

~~1. The lining manufacturer shall take full responsibility for the complete, final product and its application.~~

~~2. Pipe ends and joints of lined pipes at screwed flanges shall be epoxy-coated in order to assure continuous protection.~~

~~E.~~D. Core Drilling: Where core drilling is required for pipes passing through existing concrete, core drilling locations shall be determined by radiograph of concrete construction in order to avoid damage to embedded raceways and reinforcing bars.

~~F.~~E. Cleanup

1. After completion of the WORK, cuttings, joining and wrapping materials, and other scattered debris shall be removed from the Site.

2. The entire piping system shall be handed over in a clean and functional condition.

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SECTION 15200 - VALVES, GENERAL

PART 1 -- GENERAL

1.1 THE REQUIREMENT

A. Provide valves, actuators, and appurtenances, complete and operable, as indicated in accordance with the Contract Documents.

B. The requirements of Section 11000 – Equipment General Provisions, apply to the WORK of this Section.

C. Apply the provisions of this Section to all valves and valve actuators except where otherwise indicated.

D. Valves and actuators in particular locations may require a combination of units, sensors, limit switches, and controls, as indicated.

E. Support

1. Where a valve is to be supported by means other than the piping to which it is attached, obtain from the valve manufacturer a design for its support and foundation that satisfies the criteria in Section 11000 – Equipment General Provisions.

2. Submit the support design, including drawings and calculations sealed by an engineer, with the Shop Drawings.

3. Provide the support after the design has been approved.

F. Unit Responsibility

1. Make a single manufacturer responsible for the coordination of design, assembly, testing, and furnishing of each valve; however, the CONTRACTOR shall be responsible to the COMPANY for compliance with the requirements of each valve Section.

2. Unless indicated otherwise, the responsible manufacturer shall be the manufacturer of the valve.

G. Single Manufacturer

1. Where 2 or more valves of the same type and size are required, the valves shall be furnished by the same manufacturer.

1.2 CONTRACTOR SUBMITTALS

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

B. Furnish the following information on Shop Drawings:

1. Valve name, size, Cv factor, pressure rating, identification number (if any), and specification section number;

2. ~~complete~~Complete information on the valve actuator, including size, manufacturer, model number, limit switches, and mounting;

3. ~~cavitation~~Cavitation limits for control valves;

4. ~~assembly~~Assembly drawings showing part nomenclature, materials, dimensions, weights, and relationships of valve handles, hand wheels, position indicators, limit switches, integral control systems, needle valves, and control systems;

5. ~~data~~Data in accordance with Section 16460 – Electric Motors, for electric motor-actuated valves;

6. ~~complete~~Complete wiring diagrams and control system schematics; and,

7. A valve-labeling schedule, listing the valves to be furnished with stainless steel tags, indicating in each case the valve location and the proposed wording for the label.

C. Furnish a technical manual containing the required information for each valve, as indicated.

D. Furnish a spare parts list, containing the required information for each valve assembly, as indicated.

E. Factory Test Data

1. Where indicated, submit signed, dated, and certified factory test data for each valve requiring certification, before shipping the valve.

2. Furnish a certification of quality and test results for factory-applied coatings.

PART 2 -- PRODUCTS

2.1 PRODUCTS

A. General

1. Provide valves and gates of new and current manufacture.

2. Provide shut-off valves 6-inch and larger with actuators with position indicators.

3. Provide gate valves 18-inch and larger, or where chain wheel is required, with spur gear and hand wheel.

4. Provide buried valves with valve boxes and covers containing position indicators and valve extensions.

5. Provide manual shut-off valves mounted higher than 7 feet above the working level with chain actuators.

B. Valve Actuators

1. Unless otherwise indicated, provide valve actuators in accordance with Section 15201 – Valve and Gate Actuators.

C. Protective Coating

1. Coat the exterior surfaces and the wet interior surfaces of ferrous valves of sizes 4-inch and larger with epoxy in accordance with the requirements of Section 09800 – Protective Coating.

2. The valve manufacturer shall certify in writing that the required coating has been applied and tested in the manufacturing plant prior to shipment, in accordance with the indicated requirements.

3. Do not epoxy-coat the flange faces of valves.

D. Valve Labeling

1. Except when such requirement is waived by the ENGINEER in writing, provide a label on shut-off valves and control valves except for hose bibbs and chlorine cylinder valves.

2. Furnish a label composed of 1/16-inch thick acrylic, a minimum of 1-inch by 3-inches in size, as indicated in Section 10400 – Signage, and permanently attached to the valve or on the wall adjacent to the valve as directed by the ENGINEER. Label shall include valve tag number and function.

E. Valve Testing

1. As a minimum, unless otherwise indicated or recommended by the reference standards, test valves 3 inches in diameter and smaller in accordance with the manufacturer's standard procedure.

2. Factory-test valves 4 inches in diameter and larger as follows:

a. Hydrostatic Testing

1) Subject valve bodies to an internal hydrostatic pressure equivalent to twice the water-rated pressure of the valve.

2) Metallic valves rating pressures shall be at 100 degrees F.

3) Plastic valves rating pressures shall be at 73 degrees F, or at a higher temperature according to material type.

4) During the hydrostatic test, there shall be no leakage through the valve body, end joints, or shaft seals, nor shall parts of the valve be permanently deformed.

5) Allow ~~a~~ test duration of at least 10 minutes, in order to allow visual examination for leakage.

b. Seat Testing

1) Test the valves for leaks in the closed position, with the pressure differential across the seat equal to the water rated pressure of the valve.

2) Provide ~~a~~ test duration of at least 10 minutes, in order to allow visual examination for leakage.

3) The leakage rate shall be the more stringent of the following:

a) As recommended by the reference standard for that type of valve; or,

b) Leakage past the closed valve not to exceed one fluid ounce per hour per inch diameter for metal seated valves, and drop-tight for resilient seated valves.

c. Performance Testing

1) Shop-operate the valves from the fully-closed to the fully-open position, and reverse under no-flow conditions in order to demonstrate that the valve assembly operates properly.

F. Certification

1. Prior to shipment of valves over 12-inches in size, submit certified, notarized copies of the hydrostatic factory tests, showing compliance with the applicable standards of AWWA, ANSI, or ASTM.

G. Valve Markings

1. Permanently mark valve bodies in accordance with MSS SP25 - Standard Marking Systems for Valves, Fittings, Flanges, and Unions.

2.2 MATERIALS

A. General

1. Provide materials suitable for the intended application.

2. Provide materials in contact with potable water listed as compliant with NSF Standard 61.

3. Ensure that materials not indicated are of high-grade standard commercial quality, free from defects and imperfections that might affect the serviceability of the product for the purpose for which it is intended.

4. Unless otherwise indicated, provide valve and actuator bodies conforming to the following requirements:

a. Cast Iron: Close-grained gray cast iron, conforming to ASTM A 48 - Gray Iron Castings, Class 30, or to ASTM A 126 - Gray Iron Castings for Valves, Flanges, and Pipe Fittings

b. Ductile Iron: ASTM A 536 - Ductile Iron Castings, or to ASTM A 395 - Ferritic Ductile Iron Pressure-Retaining Castings for Use at Elevated Temperatures

c. Steel: ASTM A 216 - Steel Castings, Carbon Suitable for Fusion Welding for High-Temperature Service, or to ASTM A 515 - Pressure Vessel Plates, Carbon Steel, for Intermediate- and Higher-Temperature Service

d. Bronze: ASTM B 62 - Composition Bronze or Ounce Metal Castings, and valve stems not subject to dezincification shall conform to ASTM B 584 - Copper Alloy Sand Castings for General Applications

e. Stainless Steel: Stainless steel valve and operator bodies and trim shall conform to ASTM A 351 - Steel Castings, Austenitic, for High-Temperature Service, Grade CF8M, or shall be Type 316 stainless steel

f. PVC: Polyvinyl chloride materials for valve body, flanges, and cover shall conform to Cell Classification 12454

~~g. CPVC: Chlorinated Poly Vinyl Chloride materials for valve body, flanges, and cover shall conform to Cell Classification 23447~~

~~h. NSF Standard 14: Materials shall be listed for use in contact with potable water.~~

2.3 VALVE CONSTRUCTION

A. Bodies

1. Provide valve bodies that are cast, molded (in the case of plastic valves), forged, or welded, of the materials indicated, and with smooth interior passages.

2. Provide wall thicknesses uniform and in agreement with the applicable standards for each type of valve, without casting defects, pinholes, and other defects that could weaken the body.

3. Perform welds on welded bodies by certified welders and ground welds smooth.

4. Provide valve ends as indicated, and rated for the maximum temperature and pressure to which the valve will be subjected.

B. Valve End Connections

1. Unless otherwise indicated, valves 2-1/2 inches in diameter and smaller may be provided with threaded end connections.

2. Provide valves 3 inches in diameter and larger with flanged end connections.

C. Bonnets

1. Connect valve bonnets to the body by clamping, screwing, or flanging.

2. Provide bonnets of the same material, temperature, and pressure rating as the body.

3. Make provisions for the stem seal with the necessary glands, packing nuts, and yokes.

D. Stems

1. Provide valve stems of the materials indicated, or, if not indicated, of the best commercial material for the specific service, with adjustable stem packing, O-rings, chevron V-type packing, or other suitable seal.

E. Stem Guides

1. Provide stem guides spaced 10 feet on centers, unless the manufacturer can demonstrate by calculation that a different spacing is acceptable.

2. Construct submerged stem guides from Type 316 stainless steel or other best-suited material based on the acidity of the liquid.

F. Internal Parts

1. Provide internal parts and valve trim as indicated for each individual valve.

2. Where not indicated, construct valve trim from Type 316 stainless steel or other best-suited material.

G. Nuts and Bolts

1. Provide nuts and bolts on valve flanges and supports in accordance with the requirements of Section 05500 – Miscellaneous Metalwork.

2.4 VALVE ACCESSORIES

A. Provide valves complete with the accessories required to provide a functional system.

2.5 SPARE PARTS

A. Furnish the required spare parts, suitably packaged and labeled with the valve name, location, and identification number.

B. Furnish the name, address, and telephone number of the nearest distributor for the spare parts of each valve.

C. Spare parts are intended for use by the COMPANY, after expiration of the correction of defects period.

2.6 MANUFACTURERS

A. Valve manufacturers shall have a successful record of not less than 5 years in the manufacture of the indicated valves.

PART 3 -- EXECUTION

3.1 VALVE INSTALLATION

A. General

1. Install valves, actuating units, stem extensions, valve boxes, and accessories in accordance with the manufacturer's written instructions and as indicated.

~~2. Adequately brace gates so that they do not warp or bend under the intended use.~~

~~3.~~2. Firmly support valves in order to avoid undue stresses on the pipe.

B. Access

1. Install valves in a manner to provide easy access for actuation, removal, and maintenance, and to avoid interference between valve actuators and structural members, handrails, and other equipment.

C. Valve Accessories

1. Where combinations of valves, sensors, switches, and controls are indicated, properly assemble and install such items such that systems are compatible and operating properly.

2. Clearly note the relationship between interrelated items on Shop Drawing submittals.

- END OF SECTION -

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SECTION 15201 - VALVE ACTUATORS

PART 1 -- GENERAL

1.1 THE REQUIREMENT

A. Provide valve actuators and appurtenances, complete and operable, as indicated in accordance with the Contract Documents.

B. The provisions of this Section apply to valves except where otherwise indicated in the Contract Documents.

C. Unit Responsibility

1. Make the valve manufacturer responsible for the coordination of design, assembly, testing, and installation of actuators on the valves; however, the CONTRACTOR shall be responsible to the OWNER for compliance of the valves and actuators with the Contract Documents.

D. Where 2 or more valve actuators of the same type or size are required, the actuators shall be produced by the same manufacturer.

~~E. The requirements of Division 16000 and 17000 – Electrical and Instrumentation apply to the WORK of this Section.~~

1.2 CONTRACTOR SUBMITTALS

A. Furnish submittals in accordance with the requirements of Section 01300 – Contractor Submittals and Section 15200 – Valves, General.

B. Submit Shop Drawing information for actuators with the valve submittals as a complete package.

C. Submit calculations showing dynamic seating and unseating torques versus the output torque of the actuator.

PART 2 -- PRODUCTS

2.1 GENERAL

A. Unless otherwise indicated, provide shut-off and throttling valves and externally actuated valves and gates with manual ~~or power~~ actuators.

B. Provide actuators complete and operable with mounting hardware, ~~motors,~~ gears~~, controls, wiring, solenoids~~, hand wheels, levers, chains, and extensions, as applicable.

C. Provide actuators with torque ratings equal to or greater than required for valve seating and dynamic torques, whichever is greater, and capable of holding the valve in any intermediate position between fully-open and fully-closed without creeping or fluttering.

D. Actuator torque ratings for butterfly valves shall be determined in accordance with AWWA C504 - Rubber-Seated Butterfly Valves.

E~~E. Identify wires of motor-driven actuators by unique numbers.~~

~~F~~. Manufacturers

1. Where indicated, certain valves may be provided with actuators manufactured by the valve manufacturer.

2. Where actuators are furnished by different manufacturers, coordinate the selection to result in the fewest number of manufacturers possible.

F~~G~~. Materials

1. Provide actuators of current models, of the best commercial quality materials, and liberally sized for the required torque.

2. Provide materials suitable for the environment in which the valve is to be installed.

G~~H~~. Actuator Mounting and Position Indicators

1. Securely mount actuators by means of brackets or hardware specially designed and sized for this purpose and of ample strength.

2. Cast the word "OPEN" on each valve or actuator, with an arrow indicating the direction to open in the counter-clockwise direction.

3. Equip gear and power actuators with position indicators.

4. Where possible, locate manual actuators between 48 and 60 inches above the floor or the permanent working platform.

H~~I~~. Standards

1. Unless otherwise indicated and where applicable, provide actuators in accordance with AWWA C 540 - Power-Actuating Devices for Valves and Sluice Gates.

~~IJ. Functionality~~

~~1. Coordinate actuators with the power requirements of Division 16 – Electrical, and instrumentation equipment as indicated in Division 17 – Instrumentation and Controls.~~

~~K~~. Provide fasteners in accordance with the requirements of Section 05500 – Miscellaneous Metalwork.

J~~L~~. Provide coatings in accordance with the requirements of Section 09800 – Protective Coating.

2.2 MANUAL ACTUATORS

A. General

1. Unless otherwise indicated, provide valves with manual actuators.

2. Provide valves in sizes up to and including 4-~~-~~inches with direct-acting lever or hand wheel actuators of the manufacturer's best standard design.

3. Provide valves larger than 4-inch with gear-assisted manual actuators, with an operating pull of maximum 60 pounds on the rim of the hand wheel.

4. Provide buried and submerged gear-assisted valves for pressures higher than 250 psig, and where indicated, with worm gear actuators, hermetically-sealed water-tight and grease-packed.

5. Valves 6-inch to 24-inch diameter may be provided with traveling-nut actuators, worm gear actuators, spur or bevel gear actuators, as appropriate for each valve.

B. Buried Valves

1. Unless otherwise indicated, provide buried valves with extension stems to grade, with square nuts or floor stands, position indicators, and cast-iron or steel pipe extensions with valve boxes, covers, and operating keys.

2. Where indicated, provide buried valves in cast-iron, concrete, or similar valve boxes with covers of ample size in order to allow operation of the valve actuators.

3. Permanently label the valve box covers as required by the OWNER~~local Utility Company~~ or the ENGINEER.

4. Provide wrench-nuts in compliance with AWWA C 500 - Metal-Seated Gate Valves for Water Supply Service.

C. ~~Chain Actuator~~

~~1. Provide manually-activated valves with the stem located more than 7-feet above the floor or operating level with chain drives consisting of sprocket-rim chain wheels, chain guides, and operating chains supplied by the valve manufacturer.~~

~~2. Construct the wheel and guide from ductile iron, cast iron, or steel.~~

~~3. Chains~~

~~a. Fabricate the chain from hot-dip galvanized steel or stainless steel, and extend to 5 feet, 6 inches above the operating floor level.~~

~~b. Provide an extra strong valve stem on chain-actuated valves in order to allow for the extra weight and chain pull.~~

~~c. Provide hooks for chain storage where chains interfere with pedestrian traffic.~~

~~D. Floor Boxes~~

~~1. Provide hot-dipped galvanized cast iron or steel floor boxes and covers to fit the slab thickness, for operating nuts in or below concrete slabs.~~

~~2. For operating nuts in the concrete slab, provide a bronze-bushed cover.~~

~~E. Tee Wrenches~~

~~1. Furnish buried valves with floor boxes with 2 operating keys or one key per 10 valves, whichever is greater.~~

~~2. Size the tee wrenches such that the tee handle will be 2 to 4 feet above ground, and to fit the operating nuts.~~

~~F. Traveling-Nut Actuator~~

1. Provide the actuator with a traveling-nut and screw (Scotch yoke), contained in a weatherproof cast iron or steel housing with a spur gear and a minimum 12-inch diameter hand wheel.

2. The screw shall run in 2 end bearings, and provide a self-locking actuator in order to maintain the valve position under any flow condition.

3. Construct the screw and gear from hardened alloy steel or stainless steel, and the construct the nut and bushings from alloy bronze.

4. The bearings and gear shall be grease-lubricated by means of nipples.

5. Design gearing for a 100 percent overload.

2.3 ELECTRIC MOTOR ACTUATORS

A. General

1. Equipment Requirements

   a. Where electric motor actuators are indicated, attach an electric motor-actuated valve control unit to the actuating mechanism housing by means of a flanged motor adapter piece.

2. Gearing

   a. Provide the motor actuator with the motor, reduction gearing, reversing starter, torque switches, and limit switches in a weather-proof NEMA 4 assembly.

   b. Provide a single- or double-reduction unit, consisting of spur or helical gears and worm gearing.

   c. Construct the spur or helical gears of hardened alloy steel, and the worm gear of alloy bronze.

   d. Accurately cut gearing with hobbing machines.

   e. Power gearing shall be grease- or oil-lubricated in a sealed housing.

   f. Use ball or roller bearings throughout.

   g. Actuator output speed changes shall be mechanically possible by simply removing the motor and changing the exposed or helical gearset ratio without further disassembly of the actuator.

3. Starting Device

   a. Except for modulating valves, design the unit such that a hammer blow is imparted to the stem nut when opening a closed valve or closing an open valve.

   b. The device shall allow free movement at the stem nut before imparting the hammer blow.

   c. The actuator motor shall attain full speed before the stem load is encountered.

~~4. Switches~~

~~a. Electronic-Type Switches~~

~~1) Limit switches or valve position shall be sensed by a 15-bit, optical, absolute position encoder.~~

~~2) The open and closed positions shall be stored in a permanent, non-volatile memory.~~

~~3) The encoder shall measure valve position continuously, including both motor and hand wheel operation, with or without use of battery.~~

~~4) Provide an electronic torque sensor.~~

~~5) Provide an adjustable torque limit, from 40 to 100 percent of rating in one-percent increments.~~

~~6) The motor shall be de-energized if the torque limit is exceeded.~~

~~7) Provide a boost function in order to prevent torque-trip during initial valve unseating, and a "jammed valve" protection feature with automatic retry sequence in order to de-energize the motor if no movement occurs.~~

~~8) Provide valve actuators with electronic type switches as manufactured by **Limitorque, Rotork** or **Auma Actuators, Inc**.~~

~~b. The actuator shall be wired in accordance with the schematic diagram.~~

~~c. Connect wiring for external connections to marked terminals.~~

~~d. Provide one 1-inch and one 1-1/4 inch conduit connection in the enclosing case.~~

~~e. Mount a calibration tag near each switch, correlating the dial setting to the unit output torque.~~

~~f. Switches shall not be subject to breakage or slippages due to over-travel.~~

~~g. Do not use traveling-nuts, cams, or microswitch tripping mechanisms.~~

~~h. Provide limit switches of the heavy-duty, open contact type, with rotary wiping action.~~

~~5.~~1. Handwheel Operation

~~a. Provide a permanently attached handwheel for emergency manual operation.~~

~~b. The handwheel shall not rotate during electrical operation.~~

~~c.~~a. The maximum torque required on the handwheel under the most adverse conditions shall not exceed 60 lb-ft, and the maximum force required on the rim of the handwheel shall not exceed 60 lb.

d.b. Cast or permanently affix an arrow and either the word "OPEN" or "CLOSE" on the handwheel in order to indicate the appropriate direction to turn the handwheel.

e. Provide a clutch lever to put the actuator into handwheel operation.

f. Provide chain activator handwheels for valves with electric motor actuators having stems more than 7 feet above the floor.

g. Provide the clutch lever with a cable secured to the chain in order to allow disengagement for manual operation.

6. Motor

a. Provide a motor of the totally enclosed, non-ventilated, high-starting torque, low-starting current type, for full-voltage starting.

b. The motor shall be suitable for operation of voltage and phases as indicated on the project drawings, 60 Hz current, with Class F insulation and a motor frame with dimensions in accordance with the latest revised NEMA MG Standards.

c. The observed temperature rise by thermometer shall not exceed 55 degrees C above an ambient temperature of 40 degrees C, when operating continuously for 15 minutes under full-rated load.

d. With a line voltage ranging between 10 percent above to 10 percent below the rated voltage, the motor shall develop full-rated torque continuously for 15 minutes without causing the thermal contact protective devices imbedded in the motor windings to trip or the starter overloads to drop out.

e. Provide bearings of the ball type, and provide thrust bearings where necessary.

f. Provide the bearings with suitable seals in order to confine the lubricant and to prevent the entrance of dirt and dust.

g. Provide watertight motor conduit connections.

h. Motor construction shall incorporate the use of stator and rotor as independent components from the valve operation such that the failure of either item shall not require actuator disassembly or gearing replacement.

i. Provide two Class B thermal contacts or solid-state thermistors embedded within the motor windings in order to protect against over-temperature damage.

j. Provide the motor with a space heater suitable for operation on a 120-volt, single-phase, 60-Hz circuit, unless the entire actuator is of a hermetically sealed, non-breathing design with a separately sealed terminal compartment which prevents moisture intrusion.

k. Provide each electric motor actuator with a local disconnect switch or circuit breaker in order to isolate power from the motor and controller during maintenance activities.

7. Open/Close Operating Speed

a. Unless otherwise indicated, electric actuators shall provide a full-close-to-full-open or full-open-to-full-close operating time range from 30 to 55 seconds.

b. Provide an open/close speed for motor/power-actuated valves as indicated in the following table:

8. Elevated Valves

a. For valves with electric motor actuators where the valve centerline is located at a height greater than 6 feet above the floor, provide a remote actuator control station at a location no higher than 4 feet above the floor.

b. Provide conduit and wiring between the actuator controls and the valve actuator for these applications.

c. Wall-mount the actuator controls beneath the valve at a location approved by the ENGINEER.

B. Electric Motor Actuators (AC Reversing Control Type)

1. General

a. Where indicated, electric motor actuators shall be the AC reversing type complete with local control station with OPEN/CLOSE and LOCAL/AUTO /REMOTE selector switches.

2. Actuator Appurtenances

a. Provide the actuator for each valve with: OPEN and CLOSE status lights; OPEN, CLOSE, and LOCKOUT/STOP push buttons; and, other indicated devices.

3. Starter

a. Provide a suitably sized amperage-rated reversing starter with its coils rated for operation on voltage and phase as indicated on the project drawings, 60-Hz current.

b. Provide a control power transformer in order to provide a 120-volt source, unless otherwise indicated.

c. Equip the starter with 3 overload relays of the automatic reset type, and wire the control circuit as indicated.

d. The integral weatherproof compartment shall contain a suitably sized 120-volt AC, single-phase, 60-Hz space heater in order to prevent moisture condensation on electrical components.

e. Provide a local power disconnect switch and a close-coupled, padlockable switch with each actuator.

4. Local Control Station

a. Provide each actuator with a local control station along with the valve actuator assembly.

b. The station shall include OPEN, CLOSE, and STOP push buttons, and a LOCAL/REMOTE selector switch.

c. The local control station and local power disconnect may be provided as an integral part of the actuator, or as otherwise indicated or required in order to permit operation by a person at floor elevation and within sight of the valve actuator.

5. Electric Motor Actuators (AC Reversing Control Type) Manufacturer, or Equal

a. **Auma Actuators, Inc**.

b. **Limitorque Corp**

c. **Rotork**

C. Electric Motor Actuators (AC Modulating Control Type)

1. General

a. Where indicated, modulating electric motor actuators shall be of the AC-modulating type, provided complete with a local control station with power disconnect switch or circuit breaker, LOCAL/REMOTE switch, non-latching OPEN/CLOSE pushbuttons, and OPEN/CLOSE status lights

2. Actuator Appurtenances

a. Provide the actuator for each valve with: a padlockable disconnect switch; OPEN and CLOSED status lights; OPEN, CLOSE, and LOCKOUT/STOP pushbuttons; a LOCAL/REMOTE selector switch; and, other indicated devices.

3. Control Module

a. Provide a control module of the electronic solid-state AC type, with control outputs for positioning the valve via 4 to 20 ma input signals.

4. Starter

a. The actuator shall control a solid-state reversing starter designed for minimum susceptibility to power line surges and spikes.

b. The solid-state starter and control module shall be rated for continuous modulating applications.

c. The power supply shall be 480-volt, 3-phase, 60-Hz.

d. Provide a disconnect switch with each actuator.

5. Construction

a. The control unit shall be microprocessor-based and shall contain an analog/digital converter, separate input-output switches, non-volatile random access memory for storage of calibration parameters, and push-button calibration elements for field setup.

b. Potentiometer adjustments shall contain a PID control function internally.

c. The controller shall contain as a standard feature a loss-of-command signal protection selectable to lock in last or lock in pre-set valve position and a valve position output signal in 4 to 20 ma.

d. As an alternative to the construction requirement, provide a motor capable of modulating at a rate of 600 starts per hour at the 50-percent to 85-percent travel range of the valve.

e. The system shall allow the control of the open, close, or percent open function when the LOCAL/REMOTE switch is in the REMOTE position.

f. Provide each actuator with a frequency shut-down system, which when pre-programmed shall function as directed upon receipt of an ESD signal.

6. Electric Motor Actuators (AC Modulating Control Type) Manufacturer, or Equal

a. Limitorque

b. Rotork

c. Auma Actuators, Inc.

PART 3 -- EXECUTION

3.1 SERVICES OF MANUFACTURER

A. Field Adjustments

1. The adjustment of actuator controls and limits in the field for the required function shall be performed by field representatives of the manufacturers of valves with pneumatic actuators.

3.23.1 INSTALLATION

A. Install valve actuators and accessories in accordance with the requirements of Section 15200 – Valves, General.

B. Locate the actuators to be readily accessible for operation and maintenance without obstructing walkways.

C. Do not mount actuators where shock or vibrations will impair their operation, and do not attach the support systems to handrails, process piping, or mechanical equipment.

DD. Inspection, Startup, and Field Adjustment

1. Furnish an authorized representative of the manufacturer who shall visit the Site and witness the following:

~~a. Installation of the equipment, for not less than 3- Days;~~

~~b. Inspection, checking, and adjusting the equipment, for not less than 3-Days.~~

~~c. Startup and field-testing for proper operation, for not less than one Day.~~

~~E~~. Instruction of OWNER's Personnel

1. The authorized service representative shall visit the Site for not less than 1/2 Day~~Days~~ in order to instruct the OWNER'S personnel in the operation and maintenance of the equipment, including step-by-step troubleshooting procedures ~~with necessary test equipment~~.

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SECTION 15203 - CHECK VALVES

PART 1 -- GENERAL

1.1 THE REQUIREMENT

A. The CONTRACTOR shall provide check valves and appurtenances, complete and operable, in accordance with the Contract Documents.

B. The requirements of Section 15200 - Valves, General apply to this Section.

1.2 CONTRACTOR SUBMITTALS

A. Furnish submittals in accordance with Section 15200.

B. Submit documentation from the valve supplier indicating that the proposed materials used for valves construction are suitable for the intended fluid service, i.e. pH of 2.5.

PART 2 -- PRODUCTS

~~2.1 INTERNAL SPRING-LOADED CHECK VALVES (GLOBE STYLE)~~

~~A. **General**: Internal spring-loaded check valves for water pumps, compressors, gas, air, and steam shall be of the full-flow internal spring-loaded poppet type. The valves shall be designed for a water-working pressure of not less than 150 psi unless otherwise indicated.~~

~~B. **Body**: The bodies of valves 3-inches and larger shall be of cast iron conforming to ASTM A 126 with 125 lb flanged ends conforming to ASME B 16.1 unless otherwise indicated. Where necessary, there shall be a positive, watertight seal between the removable seat and the valve body. The stem guide shall be integrally cast with the body or screwed into the body.~~

~~C. Valves smaller than 3-inches shall have bronze bodies with screwed ends conforming to ASME B 1.201, suitable for a minimum working pressure of 200 psi, and a temperature of 250 degrees F, unless otherwise indicated. The type of bronze shall be suitable for the intended service.~~

~~D. **Disc and Stem**: The disc and stem of all valves in sizes 3-inches and larger shall be of bronze conforming to ASTM B 584 - Copper Alloy Sand Castings for General Applications, or stainless steel. The stem shall have 2 point bearings. The downstream bearing shall have a bronze or other suitable bushing, to provide a smooth operation.~~

~~E. Valves smaller than 3-inches shall have discs and retaining rings of Teflon, nylon, or other suitable material, and stems of bronze, brass, or stainless steel, suitable for the intended service.~~

~~F. **Stem Guide**: The stem guide shall be either firmly fixed in the valve body to prevent it from sliding into the adjacent pipe and damaging the pipe lining, or the valve manufacturer shall provide each valve with one matching flange compatible with the adjacent pipe and its lining to prevent damage to the lining. The compatible flange shall be part of the Shop Drawing submittal.~~

~~G. **Seat**: Valves for general service at temperatures up to 250 degrees F shall have bubble-tight shut-off with resilient seats of Buna-N, Teflon, or other suitable material.~~

Valves for steam service and temperatures over 250 degrees F shall have metal-to-metal seating of bronze or stainless steel, as recommended by the manufacturer for the specific service condition. Resilient seats shall be firmly attached to the seating ring by compression molding or other acceptable method.

H. **Spring**: Valves in sizes 3-inches and larger shall have Type 316 stainless steel springs, and valves smaller than 3-inches shall have stainless steel or beryllium copper springs, as suitable for the service. The spring tension of the valves shall be designed for the individual pressure condition of each valve.

I. Manufacturers, or Equal

1. APCO (Valve and Primer Corp.)

2. CPV (Combination Pump Valve Company)

3. Miller Valve Co., Inc.

4. VAL-MATIC (Valve and Manufacturing Corporation)

2.2 PLASTIC BALL CHECK VALVES

A. **General**: Plastic ball check valves for corrosive fluids, in sizes up to 4-inches, shall be used for vertical up-flow conditions only, unless the valves are provided with spring actions.

B. **Construction**: The valve bodies and balls shall be of polyvinyl chloride (PVC), chlorinated polyvinyl chloride (CPVC), polyvinylidene fluoride (PVDF), or polypropylene (PP) construction, as best suited for each individual service condition. They shall have unions with socket connections or flanged ends conforming to ASME B16.5 - Pipe Flanges and Flanged Fittings, class 150. Seals shall have Viton O-rings, and valve design shall minimize possibility of the balls sticking or chattering. The valves shall be suitable for a maximum working non-shock pressure of 150 psi at 73 degrees F.

C. Manufacturers, or Equal

1. ASAHI-AMERICA

2. George Fischer, Inc.

3. NIBCO Inc. (Chemtrol Division)

4. Spears Mfg. Co. (PVC, CPVC, AND PP only)

2.3 PLASTIC DIAPHRAGM CHECK VALVES

A. **General**: Plastic diaphragm check valves shall be the type which require no system pressure for sealing and operate silently with minimal pressure drop in either horizontal or vertical flow conditions. They shall utilize either an elastomer diaphragm or teflon encapsulated spring to cause closure.

B. **Construction**: The valve bodies shall be PVC, CPVC, polypropylene (PP), or polyvinylidene fluoride (PVPF) as indicated on the piping schedule. Union connections shall be either NPT or socket ends conforming to ASME B 16.5 Class 150. They shall give bubble tight shutoff without dependence on gravity direction, mounting positon, or

~~reverse flow. Seats and seals shall be EPDM, Buna-N, or Viton, as best suited for the service. Inlet pressure ratings shall be 150 psi at 73 degrees F for PVC and PVDF and 100 psi at 73 degrees F for PP.~~

~~C. Manufacturers or Equal~~

~~1. Plastic-O-Matic Valves, Inc.~~

~~2. Spears Mfg. Co.~~

~~2.4~~2.1 PLASTIC SWING OR WYE-CHECK VALVES

A. **General**: Plastic swing or wye-check valves for corrosive fluids, in sizes up to 8-inches or as available, may be used for horizontal or vertical up-flow conditions.

B. **Construction**: The valve bodies and discs or piston shall be of PVC, PP, or PVDF construction as best suited for each individual service condition. They shall have flanged ends conforming to ASME B16.5 Class 150, and flanged top access covers and shall shut positively at no-flow conditions. The seats and seals shall be of EPDM, Teflon, or Viton. The PVC valves shall be rated for a maximum non-shock working pressure of 150 psi at 73 degrees F for sizes 3-inches and smaller. For larger sizes and other materials and temperatures the pressure rating may be lower.

C. Manufacturers, or Equal

1. ASAHI-AMERICA

2. George Fischer, Inc.

3. **Spears Mfg. Co.** (Plastic Swing Check only)

PART 3 -- EXECUTION

3.1 GENERAL

A. Valves shall be installed in accordance with provisions of Section 15200 - Valves, General.

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SECTION 16000 - GENERAL ELECTRICAL REQUIREMENTS

PART 1 -- GENERAL

1.1 SCOPE OF WORK

A. It is the intent of this part of the Contract Documents to cover the work and materials necessary for erecting a complete electrical system, tested and ready for continuous use. The system shall be constructed in accordance with the Contract Documents, and Federal, State, and Local codes and regulations.

1.2 RELATED SECTIONS

A. The Contractor shall coordinate the work with other trades, and furnish and install the equipment in accordance with the manufacturers' requirements.

B. The Related Work can be found in other Divisions of these specifications, such as, but not limited to:

Division 0	Bidding Requirements, Contract Forms, and Conditions of the Contract
Division 1	General Requirements
Division 2	Sitework
Division 3	Concrete
Division 9	Finishes
Division 11	Equipment
Division 13	Special Construction
Division 15	Mechanical
Division 17	Instrumentation

1.3 GENERAL PROVISIONS

A. Minimum sizes of equipment, and electrical devices, are indicated but it is not intended to show every offset and fitting, nor every structural or mechanical difficulty that will be encountered during the installation of the work.

B. Work indicated on the Plans is approximately to scale, but actual dimensions and detailed Plans should be followed as closely as field conditions permit. Field verification of scale dimensions on Plans is governed by field conditions. Installation of systems and equipment is subject to clarification as indicated in reviewed shop drawings and field coordination.

C. Discrepancies indicated on different Plans, between Plans and actual field conditions, or between Plans and Contract Documents shall be promptly brought to the attention of the Engineer for clarification, prior to purchasing and installing equipment.

D. The alignment of equipment and conduit shall be adjusted to accommodate architectural changes, or to avoid work of other trades, without extra expense to the COMPANY~~Owner~~.

E. The Contractor shall furnish and install the parts and pieces necessary to the installation of equipment, in accordance with the best practice of the trade, and in conformance with the requirements of these Contract Documents.

F. Items not specifically mentioned in these Contract Documents, or noted on the Plans, or indicated on reviewed shop drawings, but which are obviously necessary to make a complete working installation, shall be deemed to be included herein.

G. The Contractor shall layout and install electrical work prior to placing floors and walls. Furnish and install sleeves and openings through floors and walls, required for installation of conduits. Sleeves shall be rigidly supported and suitably packed, or sealed, to prevent ingress of wet concrete. Spacers shall be installed in order to prevent conduit movement. Dimensions indicated for electrical equipment and their installation are restrictive dimensions.

H. The Contractor shall furnish and install inserts and hangers required to support conduits and other electrical equipment. If the inserts, hangers, sleeves, or other mounting hardware are improperly placed, or installed, the Contractor shall do necessary work, at their own expense, to rectify the errors.

I. Electrical equipment shall be capable of operating successfully at full-rated load, without failure, at an ambient air temperature of 40 degrees C, and specifically rated for the altitude indicated on the Plans. Electrical equipment not rated for operation at that temperature shall be provided with air conditioning to meet the manufacturers' operating temperature.

J. If any contradictions, contrasts, nonhomogeneity, or inconsistency appears, the most strict criteria noted and the collective requirements in any and all of the project documents shall apply.

K. The Contractor shall perform necessary saw cutting, core drilling, excavating, removal, shoring, backfilling, and other work required for the proper installation of conduits, whether inside, or outside of the buildings and structures. The Contractor shall repair and patch where demolition has taken place in a manner to match existing original structure.

1.4 REGULATIONS, CODES, AND STANDARDS

A. Electrical work, including connection to electrical equipment integral with mechanical equipment, shall be performed in accordance with the latest published regulations, codes, and standards, of the following:

1. National Electrical Code (NEC)

2. State and local codes

3. Institute of Electrical and Electronic Engineers (IEEE)

4. American National Standards Institute (ANSI)

5. American Society for Testing and Materials (ASTM)

6. Insulated Cable Engineers Association (ICEA)

7. National Electrical Manufacturers Association (NEMA) Standards

8. Federal Occupational Safety and Health Act (OSHA)

9. National Fire Protection Association (NFPA)

B. When applicable, the material used in the performance of the electrical work shall be listed by the Underwriters' Laboratories, Inc. (UL) for the class of service for which they are intended.

1.5 SUBMITTALS

A. It is the obligation of the Contractor to organize their work, so that a complete electrical, instrumentation, and control system for the facility will be provided, and will be supported by accurate shop and record drawings, and O&M manuals.

B. The Contractor shall submit detailed shop drawings and data prepared and organized by the suppliers. The quantity of submittal sets required shall be as specified in the Contract Documents.

C. The submittals shall be neatly grouped and organized by specification section number, and sub-section. Related information shall be highlighted, and the specific product shall be marked. All submittals shall be complete, and presented in one package. Incomplete submittals will be returned without review. If a portion of the project requires a fast track schedule, that portion only may be submitted earlier under a separate cover letter. The following shall be submitted to the Engineer and returned, reviewed to the Contractor before fabrication is started.

1. A complete list of the equipment and materials, including the manufacturer's name, product specification, descriptive data, technical literature, performance charts, catalog cuts, installation instructions, and spare part recommendations for each different item of the equipment specified. The above shall clearly show all the specified requirements as described in the Specifications including but not limited to specific U.L. and NEMA rating, technical capabilities, test result verifications, Seismic Zone rating, and acceptance letters.

2. Drawings containing complete wiring and schematic diagrams, control diagrams, and any other details required to demonstrate that the system has been coordinated and will operate as intended. Drawings shall also show proposed layout, anchoring, support, and appurtenances of equipment, and equipment relationship to other parts of the work including clearances for maintenance and operations.

3. Any exceptions to these specifications, with the reasons for requesting such exceptions, with calculations and drawings for redesign of related components, including detail drawings showing internal and assembly details, with installation instructions. Proposed layout showing any modifications or exceptions to related work made necessary by this work, with calculations and drawings showing such modifications or exceptions.

4. Prior to project acceptance, The Contractor shall submit “Record Drawings” of the electrical, control, and instrumentation, along with step-by-step procedure manuals for the installation, operation start-up, and maintenance of the equipment. Each set shall include installation, operating, troubleshooting, and maintenance and overhaul instructions in complete detail. It shall also include possible breakdowns and repairs, and troubleshooting guides, as well as simplified wiring and control

diagrams of the system installed. This shall provide the COMPANY~~Owner~~ with comprehensive information on all systems and components to enable operation, service, maintenance and repair. Exploded or other detailed views of all equipment, devices, assemblies, and accessory components shall be included, together with complete parts lists and ordering instructions.

5. Record Drawings:

   a. The Contractor shall maintain a marked up set of Contract Document Plans showing actual installed circuit numbers, conduit sizes, cable tray routing, number of conductors, conductor sizes (larger than #12 AWG), and all other deviations from the design Plans.

   b. Underground conduit and concealed items shall be dimensioned on the Plans from permanent, visible, building features.

   c. The Contractor shall provide actual motor size, starter size, and overload heater size, along with all other protective equipment for all 480 V and motor circuits as part of the one-line record drawings.

   d. The Contractor shall revise all conductor identification and panel schedules to indicate as-built conditions.

PART 2 -- PRODUCTS

2.1 GENERAL MATERIALS AND METHODS

A. Materials, equipment, and parts comprising any unit, or part thereof, specified or indicated on the Plans, shall be new and unused, of current manufacture, and of highest grade consistent with the state of the art. Damaged or dirty materials, equipment, and parts, are not considered to be new and unused, and will not be accepted.

B. Field verification of scale dimensions on Plans is directed, since actual locations, distances, and levels will be governed by actual field conditions. The Contractor shall also review architectural, structural, yard, mechanical, and other Plans, and the accepted electrical and mechanical shop drawings, and shall adjust their work to conform to the conditions indicated therein.

C. The fabricator of major components, such as distribution panelboards, switchgear, and motor control centers, shall also be the manufacturer of the major devices therein. Were possible, the major components shall be manufactured and supplied by the same fabricator.

D. Refer to various Division sections for individual equipment manufacturers. Indicated manufacturers are subject to strict compliance with the specifications and complete project documents. The reference to a particular manufacturer does not relieve the Contractor from conforming to the specified requirements.

2.2 NAMEPLATES

A. Where indicated elsewhere in these specifications, or on the Plans, the Contractor shall furnish and install nameplates, which shall be white laminate with black letters. The nameplates shall be fastened to the various devices with round head stainless steel

screws. Each disconnecting means for service, feeder, branch, or equipment conductors shall have nameplates indicating its purpose.

2.3 EQUIPMENT ASSEMBLIES

A. Equipment assemblies, such as Service Entrance Sections, Switchgear, Switchboards, Control and Distribution Panels, and other custom fabricated electrical enclosures shall bear a UL label as a complete assembly. The UL label on the individual components making up the assembly will not be considered sufficient to meet the present requirement. Whenever a generic UL label does not apply for the assembly, a serialized UL label shall be affixed to the assembly, and the serial number shall be submitted with the assembly record shop drawings.

B. Custom fabricated electrical control panels, and enclosures shall bear a serialized UL label affixed by a local inspector, and the serial number shall be submitted with the assembly record shop drawings.

2.4 SEISMIC RESTRAINT

A. The construction area is classified by the Uniform Building Code (UBC) as Seismic Zone III. The Code requires that not only the structures, but also major electrical components be designed and installed in a manner which will preclude damage during a seismic event. All electrical equipment shall be securely anchored and seismic braced in accordance with regulations contained in the most recent adopted edition of the UBC, and the Sheet Metal and Air Conditioning Contractor’s National Association (SMACNA) "Guidelines for Seismic Restraints of Electrical Systems".

B. Units mounted and secured directly to structure shall be provided with connectors of sufficient strength to meet the restraining criteria.

C. All electrical equipment which is securely anchored (hard mounted) to the building or structure shall have supports designed to withstand lateral and vertical "G" loadings equal to or greater than UBC requirements and SMACNA guidelines.

D. Shop drawings are required for all equipment anchors, supports and seismic restraints. Submittals shall include weights, dimensions, load/deflection data, center of gravity, standard connections, manufacturer's recommendations, and behavior problems (vibration, thermal, expansion, etc.) associated with equipment.

PART 3 -- EXECUTION

3.1 UTILITY SERVICE AND EQUIPMENT

A. The Contractor shall be responsible for contacting and coordinating the electrical utility work with the electrical utility company. The Contractor shall be responsible for furnishing and installing equipment and material required to bring electrical power service to the service location in conformance with the electrical utility requirements. The Contractor may have to provide the following for the electrical utility company's primary (from utility power line to the utility transformer) and secondary (from utility transformer to the service) electrical lines in accordance with the electrical utility company’s specifications and requirements:

1. Conduits and cables (verify quantity and sizes)

2. Trenching, backfill, and compacting (verify trench size(s), backfill material, and compaction percentage requirements)

2. Concrete pad(s) (for pad mounted transformer(s))

3. Cable protection along the vertical drop at the utility company's pole (if pole mounted transformer(s))

4. Other items required by the power utility company's specifications

5. The Contractor shall also submit copies of service entrance shop drawings to the utility, per utility submittal requirements, prior to submittal to the Engineer. The Contractor shall obtain written approval from the power utility company that the service entrance equipment is acceptable prior to release the order to the supplier for fabrication. A copy of the approval letter from the utility shall be transmitted to the Engineer along with the submittal.

3.2 INSTALLATION OF ELECTRICAL EQUIPMENT

A. Coordinate the installation of electrical equipment with other trades.

~~1. Arrange for the building in of equipment during structure construction.~~

~~2.~~ Where equipment cannot be built-in during construction, arrange for sleeves, box-outs, and other openings, as required to allow installation of equipment after structure construction is complete.

B. Verify that equipment will fit support layouts indicated.

C. Equipment Dimensions and Clearances:

1. Do not use equipment that exceeds the indicated dimensions except as approved in writing by the Engineer.

2. Do not use equipment or arrangements of equipment that reduce required clearances or exceed the space allocation.

D. Install equipment in accordance with the manufacturer's instructions.

E. Equipment Access:

1. Install equipment so it is readily accessible for operation and maintenance.

2. Equipment shall not be blocked or concealed.

3. Do not install electrical equipment such that it interferes with normal maintenance requirements of other equipment.

F. Equipment shall be installed plumb, square and true with the building construction, and shall be securely fastened.

G. Outdoor wall-mounted equipment, and indoor equipment mounted on earth, or water bearing walls, shall be provided with corrosion-resistant spacers to maintain ¼-inch separation between the equipment and the wall.

H. Screen or seal all openings into outdoor equipment to prevent the entrance of rodents and insects.

I. Equipment fabricated from aluminum shall not be imbedded in earth or concrete.

J. Provide all necessary anchoring devices and supports.

1. Use supports as detailed on the Plans and as specified.

2. Supports and anchoring devices shall be rated and sized based on dimensions and weights verified from approved equipment submittals.

3. Hardware shall be stainless steel.

4. Do not cut, or weld to, building structural members.

5. Do not mount safety switches and external equipment to other equipment enclosures, unless enclosure mounting surface is properly braced to accept mounting of external equipment.

K. Contractor shall verify exact rough-in location and dimensions for connection to electrical items furnished by others.

1. Shop drawings shall be obtained from those furnishing the equipment.

2. Proceeding without proper information may require the Contractor to remove and replace work that does not meet the conditions imposed by the equipment supplied.

3. Provide sleeves wherever openings are required through new concrete or masonry members. Place sleeves accurately and coordinate locations with the Engineer.

4. Should any cutting and patching be required on account of failure of the Contractor to coordinate penetrations, such cutting and patching shall be done at the expense of the Contractor.

a. The Contractor shall not endanger the stability of any structural member by cutting, digging, chasing, or drilling and shall not, at any time, cut or alter the work without the Engineer's written consent.

1) Provide additional reinforcing if required.

2) Cutting shall be done neatly using proper tools and methods.

~~b. Subsequent patching to restore walls, ceilings, or floors to their original condition shall be done by the Contractor.~~

L. Provide concrete foundations or pads required for electrical equipment and control panels as indicated or specified.

1. Floor-mounted or ground-mounted equipment shall be mounted on a 6~~3~~-inch concrete housekeeping pad unless otherwise noted on the drawings. Pad shall be poured on top of the finished floor or slab or placed on an appropriately compacted base material approved by the ENGINEER. Rebar reinforcements and their spacing shall be approved by the ENGINEER if not specified on the drawings. If

the pad is for ground-mounted equipment/control panels, the surrounding earthen material shall be graded to be level with the top of the pad and properly compacted.~~.~~ Contractor shall verify the distance to all equipment from the finished floor meets the current NEC requirements. All modifications shall be made to the electrical equipment as required.

2. All conduits penetrating concrete floors or pads shall have a 3-inch concrete housekeeping pad unless otherwise noted on the drawings. Conduits should be grouped as allowed to limit the number of housekeeping pads required.

3.3 TEMPORARY POWER

A. The Contractor shall furnish, install, and maintain, temporary power and lighting systems needed for construction in accordance with Section 01515 – Temporary Distribution Line. This temporary system shall include weatherproof panel(s) for the Contractor's main breakers and distribution system. Ground fault interrupting equipment shall be installed. Connections shall be watertight, with wiring done with Type SO portable cable. After construction is completed, the Contractor shall remove temporary power equipment and devices.

3.4 CUTTING AND REPAIRING

A. Where it becomes necessary to cut into existing work for the purpose of making electrical installations, core drills shall be used for making circular holes. Other demolition methods for cutting or removing shall be reviewed by the Engineer prior to starting the work.

B. The Contractor shall repair damage caused by construction, or demolition work, and restore damaged areas to original condition.

3.5 CORROSION PROTECTION

A. Wherever dissimilar metals, except conduit and conduit fittings, come in contact, the Contractor shall isolate these metals, as required, with neoprene washers, 9 mil polyethylene tape, or gaskets. Where fastening conduit, electro plated, or equivalent fasteners and stainless steel bolts shall be used.

B. Factory finishes damaged during shipping, or construction, shall be restored to original new condition. Rust shall be removed, and bare metal surfaces shall be primed and painted to match the original surrounding finish.

C. Electrical panels, switchgear, motor control centers, and other electrical equipment, shall be shipped in sealed dust and moisture proof plastic sheet enclosures, and the seal maintained until units are installed. Said units shall be new and free of any dirt, dust, water, grease, rust, damaged parts or components. Relays, starters, circuit breakers, switches, contacts, insulators, mechanisms, and buses shall be free of dust, dirt, oil, moisture, metal shavings, and other debris before testing and energizing.

D. Equipment shall be protected at all times with plastic sheet covers until the area is free of dirt, dust, paint spray, water, heat, and other trades. Heat shall be provided to eliminate condensation. All repairs due to storage will be the responsibility of the contractor.

3.6 COORDINATION OF THE ELECTRICAL SYSTEM

A. The Contractor shall verify actual equipment, and motor full-load, and locked-rotor current ratings. The necessary minimum equipment, wire, and conduit sizes are indicated on the Plans. If the Contractor furnishes equipment of different ratings, the Contractor shall coordinate the actual current rating of equipment furnished with the branch circuit conductor size, the overcurrent protection, the controller size, the motor starter, and the branch circuit overcurrent protection. The branch circuit conductors shall have a current carrying capacity of not less than 125 percent of the actual full-load current rating. The size of the branch circuit conductors shall be such that the voltage drop from the overcurrent protection devices, up to the equipment, shall not exceed 2 percent, when the equipment is running at full-load and rated voltage.

3.7 TESTING

A. The electrical work shall be free from improper grounds, and from short circuits. The correctness of the wiring shall be verified first by visual comparison of the conductor connections with connection diagrams. Next, individual circuit continuity checks shall be made by using electrical circuit testers. Last, the correctness of the wiring shall be verified by the actual electrical operation of the electrical and mechanical devices. Any deviation from the wiring indicated on the Plans, or accepted Drawings, shall be corrected and indicated on the record drawings.

B. Each conductor shall be identified as required by the Contract Documents. This identification shall be indicated on the record drawings to enable rapid and accurate circuit tracing by maintenance personnel.

3.8 ONE-LINE DIAGRAMS

A. One-line diagrams, as indicated on the Drawings, show circuit voltages, circuit protection rating, and other pertinent data. Where conflicts exist on the Drawings, the one-line diagrams shall take precedence. Grounding conductors are not necessarily indicated. See grounding requirements specified elsewhere herein.

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SECTION 16111 - CONDUITS

PART 1 -- GENERAL

1.1 SCOPE OF WORK

A. Furnish and install conduits as required, and as shown on the Plans. Materials employed shall be as shown on the Plans.

1.2 SUBMITTALS

A. Submit product literature including manufacturer part number, model number, material, size, and specifications. Material shall not be installed until the Engineer has reviewed the submittal data.

B. If changes from the Plan are proposed, shop drawings shall be submitted for review and acceptance showing routing, conduit size, and number and size of wires in each conduit before installation of conduit and any related work.

C. Proposed routing of conduits buried under floor slabs-on-grade and below grade.

D. Identify conduit by tag number of equipment served or by circuit schedule number.

E. Proposed routing and details of construction including conduit and rebar embedded in floor slabs, columns, etc.

F. Proposed location and details of construction for openings in slabs and walls for raceway runs.

G. Refer to Section 16000 General Electrical Requirements for further submittal requirements.

1.3 REFERENCES

A. American National Standards Institute (ANSI): C80.1, Rigid Steel Conduit - Zinc-Coated.

B. National Electric Manufacturers Association (NEMA): RN-1, Polyvinyl-Chloride (PVC) Externally Coated Galvanized Rigid Steel Conduit.

C. Underwriters Laboratories Inc. (UL):

1. 1, Flexible Metal Conduit.

2. 6, Rigid Metal Conduit.

3. 360, Liquid-Tight Flexible Steel Conduit.

4. 467, Grounding and Bonding Equipment.

5. 514, Nonmetallic Outlet Boxes, Flush-Device Boxes and Covers.

6. 651, Schedule 40 and 80 Rigid PVC Conduit.

7. 870, Wireways, Auxiliary Gutters, and Associated Fittings.

8. 884, Underfloor Raceways and Fittings.

9. 886, Outlet Boxes and Fittings for Use in Hazardous (Classified) Locations.

PART 2 -- PRODUCTS

2.1 RACEWAYS

A. Exposed conduits in an unclassified or hazardous area shall be galvanized rigid steel (GRS) unless specifically indicated otherwise on the Plans. Conduits in corrosive, hazardous, or damp areas shall be PVC coated GRS unless otherwise indicated. Underground and/or concrete encased conduits shall be PVC, unless otherwise indicated. All conduits concealed in block walls or steel framing shall be EMT with compression fittings unless otherwise indicated. Set screw type fittings in EMT conduit will not be accepted. All wiring, except as otherwise noted, shall be in conduit. Conduit size shall not be less than the National Electrical Code (NEC) size required for the conductors therein and shall not be smaller than 3/4-inch. No underground conduit shall be less than one inch.

B. Condulets type fittings shall be Crouse-Hinds, Appleton, or equal with wedge nut covers. All condulets located outdoors, damp or wet locations shall be weather tight.

C. In unclassified areas, flexible conduit shall be grounding type, weatherproof, corrosion resistant, and watertight.

D. Couplings, connectors, and fittings shall be standard types specifically designed and manufactured for the purpose. They shall be installed to provide a firm mechanical assembly and electrical conductivity throughout. Conduit systems shall be water tight.

E. Expansion fittings shall be OZ type AX with jumper for exposed locations and type DX at structural expansion joints, Spring City, or equal. Conduits shall have expansion fittings in accordance with NEC.

F. The conduits and fittings shall be supported per NEC requirements as a minimum.

G. Sealing fittings shall be provided for classified areas per the NEC requirements in hazardous or corrosive areas. Fittings shall be poured after the final walk-thru unless otherwise directed in writing by the Engineer.

2.2 GALVANIZED RIGID STEEL (GRS)

A. Conduits and couplings shall be hot-dipped galvanized with zinc-coated threads and outer coating of zinc bichromate, in accordance with ANSI C80.1 standards, as manufactured by Jones & Laughlin Steel Corporation, Allied Tube & Conduit Corporation, Triangle PWC, or equal.

B. Steel conduit shall not be buried in earth without concrete encasement and additional corrosion protection. A half lapped rapping of 20 mil PVC based corrosion protection tape shall be used.

2.3 PVC COATED GALVANIZED RIGID STEEL (PVC-GRS)

A. PVC coated GRS conduit shall be installed where shown on the Plans or elsewhere specified and shall conform to NEMA RN-1 and ANSI C80.1 standards.

B. The zinc surface of the conduit shall remain intact and undisturbed on both the inside and the outside of the conduit throughout the preparation and application processing. A PVC coating shall be bonded to the galvanized outer surface of the conduit. The bond between the PVC coating and the conduit surface shall be greater than the tensile strength of the plastic. The thickness of the PVC coating shall be a minimum of 0.040-inch (40 mil).

C. A loose coupling shall be furnished with each length of conduit. A PVC coating shall be bonded to the outer surface of the coupling and a PVC sleeve equal to the outside diameter of the uncoated conduit shall extend beyond both ends of the coupling approximately one pipe diameter or 1-1/2 inches, whichever is smaller. The wall thickness of the coating on the coupling and the sleeve shall be a minimum of 0.055-inch (55 mil).

D. A PVC coating shall be bonded to the inner and outer surface of all conduit bodies and fittings and a PVC sleeve shall extend from all hubs. The wall thickness of the coating on conduit bodies and fittings and the sleeve walls shall be identical to those on couplings in length and thickness. The covers on all conduit bodies shall be coated on both sides and shall be designed to be completely interchangeable. The inside of conduit bodies shall remain undisturbed in the processing.

E. Type 304 stainless steel screws shall be furnished and used to attach the cover to the conduit body. All coated material shall be installed and patched according to the manufacturer's recommended installation and patching instructions.

F. Conduit straps shall be PVC coated or stainless steel.

G. PVC coated conduits and fittings shall be as manufactured by Kor Kap Corporation, Occidental Coating Company, Rob-Roy, or equal.

H. PVC coated flexible conduits shall be liquid and vapor-tight and manufactured in accordance with UL 360 standards.

2.4 RIGID NONMETALLIC - PVC

A. Where specifically indicated on the Plans, or elsewhere specified, conduit may be high density Schedule 40, 90 degrees C, heavy-duty PVC. The conduit shall be manufactured from virgin polyvinyl chloride compound which meets ASTM D1784, NEMA TC-2, ANSI C33.91, and UL 651 standards. Smoke emissions shall be limited to less than 6 grams per 100 grams of material tested.

B. Where conduit concrete encasement is indicated on the Plans, conduit supports shall be installed at five-foot intervals. PVC conduit shall be manufactured by Carlon, Triangle Conduit & Cable, or equal.

2.5 LIQUIDTIGHT FLEXIBLE METAL CONDUIT

A. Liquidtight flexible metal conduit shall be liquid and vapor-tight, oil and ultraviolet ray resistant and manufactured in accordance with UL 360 standards. Liquidtight flexible metal conduit shall be formed of a continuous, spiral wound, galvanized steel core with an extruded PVC jacket. The PVC jacket shall be rated for high ambient heat applications, 90 degrees Celsius.

B. For corrosive locations, liquidtight flexible metal conduit shall be formed of a continuous, spiral wound, aluminum core with an extruded PVC jacket. The PVC jacket shall be impervious to corrosive liquids and vapors.

C. An external bonding conductor shall be required for flexible conduit connections containing circuits rated at 60 amps or greater and for sizes 1 1/2 " or larger. Flexible conduits and connectors for 1 1/4 " and smaller shall be listed for grounding.

D. Connectors for liquidtight flexible conduit shall be galvanized, furnished with a sealing ring and locknut, and suitable for wet locations.

~~2.5 ELECTRICAL METALLIC TUBING (EMT)~~

~~A. Per UL Standard for Electrical Metallic Tubing No. 797. Galvanized mild steel with interior coat of enamel.~~

~~B. Fittings shall be steel set-screw type. Cast type, indenter type or compression steel fittings are not acceptable.~~

~~C. Approved for plan specified locations only. Approved for conduits concealed in block walls and concealed in steel framed walls. Not approved for process areas where wash down or high humidity conditions exist.~~

~~2.6 ALUMINUM CONDUIT~~

~~A. Aluminum conduit is approved for wet and corrosive areas only. Prior approval from the engineer must be obtained when substituting for PVC coated.~~

~~B. Aluminum hardware and conduit shall be isolated from all dissimilar materials as appropriate.~~

~~1. Isolation from dissimilar metals in channel or support by a single layer of scotch #33+ or approved equal.~~

~~2. Isolation from concrete shall be by neoprene gaskets.~~

~~3. Aluminum shall not be used for concrete penetrations.~~

~~C. Aluminum conduit shall contain less than 0.4% copper~~

PART 3 - EXECUTION

3.1 INSTALLATION

A. Conduit runs are schematic only, and shall be modified as required to suit field conditions, subject to review and acceptance by the Engineer.

B. Conduit shall run continuously between outlets and shall be provided with junction boxes where connections are made. Couplings, connectors, and fittings shall be acceptable types designed and manufactured for the purpose, and shall provide a firm mechanical assembly, and electrical conductivity throughout.

C. Conduit runs shall be straight and true. Elbows, offsets, and bends shall be uniform and symmetrical. Changes in direction shall be made with long radius bends, or with fittings of the condulet type.

D. Conduit runs in buildings and structures shall be concealed where possible except as specifically noted, or accepted by the Engineer.

E. Conduit runs shall not interfere with the proper and safe operation of equipment, and shall not block or interfere with ingress or egress, including equipment removal hatches.

F. Exposed conduits shall be securely fastened with clamps, or straps, intended for conduit use. All exposed conduit shall be run on the walls and ceiling only and shall be parallel to the planes of the walls or ceiling. No diagonal runs will be permitted. Flexible conduit shall be used only for short lengths required to facilitate connections between rigid conduit to vibrating equipment such as motors, fans, and transformers. The maximum length of flexible conduit shall be 3 feet, unless approved in writing by engineer. Flexible conduit shall not be used for electrician's~~electricians~~ convenience where rigid conduit could be used.

G. Conduit runs on water-bearing walls shall be supported one inch away from the wall on an accepted channel. When channel galvanizing, or other coating, is cut or otherwise damaged, it shall be field coated to original condition. No conduit shall be run in water-bearing walls, unless specifically designated otherwise.

H. Conduit shall be thoroughly reamed to remove burrs. IMC or GRS shall be reamed during the threading process, and Rigid Nonmetallic PVC shall be reamed before applying fittings. A zinc-rich cold galvanizing shall be used to restore corrosion protection on field cut threads.

I. Bushings and lock nuts or hubs shall be used at conduit terminations. Conduit, bushings, locknuts, and enclosures shall be fastened to the conduit system prior to pulling wire. Splitting the bushings for installation will not be accepted. Hubs shall be used in all process areas outside of electrical rooms unless otherwise specified. The total number of bends in any run between pull points shall not exceed 360 degrees. Junction boxes and pull boxes shall be installed at points acceptable to the Engineer. Conduit ends shall be plugged to prevent the entrance of moisture or debris during construction. All spare conduits shall be adequately capped and shall contain a suitable pull string. Splices shall be made in junction boxes only. Splices in conduit bodies will not be accepted.

J. Joints shall be set up tight. Hangers and fastenings shall be secure, and of a type appropriate in design, and dimensions, for the particular application.

K. Conduit runs shall be cleaned and internally sized (obstruction tested) so that no foreign objects, or obstructions remain in the conduit prior to pulling in conductors.

L. After installation of complete conduit runs 2 inches and larger, conduits shall be snaked with a conduit cleaner equipped with a cylindrical mandrel of a diameter not less than 85 percent of the nominal diameter of the conduit. Conduits through which the mandrel will not pass shall not be used. Test results should be submitted to the Engineer.

M. Expansion fittings shall be installed across all expansion joints and at other locations where necessary to compensate for thermal expansion and contraction.

N. Provide trenching, backfill, and compaction for conduits installed underground.

O. Empty or un-used conduits shall contain a pull cord securely fastened on each end.

- END OF SECTION -

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SECTION 16123 - 600 VOLT CLASS CABLE

PART 1 -- GENERAL

1.1 SCOPE OF WORK

A. This section covers the furnishing and installation of 600 Volt Class cables and conductors, terminations and splicing, and pulling lubricants.

B. SO & SJO Conductors are specified elsewhere in these specifications.

1.2 SUBMITTALS

A. Products shall be submitted in accordance with Section 16000 General Electrical Requirements, and elsewhere in the Contract Documents, prior to installation.

1.3 REFERENCES

A. Insulated Cable Engineers Association/National Electrical Manufacturers Association (ICEA/NEMA):

1. S-68-516/WC 8, ethylene-propylene rubber-insulated wire and cable for the transmission and distribution of electrical energy.

2. S-61-402/WC 5, thermoplastic-insulated wire and cable for the transmission and distribution of electrical energy.

3. S-66-524/WC 7, cross-linked thermosetting-polyethylene-insulated wire and cable for transmission and distribution of electrical energy.

B. Underwriters Laboratory, Inc.

1. 44, rubber insulated wires and cables.

2. 83, thermoplastic-insulated wires and cables.

3. 486A, wire connectors and soldering lugs for use with copper conductors.

4. 486B, wire connectors for use with aluminum conductors.

5. 510, insulating tape.

C. National Electric Code

D. Insulated Cable Engineers Association

PART 2 -- PRODUCTS

2.1 ACCEPTED MANUFACTURERS

A. Conductors and Multi Conductor Cables (MCC), subject to compliance with Contract Documents, the following manufacturers are acceptable: American Insulated Wire Corporation, Cablec Corporation, Okonite Company, Southwire Company, or equal.

2.2 CONDUCTORS

A. Wire sizes shall be American Wire Gauge (AWG) sizes with Class B stranded construction. Number 2 AWG and smaller shall be factory color coded with a separate color for each phase and neutral, which shall be used consistently throughout the system. Larger cables shall be coded by the use of colored tape. Conductors #6 AWG or smaller shall be THWN or XHHW. Conductors #2 AWG or smaller shall be XHHW. Conductors #1 AWG or larger shall be XHHW-2. The minimum power or ground conductor size shall be #12 AWG.

B. Individual or multiple conductor cables for power, control, and alarm circuits of 480 volts or less shall be insulated for not less than 600 volts and shall have insulation type as indicated on the Plans. "THHW" shall conform to ICEA S-61-402/NEMA WC 5 and UL 83 and "XHHW" shall conform to ICEA S-66-524/NEMA WC 7 and UL 44. Where wire size is not indicated, they shall be of the size required by the NEC, except that no wire external to panels and motor control centers shall be less than No. 12 AWG, unless specifically noted on the Plans. Panel control wiring shall not be less than No. 14 AWG.

C. Multi-conductor tray cables shall be rated 600 volts, listed by UL as Type TC cable or ITC for instrumentation cable only per Article 340 of the NEC. The individual conductors shall be UL listed as Type XHHW, with a sunlight-resistant overall jacket. Conductor sizes shall be the same as for power and lighting wire and control wire above. Connectors/Terminators shall be water tight and manufactured of the same material as the cabling system referenced elsewhere in Division 16.

D. Multi-conductor tray cables to be installed in classified areas shall be armored, rated 600 volts, listed by UL as Type MC-HL cable per Article 340 of the NEC. The individual conductors shall be UL listed as Type XHHW, with a sunlight-resistant overall jacket. Conductor sizes shall be the same as for power and lighting wire and control wire above. Connectors/terminators shall be rated for classified areas and submitted upon accordingly.

E. All wiring shall be as indicated on the Plans. Wires shall be new and shall be soft drawn copper with not less than 97 percent conductivity. The wire and cable shall have size, grade of insulation, voltage, and manufacturer's name permanently marked on the outer covering at not more than 2-foot intervals. All wires shall conform to the latest Standards of the ASTM, and ICEA, and shall be tested for their full length by these Standards. Insulation thickness shall be not less than that specified by the National Electrical Code.

2.3 TERMINATIONS AND SPLICES

A. Cable shall be rated 600 volts. Other parts of cable systems such as splices and terminations shall be rated at not less than 600 volts. Splicing shall join conductors mechanically and electrically to provide a complete circuit prior to installation of insulation.

B. Splices in wires No. 10 AWG and smaller shall be made with an insulated, solderless, pressure type connector, Type I, Class 1, Grade B, Style G, or Type II, Class 1 of FS W-S-610 and conforming to the applicable requirements of UL 486A.

C. Splices in wires No. 8 AWG and larger shall be made with noninsulated, solderless, pressure type connector, Type II, Class 2 of FS W-S-610, conforming to the applicable requirements of UL 486A and UL 486B. They shall then be covered with an insulation and jacket material equivalent to the conductor insulation and jacket.

D. Insulated conductor splices below grade or in wet locations shall be sealed type conforming to ANSI C119.1 or shall be waterproofed by a sealant-filled, thick wall, heat shrinkable, thermosetting tubing or by pouring a thermosetting resin into a mold that surrounds the joined conductors.

E. Bare conductor splices in wet locations or below grade shall be of the exothermic type.

2.4 PULLING LUBRICANT

A. All cables shall be properly coated with pulling compound (Aqua Gel, Polywater, or equal) before being pulled into conduits so as to prevent mechanical damage to the cables during installation. “Yellow 77” is not acceptable.

B. Other lubricants to be substituted must be accompanied by a statement from the cable manufacturer as to its acceptable use with the cable being installed.

2.5 IDENTIFICATION

A. All conductors shall be numbered with "tube sleeve" type tags with heat impressed letters and numbers.

B. Color code all wiring as follows:

1. Lighting and power wiring:

	120/208 VAC	**480VAC**	**12V DC**	**24V DC**	**120 VAC Control/ Power**
a. Phase 1	Black	Brown	Orange	Blue	Red
b. Phase 2	Red	Orange			
c. Phase 3	Blue	Yellow			
d. Neutrals	White	White	Grey	Blue/White	White

2. Color code ends of feeder phase conductors only.

PART 3 - EXECUTION

3.1 INSTALLATION

A. The pulling tension and side-wall pressures, as recommended by the cable manufacturer, shall not be exceeded.

B. As far as practical, all circuits shall be continuous from origin to termination without splices in intermediate pull boxes. Sufficient slack shall be left at the termination to make proper connections. In no case shall a splice be pulled into the conduit. Conductor splicing shall not be permitted without the Engineer's approval. Conductor splices shall not be made in underground junction boxes or manholes unless specifically noted on the plans.

C. Install all cables in conduit. Manufacturer's cables and SO cord may be installed without conduit where approved and noted on the plans.

D. Each feeder and branch circuit shall be installed in its own individual conduit unless combining feeder and branch circuits is permitted as defined in the following:

1. As specifically indicated on the Plans.

2. For lighting, multiple branch circuits may be installed in a conduit as allowed by the NEC and with the wire ampacity de-rated in accordance with the requirements of the NEC. Conduit fill shall not exceed the limits established by the NEC.

3. When field conditions dictate and written permission is obtained from the Engineer.

E. Feeder and branch circuits shall be isolated from each other and from all instrumentation and control circuits.

F. Control circuits shall be isolated from all other feeder, branch and instrumentation circuits, except as noted above.

1. 12 V DC, 24 V DC and 48 V DC control circuits may be combined in common conduit.

2. 120/208/240 V AC control circuits shall be isolated from all DC control circuits.

3. 277/480 V AC circuits shall be isolated from all other voltages.

G. Single conductor cable in cable trays shall be No. 1/0 or larger and shall be of a type listed and marked for use in cable trays. Tray cable smaller than 1/0 shall be multi-conductor with outer jacket.

H. Make splices only at pull or junction boxes.

Crimp or indented-type connectors are not allowed, unless approved by engineer.

- END OF SECTION -

SECTION 16124 - INSTRUMENTATION CLASS CABLE

PART 1 -- GENERAL

1.1 SCOPE OF WORK

A. This section covers cable use for process signal and controls.

1.2 SUBMITTALS

A. Products shall be submitted in accordance with Section 16000 General Electrical Requirements, and elsewhere in the Contract Documents, prior to installation.

PART 2 -- PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with Contract Documents, the instrumentation cable shall be as manufactured by Belden, Okonite, or equal.

2.2 INSTRUMENTATION CABLE

A. Instrument cable shall be Type TC, and have the number of individually shielded twisted pairs indicated on the Plans and shall be insulated for not less than 600 volts. Unless otherwise indicated, conductor size shall be No. 18 AWG minimum. Shielded, grounded instrumentation cable shall be used for all analog and low voltage digital signals.

B. The jacket shall be flame retardant with 90 degrees C temperature rating. The cable shield shall be a minimum of 2.3 mil aluminum or copper tape overlapped to provide 100 percent coverage and a tinned copper drain wire.

C. The conductors shall be bare soft annealed copper, Class B, 7 strand minimum concentric lay with 15 mils nominal thickness, nylon jacket, 4 mil nominal thickness, 90 degrees C temperature rating. One conductor within each pair shall be numerically identified.

D. Pairs shall be assembled with a nominal 2-inch lay and shall then be group shielded with a minimum of 1.3 mil aluminum or copper tape overlapped to provide 100 percent coverage. All group shields shall be completely isolated from each other.

E. Pairs installed in a cable tray shall have a UV resistant jacket, and shall have a jacket intended for cable tray use.

PART 3 -- EXECUTION

3.1 INSTALLATION

A. Feeder and branch circuits shall be isolated from each other, and from instrumentation and control circuits. Instrumentation cables shall be installed in separate raceways from other cables and wiring. This includes portions running through manholes. Instrumentation cable shall be continuous between instruments or between field devices and instrument enclosures. There shall be no intermediate splices or terminal boards, unless otherwise shown on the Plans.

B. Maintain electrical continuity of the shield when splicing twisted shielded pair conductors. Drain wires shall be terminated inside enclosures at grounded terminal blocks. Only one end of each instrument loop cable drain wire shall be grounded. Ground drain wires of shielded conductors at one end only.

C. Terminate instrumentation and control wiring, including spare wires, at control panels and motor control centers on terminal boards mounted inside the equipment.

1. Contractor shall supply terminal boards as required.

2. Do not field wire directly to devices.

- END OF SECTION -

SECTION 16141 - WIRING DEVICES

PART 1 -- GENERAL

1.1 SUMMARY

A. Section Includes:

1. Light switches, receptacles, device plates, dimmers, plug-in strips and tele-power poles.

B. Related Sections include but are not necessarily limited to:

Division 0	Bidding Requirements, Contract Forms, and Conditions of the Contract~~.~~
Division 1	General Requirements~~.~~
Section 16000	General Electrical Requirements~~.~~
Section 16130	Outlet, Pull, and Junction Boxes~~.~~
Section 16170	Grounding~~.~~

1.2 QUALITY ASSURANCE

A. Referenced Standards:

1. Refer to Section 16000~~.~~

1.3 SUBMITTALS

A. Shop Drawings:

1. Refer to Section 16000~~.~~

PART 2 -- PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:

1. Light switches ~~(except explosion proof):~~

a. Not Used

2. Receptacles

a. Hubbell~~.~~

b. Slater~~.~~

c. P&S~~.~~

d. Arrow Hart~~.~~

e. General Electric~~.~~

f. Leviton~~.~~

~~2. Explosion-proof light switches (Class 1 Div I & II):~~

~~a. Crouse-Hinds.~~

~~b. Appleton Electric Co.~~

~~c. Killark.~~

~~3. Door switches:~~

~~a. General Electric.~~

~~b. Slater.~~

~~c. P&S.~~

~~d. Arrow Hart.~~

~~e. Micro-switch.~~

~~4. Receptacles (except explosion proof):~~

~~a. Hubbell.~~

~~b. Slater.~~

~~c. P&S.~~

~~d. Arrow Hart.~~

~~e. General Electric.~~

~~f. Leviton.~~

~~5. Explosion proof receptacles (Class 1 Div I & II):~~

~~a. Crouse-Hinds.~~

~~b. Appleton Electric Co.~~

~~c. Killark.~~

~~6. Welding receptacles:~~

~~a. Crouse-Hinds.~~

~~b. Appleton Electric Co.~~

~~7. Tele-power poles:~~

~~a. Wiremold.~~

~~b. Walker.~~

~~8. Dimmers:~~

~~a. Lutron.~~

~~b. General Electric.~~

~~c. P&S.~~

~~9. Plug-in strip:~~

~~a. Wiremold.~~

~~b. Walker.~~

~~B. Submit requests for substitution in accordance with Specifications.~~

2.2 MATERIALS

A~~A. Light Switches for Unclassified Areas:~~

~~1. Toggle type, quiet action, specification grade with grounding terminal.~~

~~2. Back and side wired.~~

~~3. Solid silver cadmium oxide contacts.~~

~~4. One-piece switch arm rated 20 A, 120/277 V AC.~~

~~5. UL listed.~~

~~6. Color: White unless Owner or Engineer specifies otherwise.~~

~~7. Wall plate: Type 304 stainless steel.~~

~~8. Type: As indicated on Drawings.~~

~~B~~. Receptacles for Unclassified Areas:

1. Straight blade, grounding type, specification grade~~.~~

2. Back and side wired with wrap-around bridge~~.~~

3. Rated 20 A, 125 V AC~~.~~

4. UL listed~~.~~

5. Color:

   a. For use on normal power: White unless Owner or Engineer specifies otherwise.

   b. For use on UPS systems: Red.

c. For use on isolated ground systems: Orange.

d. For special purpose receptacles: Black

6. Wall plate: Type 304 stainless steel.

7. Type: As indicated on Drawings.

B~~C. Light Switches for Wet Areas:~~

~~1. Presswitch type, quiet action, specification grade, with grounding terminal.~~

~~2. Back and side wired.~~

~~3. Solid silver cadmium oxide contacts.~~

~~4. One-piece switch arm rated 20 A, 120/277 V AC.~~

~~5. UL listed.~~

~~6. Color: White unless Owner or Engineer specifies otherwise.~~

~~7. Wall plate: Gray weatherproof presswitch type.~~

~~8. Type: As indicated on Drawings.~~

~~D~~. Receptacles for Wet Areas:

1. Straight blade, grounding type, specification grade.

2. Back and side wired with wrap around bridge.

3. Rated 20 A, 125 V AC.

4. UL listed.

5. Color: Ivory.

6. Wall plate: Weatherproof, cast aluminum, UL listed.

7. Type: As indicated on Drawings.

C~~E~~. Ground Fault Circuit Interrupter Receptacles:

1. Straight blade, grounding type, specification grade.

2. Rated 20 A, 125 V AC.

3. UL listed.

4. Test and reset buttons.

5. Wall plate: Indoor or weatherproof as required.

6. Feed-through type.

~~F. Light Switches for Corrosive Areas:~~

~~1. Corrosion-resistant NEMA 4X enclosure with switch consisting of:~~

~~a. Fiberglass reinforced polyester enclosure.~~

~~b. Fiberglass reinforced polyester gasketed wall plate with built-in toggle lever switch with stainless steel shaft.~~

~~c. Grounding bushing.~~

~~d. Rated 20 A, 125 V AC.~~

~~e. UL listed.~~

~~f. Type: As indicated on Drawings.~~

~~g. Color: Yellow.~~

~~2. Optional: Corrosion-resistant enclosure and switch consisting of:~~

~~a. Cast copper-free aluminum "FS" or "FD" ridge type hub box.~~

~~b. Toggle type, quiet action, specification grade with grounding terminal.~~

~~c. Rated 20 A, 125 V AC with solid silver cadmium oxide contacts.~~

~~d. UL listed.~~

~~e. Neoprene gasket.~~

~~f. Cast aluminum cover with stainless steel screws and lever to activate switch.~~

~~g. Type: As indicated on Drawings.~~

~~h. Color: Yellow.~~

~~G. Receptacles for Corrosive Areas:~~

~~1. Corrosion-resistant straight blade, grounding type, specification grade.~~

~~2. Back and side wired with wrap-around bridge.~~

~~3. Rated 20 A, 125 V AC.~~

~~4. UL listed.~~

~~5. Color: Yellow.~~

~~6. Box: "FS" or "FD" ridge type cast hub box of copper-free aluminum.~~

~~7. Gasket: Neoprene.~~

~~8. Wall plate: Weatherproof, cast aluminum, UL listed, WDL open or closed.~~

~~9. Type: As indicated on Drawings.~~

~~H. Explosion-proof Light Switches for Use in Hazardous Areas:~~

~~1. Explosion proof, UL listed for Class I, Division 1 and 2, Groups B, C, and D; and Class II, Division 1 and 2 areas, Groups E, F, and G.~~

~~2. EDS factory sealed.~~

~~3. Malleable iron body and cover.~~

~~4. Aluminum sealing chamber.~~

~~5. Front operated handle with stainless steel shaft.~~

~~6. Rated 20 A, 125 V AC.~~

~~7. With grounding screw.~~

~~8. Type: As indicated on Drawings.~~

~~I. Explosion-proof Receptacles for Use in Hazardous Areas:~~

~~1. Explosion-proof, UL listed for Class I, Division 1 and 2, Groups B, C, and D; and Class II, Division 1 and 2, Groups F and G.~~

~~2. Factory-sealed malleable iron receptacle with spring-loaded cover.~~

~~3. Malleable iron mounting box.~~

~~4. Rated 20 A, 125 V AC.~~

~~5. "Dead-front" construction requiring plug to be inserted and rotated to activate receptacle.~~

~~6. Type: As indicated on Drawings.~~

~~J. Welding Receptacles:~~

~~1. 60 A, 480 V, 3 pole, 4 wire, grounding type.~~

~~K. Plug-In Strip: Surface steel raceway plug-in strip with single 15 A, 125 V, 3 wire grounding-type receptacles spaced 18 IN on center.~~

~~1. Pre-wired with two #12 TW and one #12 TW green insulated ground.~~

~~2. Minimum 1-1/4 IN wide x 3/4 IN deep.~~

~~3. Suitable fittings and snap-in cover.~~

~~4. Finish:~~

~~a. Stainless steel.~~

~~5. Receptacle color:~~

~~a. For use on normal power: White unless Owner or Engineer specifies otherwise.~~

~~b. For use on UPS systems: Red.~~

~~c. For use on isolated ground systems: Orange.~~

PART 3 -- EXECUTION

3.1 INSTALLATION

A. Mount devices where indicated on the Drawings.

B. Surface mount receptacles and light switches in concrete construction.

C. In masonry and metal stud construction, recess-mount receptacles and light switches unless device precludes recessed mounting or unless otherwise noted on the Drawings.

D. Where more than one receptacle is installed in a room, they shall be symmetrically arranged.

E. Set switches and receptacles plumb and vertical to the floor.

F. Set recess-mounted switches and receptacles flush with face of walls.

G. Do not connect dimmers to loads in excess of 80% of the rating of the dimmer.

H. Provide blank plates for empty outlets.

- END OF SECTION -

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SECTION 16142 - WEATHERPROOF WHILE IN USE OUTLET ENCLOSURES

PART 1 -- GENERAL

1.1 SCOPE OF WORK

A. These specifications encompass outlet enclosures used on outlet devices where outlets are required to be weatherproof and/or physically protected while in use or idle.

B. These safety outlet enclosures shall be used in locations where attachment plugs will be connected permanently, or for an indefinite period of time, in potentially wet or weather exposed environments.

C. They are also to be used where outlets are subject to contamination, corrosion, or damage.

1.2 DESCRIPTION

A. The safety outlet enclosure shall consist of a suitable style outlet/receptacle plate with a hinged safety cover.

B. The safety outlet enclosure shall have cord port(s) capable of allowing an appropriate size electrical cord(s) to pass through when safety cover is closed.

C. The safety outlet enclosure shall have a latching mechanism to allow the enclosure to maintain weatherproof integrity. The latch shall be a tamper resistant (locking/security) style in areas where security is needed.

D. The safety outlet enclosure shall be sufficient depth to allow full closure with attachment plug(s) in use.

1.3 SUBMITTALS

A. Products shall be submitted in accordance with Section 16000 General Electrical Requirements, and the Contract Documents, prior to installation.

1.4 MANUFACTURER

A. Manufacturer shall be Taymac Corporation, or equal.

PART 2 -- PRODUCTS

2.1 WEATHERPROOF WHILE IN USE OUTLET ENCLOSURES

A. The enclosures shall be used in locations, where attachment plugs will be connected permanently, or for an indefinite period of time, in potentially wet or weather exposed environments, or as indicated on the Plans.

B. They are also to be used where outlets are subject to contamination, corrosion or damage.

C. The enclosure shall consist of a suitable style outlet/receptacle plate with a hinged safety cover, and shall be of sufficient depth to allow full closure with attachment plugs in use.

D. The enclosure shall have cord ports capable of allowing appropriate size electrical cords to pass through when safety cover is closed.

E. The enclosure shall have a latching mechanism to allow the enclosure to maintain weatherproof integrity. The latch shall be a tamper resistant, and locking style, in areas where security is needed, as shown on the Plans.

F. The enclosure shall be Underwriters Laboratories (UL) listed per UL Standard 514C for non-metallic boxes, flush device boxes and enclosures, and conform to National Electric Code (NEC), Article 410.57 paragraphs a and b, Article 110.3 and Article 110.11, pertaining to damp, wet or possible corrosive installations.

G. Body materials shall be of a flame resistant, self extinguishing, ultraviolet inhibiting, impact resistant, polycarbonate resin such as GE Lexan 943A, or Mobay Makrolon 6457. Material must meet UL Standard 94.

H. Gasket materials shall be of sufficient thickness to form a weatherproof seal under normal mounting conditions. Thicknesses; 3/16” for base plate and 1/8" for covers. Material is to be closed cell neoprene foam by Monarch Rubber A5032, or equivalent, self extinguishing and flame retardant. Material must meet UL Standard 94 HF1.

I. Mounting hardware shall be stainless steel, and of sufficient length to properly secure the device, and ensure seal to mounting surface.

J. The enclosures shall be installed over a weatherproof box and outlet in conformance with the manufacturer's instruction. Cover shall be mounted to insure that access holes for the portable line cords will be located at the lower end of the cover.

PART 3 -- EXECUTION

3.1 INSTALLATION

A. Equipment shall be installed in accordance with the manufacturer’s recommendations.

- END OF SECTION -

SECTION 16143 - TERMINAL BLOCKS

PART 1 -- GENERAL

1.1 SCOPE OF WORK

A. This section covers terminal blocks for control and other wiring.

1.2 SUBMITTALS

A. Products shall be submitted in accordance with Section 16000 General Electrical Requirements, and elsewhere in the Contract Documents, prior to installation.

1.3 MANUFACTURERS

A. Terminal blocks shall be Entrelec, Phoenix Contact, Weidmuller, Allen Bradley or equal.

B. Surge protection blocks shall be Telematic, series SD, or equal.

C. Power distribution blocks shall be Ilsco Corporation, or equal.

PART 2 -- PRODUCTS

2.1 TERMINAL BLOCKS

A. Terminal blocks shall mount on standard DIN rail, and be of the size required for conductors therein. A minimum of 25 percent spares shall be provided in each terminal box. No more than 2 conductors shall be allowed per termination. Jumper bar assemblies shall be installed for interconnecting terminal blocks, distributing power and signal commons. Terminal blocks shall be UL rated for 600 Volts, and 30 Amps, minimum.

B. Grounding terminal blocks shall be provided for instrumentation cable shields. The terminal blocks shall have distinctive 2-color bodies yellow and green, and shall be mounted to the DIN rail with metal screw down type clamps, providing a positive ground connection. One grounding terminal block shall be installed for every 2 instrument cables terminated. Grounding terminal blocks shall be UL rated for 600 Volts, and 20 Amps, minimum.

C. Terminal blocks shall be available in a variety of colors, including red, green, blue, gray, black, yellow, and orange.

D. DIN mount fuse holders shall have blown fuse indicators for DC and AC circuits. Fuse holders shall be of the compression clamp type. Fuse holders shall be U.L. listed, and rated for 600 Volts. Fuse sizes shall not exceed the UL current rating for the fuse holders.

E. DIN rail shall be prepunched, zinc bichromate plated steel. Symmetrical DIN rail shall be 35 mm X 7.5 mm, minimum.

F. Terminal blocks for 4 to 20 milliamp signals shall have knife disconnect switches, and accessible test points for testing and measurement of current loop signals, without the need for removing wire terminations.

2.2 SURGE PROTECTION BLOCKS (SPB)

A. Analog inputs and outputs shall be terminated at surge protection blocks (SPB). The SPBs shall be designed for a working voltage of 32 volts, and shall be fused.

B. SPBs shall provide full hybrid line to line protection, and shall have a GDT rating of 10,000 A (8/20μs pulse waveform).

C. SPBs shall be UL94 V-2 listed.

2.3 POWER DISTRIBUTION BLOCKS (PDB)

A. PDBs shall be Electro-tin plated and manufactured from high strength 6061-T6 aluminum alloy.

B. PDBs shall be UL Recognized rated 90º C and CSA Certified.

C. PDBs shall provide flexibility in using the connector as an in line splice or to reduce conductor size.

D. PDBs shall be rated for 600 Volts and dual rated for Copper and Aluminum Conductor.

E. PDBs shall have the sizes and ratings as shown on the Plans.

PART 3 -- EXECUTION

3.1 INSTALLATION

A. Each terminal block and fuse holder shall be identified with the circuit number, or conductor number, corresponding to the identification appearing on the shop Drawings for the equipment, or system.

B. Terminal block and fuse holder markers shall be computer printed plastic-type, with permanent markings.

C. End clamps and end sections shall be installed on each terminal block and fuse holder assembly.

D. Terminal blocks shall be gray unless specified otherwise.

- END OF SECTION -

SECTION 16160 – ENCLOSURES

PART 1 -- GENERAL

1.1 SCOPE OF WORK

A. This specification includes enclosures to house electrical controls, instruments, terminal blocks, and serve a junction boxes where shown on the Plans.

1.2 SUBMITTALS

A. Products shall be submitted in accordance with Section 16000 General Electrical Requirements, and elsewhere in the Contract Documents, prior to installation.

1.3 MANUFACTURERS

A. Enclosures shall be manufactured by Hoffman, Rittal, or equal.

PART 2 -- PRODUCTS

2.1 STEEL

A. Enclosures shall be fabricated from 14 gauge steel with seams that are continuously welded. Doors shall have full length piano hinges with the door removable by pulling the hinge pin.

B. A rolled lip shall be provided around three sides of the door and around all sides of the enclosure opening. The gasket shall be attached with oil-resistant adhesive and held in place with steel retaining strips. Exterior hardware, such as clamps, screws, and hinge pins, shall be of stainless steel for outdoor installations. A hasp and staple shall be provided for padlocking. Each enclosure shall have a print pocket. All wires entering or leaving the enclosure shall terminate on terminal strips. All wires and terminals shall be clearly identified as specified elsewhere in these specifications.

C. Finish shall be white enamel interior, light gray enamel, ANSI 61 exterior, over phosphatized surfaces. Special finishes and colors shall be furnished for wet locations. Plans should be checked for special conditions.

2.2 NEMA RATING

A. Unless otherwise indicated on the Plans, enclosures shall be NEMA 12 for indoors, NEMA 4X for corrosive areas, and NEMA 4 for outdoor installations. NEMA 4X enclosures shall be stainless steel, unless noted otherwise. NEMA 4X enclosures shall also be used in wet, or wash down areas.

B. All enclosures used in classified areas shall be NEMA 7.

C. In Waste Water facilities all enclosures in process areas shall be NEMA 4X stainless steel. Enclosures in electrical rooms, meeting rooms, offices and shops shall be NEMA 12 unless otherwise specified.

D. Areas not specified in Water Treatment, Wastewater, or other water related facilities shall be approved by the Engineer for NEMA type prior to installation.

2.3 FIBERGLASS

A. Enclosures shall be heavy-duty, compression molded, fiberglass reinforced polyester, high impact, heat resistant, NEMA 4X.

PART 3 -- EXECUTION

3.1 INSTALLATION

A. Enclosures shall be installed as indicated on the Plans, and according to manufacturer's instructions.

B. Enclosures shall be properly grounded, and shall include ground straps connected to hinged doors and accessories.

- END OF SECTION -

SECTION 16161 - CONTROL PANELS

PART 1 -- GENERAL

1.1 SUMMARY

A. Section Includes:

1. Control panels.

B. Products shall be submitted for review in accordance with Section 16000 General Electrical Requirements, and elsewhere in the Contract Documents, prior to installation.

1.2 QUALITY ASSURANCE

A. Referenced Standards:

1. American Society for Testing and Materials (ASTM):

a. A269, Standard Specification for Seamless and Welded Austenitic Stainless Steel Tubing for General Service.

2. Joint Industrial Council (JIC):

a. EMP-1, Mass Production Equipment.

3. National Electrical Manufacturers Association (NEMA):

a. ICS 4, Terminal Blocks for Industrial Use.

b. ICS 6, Enclosures for Industrial Controls and Systems.

c. 250, Enclosures for Electrical Equipment (1000 V Maximum).

4. National Fire Protection Association (NFPA):

a. National Electric Code (NEC).

B. Miscellaneous:

1. Prior to placement of conduit feeds, assure approved control panel layouts available.

2. Assure completely matching color tones for any individual color specified.

3. Provide panel with the required NEMA rating per NEMA Publication No. 250 to meet classifications shown on drawings or specifications.

1.3 SUBMITTALS

A. Shop Drawings:

1. Scaled panel face and subpanel face instrument and nameplate layout drawings.

2. Panel and subpanel materials of construction.

3. Panel and subpanel dimensions and weights.

4. Panel access openings.

5. Conduit and wiring access locations.

6. Internal wiring and terminal block drawings.

7. Nameplate text.

8. Scaled layouts of any graphic panels.

9. Seismic restraint requirements.

B. Operation and Maintenance Manuals.

PART 2 -- PRODUCTS

2.1 ENCLOSURES

A. Enclosures shall be sized and rated for the application, and shall be as specified elsewhere.

2.2 ACCESSORIES

A. Furnish electrical equipment, devices, and accessories as required for a complete and operable control panel. Equipment, devices, and accessories shall be as specified elsewhere.

2.3 FABRICATION

A. General:

1. Fabricate panels with devices and instrument arrangements as required by the Plans.

2. Prime control panels with rust inhibitive shop applied primer and paint with two coats of UV resistant white water-based paint.

3. Finish interior of panel with epoxy glass white.

4. Provide control panels which meets the following requirements:

a. Panel depth per JIC EMP-1-1967, E7.1.4.

b. Door opening per JIC EMP-1-1967, E7.1.5.

c. Data pocket per JIC EMP-1-1967, E7.1.6.

d. Rigidity per JIC EMP-1-1967, E7.1.7.

e. Door alignment and reinforcement per JIC EMP-1-1967, E7.1.8.

f. Panel holes and openings per JIC EMP-1-1967, E7.3.2, E7.3.3, and E7.3.4.

g. Doors per JIC EMP-1-1967, E7.5.

h. Clear panel mounting space per JIC EMP-1-1967, E8.2.9.

i. Panel mounted control device location per JIC EMP-1-1967, E8.3.4.

j. Clearances in enclosures per JIC EMP-1-1967, E8.4.

B. Free-Standing Panels:

1. Minimum construction thicknesses:

a. Front panel, subpanel, or front door with cutouts: 0.123”.

b. Top, sides, back, filler plates and side or doors with no cutouts: Minimum thickness per, NEMA ICS 6, Tables 3-8,9.

2. Welded construction.

3. Completely enclosed, self-supporting, and gasketed dust tight.

4. Edges turned back minimum of 2”.

5. Seams and corners welded and ground smooth to touch and smooth in visual appearance.

6. Arrange control panel faces continuous and flush with face of adjacent electrical motor control centers.

7. Provide filler panels where necessary to close gaps between panels or back of panel and wall. Provide full length flush pan doors.

8. Provide full length piano hinges rated for 1.5 times door plus instrument weight.

9. Furnish doors with keyed alike locking handles and three point catch.

10. Provide appropriate conduit, wiring, and instrument openings in accordance with best panel design.

11. After cutouts have been made, finish opening edges to smooth and true surface condition.

12. Provide each panel with lifting eyebolts.

C. Wall Mounted Panels:

1. Minimum construction thicknesses:

a. Front panel, sub-panel or door with cutouts:

1) Width or height not exceeding 42”: 0.093”.

2) Width or height exceeding 42”: 0.123”.

b. Side, top, back and doors without cutouts: minimum thickness per NEMA ICS 6, Tables 3-8, 3-9.

2. Seams continuously welded and ground smooth.

3. Body stiffeners for extra rigidity if either height or width exceeds 28”.

4. Rolled lip around all sides of enclosure door opening.

5. Gasketed dust tight.

6. Three-point latching mechanism operated by oil tight key-locking handle.

7. Furnish doors with keyed alike locking handles and three point catch.

8. Continuous heavy gage hinge pin on doors.

   a. Hinges rated for 1.5 times door plus instrument weight.

9. After cutouts have been made, finish opening edges to smooth and true surface condition.

10. Front full opening door.

11. Brackets for wall mounting.

12. Maximum size shall be 60” tall 40” wide. All larger panels shall be supplied as free standing unless otherwise specified on the plans.

D. Panel Front Construction:

1. Minimum construction thicknesses: per NEMA ICS 6, Tables 3-8, 3-9.

2. Welded construction.

3. Edges turned and ground smooth to touch and visual appearance.

4. At joints where panel face meets side walls, provide dustproof sponge rubber gasket entire height and face.

5. Use full length piano hinges rated for 1.5 times door weight for panel access door.

6. Equip doors with locking devices and handle and three point catches.

7. Finish all instrument cutouts smooth and true.

E. Panel Wiring and Piping:

1. Factory pipe and wire panels to identified terminal blocks equipped with screw type lugs.

2. Install all wiring without splicing in factory in raceways:

   a. Size raceways per the requirements of NEC Article 373.

b. Raceways shall have removable covers.

3. Wire bending space shall be in accordance with Tables 307B, C in NEMA ICS 6.

4. Keep AC power lines separate from low-level DC lines, I/O power supply cables, and all I/O rack interconnect cables.

5. Keep AC signal wires separate from DC signal wires.

6. When I/O wiring must cross AC power wiring, it shall only do so at right angles.

7. Arrange circuits on terminal blocks plus any spare conductors on adjacent terminals.

8. Provide necessary power supplies for control equipment.

9. Equip each panel with a main thermal magnetic circuit breaker. Limit load to maximum of 80 percent of circuit breaker rating.

10. Provide all necessary stabilizing voltage transformers, balancing potentiometers and rectifiers as necessary for specific instrument requirements.

11. Assure each panel mounted device is bonded or otherwise grounded to panel or panel grounding system by means of locknuts or pressure mounting methods.

    a. Equip panel with grounding terminals.

12. Arrange wiring with sufficient clearance for all leads.

13. Wiring to sub-panels or rotary switches shall be individually bundled and installed with a "flexible loop" of sufficient length to permit the component to be removed from panel for maintenance without disconnecting wiring.

14. Identify all wires with plastic sleeve type wire markers at each end. Markers shall:

    a. Identify circuit numbers.

    b. Identify function and polarity.

15. Provide all wiring according to color code as follows:

COLOR OF INSULATION	120 V, 60 hZ SERVICE	CONTROL WIRING	LOW VOLTAGE DC SERVICE
Black	Phase Conductor		Negative (analog transmission)
Red		120V AC Controls	Positive (analog transmission)
White	Neutral	120V Neutral	
Blue		24V DC Controls	
Blue/White		24V DC Neutral	
Orange		12V DC Controls	
Orange/White		12V DC Neutral	
Green	Ground	Ground	
Yellow		Intrinsically safe circuits	

16. Termination requirements:

    a. Terminal block markings, mechanical characteristics and electrical characteristics shall be in accordance with NEMA ICS 4.

    b. Terminals shall facilitate wire sizes as follows:

        1) 120 V AC applications: Wire size 12 AWG and smaller.

        2) Other: Wire size 14 AWG and smaller.

    c. Provide terminal blocks with continuous marking strip.

    d. Tag each I/O terminal to indicate tag number of the connected device.

    e. Provide terminals for individual termination of each signal shield.

    f. Provide 20 percent excess terminals for future expansion.

17. Pneumatic tubes and appurtenances:

    a. Provide ¼" OD pneumatic control tubing.

    b. Main headers within panels shall be minimum 1".

    c. Compression-type pressure fittings.

d. Equip panel instrument leads with globe type isolation valve.

e. Connection to devices not in the panel shall be terminated on tubing terminal plate.

f. Install tubing neatly and mount securely.

g. Do not route tubing in front of or in wiring raceways.

h. Code terminal plates.

i. Supply and install dual function filter regulator to serve pneumatic devices.

F. Panel Lighting and Power:

1. Receptacles:

a. Panels less than 4 feet long:

1) One electrical outlet.

2) One compact fluorescent light fixture with door switch(es) and separate circuit breakers.

b. Panels or panel faces greater than 4 feet long:

1) One electrical outlet per 4 feet of length.

2) Continuous fluorescent lighting strip with door switches and separate circuit breakers.

G. Environmental Controls:

1. NEMA 1:

a. Furnish circulation fans with filters and/or air conditioning as required to cool panel. Maintain panel temperature below 40 degrees Celsius or below requirements of equipment within the enclosure whichever is less.

b. Furnish panel heaters as required to prevent moisture condensation and maintain minimum temperature requirements of equipment within the enclosure.

2. Air conditioning applications shall include means of preventing moisture condensation.

3. For panels or control cabinets located outside, hazardous areas, classified areas or plans that require a NEMA 4 or 4X rating:

a. Furnish panel heaters as required to prevent moisture condensation and maintain minimum temperature requirements of equipment within the enclosure.

b. Furnish circulation fans with filters and/or air conditioning as required to cool panel. Maintain panel temperature below 40 degrees Celsius or below requirements of equipment within the enclosure whichever is less.

4. Maintain NEMA rating of original enclosure when installing heating or cooling equipment.

2.5 MAINTENANCE MATERIALS

A. Spare Parts:

1. Replacement Bulbs. Provide minimum 25 percent or 5 bulbs, whichever is greater, for each type of indicating light bulb for each type of indicator furnished in this Project.

2. Replacement Fuses. Provide minimum of 25 percent or 5 fuses, whichever is greater, for all sizes and types of control fuses provided within the control panel.

PART 3 -- EXECUTION

3.1 INSTALLATION

A. Install free-standing panels on concrete housekeeping pads as detailed on the Drawings.

B. Anchor panel fronts rigidly into wall system with approved anchoring devices.

- END OF SECTION -

SECTION 16170 - GROUNDING

PART 1 -- GENERAL

1.1 SCOPE OF WORK

A. A ground grid system consisting of the indicated configuration of copper wires, and ground rods, or concrete encased grounding electrodes ("UFER's") shall be provided to minimize station potential gradient irregularities and drain leakage and fault currents to earth.

B. Whether indicated on the Plans or not, neutral conductors, cable shields, metallic conduits, cable terminations, junction boxes, poles, surge arresters, metal buildings, skid mounted equipment, and other non-current carrying metallic parts of equipment shall be grounded to the ground grid per NEC.

1.2 SUBMITTALS

A. Products shall be submitted in accordance with Section 16000 General Electrical Requirements, and elsewhere in the Contract Documents, prior to installation.

1.3 REFERENCES

A. National Electrical Code (NEC) Article 250

PART 2 -- PRODUCTS

2.1 GENERAL REQUIREMENTS

A. A resistance of not greater than 25 ohms shall be provided, unless otherwise specified. Ground resistances shall be measured as herein described. Resistances of systems requiring separate ground rods, rather than a counterpoise, shall be measured separately before bonding below grade. The combined ground resistance of separate systems bonded together below grade may be used to meet the specified ground resistance, but the minimum number of rods indicated must still be provided.

2.2 GROUND RODS

A. Ground rods shall be copper-clad steel conforming to UL 467, 3/4 inch in diameter by 10 feet in length. Unless otherwise indicated, ground rods shall be driven into the ground until tops of rods are approximately 6 inches below finished grade. In counterpoise systems, tops of ground rods shall be approximately at elevations of counterpoises. Where the specified ground resistance cannot be met with the indicated number of ground rods, additional ground rods, longer ground rods, or deep-driven sectional rods shall be installed and connected until the specified resistance is obtained, except that not more than three additional ground rods shall be required at any one installation. Ground rods shall be spaced as evenly as possible at least 10 feet apart and 10 feet from structures. Connections shall be made below grade. Contractor shall install a minimum of two ground rods unless more are specified.

2.3 CONNECTIONS

A. Connections above grade shall be made with bolted solderless connectors, and those below grade shall be made by a fusion-welding process. In lieu of a fusion-welding process, a compression ground grid connector of a type which uses a hydraulic compression tool to provide the correct circumferential pressure may be used. Tools and dies shall be as recommended by the manufacturer. An embossing die code or other standard method shall provide visible indication that a connector has been adequately compressed on the ground wire.

2.4 GROUNDING ELECTRODE CONDUCTOR

A. Service entrance grounding electrode conductors shall be sized in accordance with NEC Table 250.66, unless otherwise indicated on the Plans. After being located to provide maximum physical protection, exposed ground wires shall be securely attached to structural supports at not more than 2-foot intervals with suitable fasteners. Bends greater than 45 degrees in ground wires are not permitted. Routing of ground conductors through concrete should be avoided, except where specifically called for in these Documents. When concrete penetration is necessary, nonmetallic conduit shall be cast flush with the points of concrete entrance and exit, so as to provide an opening for the ground wire. The opening shall be sealed with a suitable compound after installation of the ground wire.

2.5 EQUIPMENT GROUNDING CONDUCTOR

A. Neutral conductors shall be grounded where indicated. Equipment grounding conductors shall be sized in accordance with NEC Table 250.122, unless otherwise indicated. Ground wires shall be protected by conduit, where such wires run exposed above grade in non-fence enclosed areas, or are run through concrete construction. Where concrete penetration is necessary, nonmetallic conduit shall be cast flush with the points of concrete entrance and exit, so as to provide an opening for the ground wire. The opening shall be sealed with a suitable compound after installation of the ground wire. Bends greater than 45 degrees in ground wire connections to the ground rods, or counterpoises are not permitted.

2.6 EQUIPMENT GROUNDING

A. Equipment frames of motor housings, equipment skids, metallic tanks, metallic equipment enclosures, metal splicing boxes, chain-link fencing, and other metallic non-current carrying metal items, shall be grounded. Connections to earth shall be made in the same manner as required for system grounding.

2.7 SURGE ARRESTER GROUNDING

A. Surge arresters shall be grounded. Resistance to ground for intermediate-class arresters shall be not more than 10 ohms and for distribution-class arresters shall be not more than 25 ohms. Ground wire connections shall be not less than No. 4 AWG for distribution arresters and No. 1/0 AWG for intermediate arresters. Connections to earth shall be made in the same manner as required for neutral conductors. Surge arrester grounds may use the same ground wires provided for equipment operating at more than 750 volts. Surge arrester and secondary neutral grounds shall be separate from and independent of each other.

2.8 LIGHTING POLE GROUNDING

A. Base of lighting poles shall be connected to an adjacent ground rod as indicated on Plans. A ground connection from poles back to neutral ground points shall also be provided utilizing equipment grounding conductor.

~~2.9 METALLIC STRUCTURES~~

~~A. Metallic structures and buildings shall be grounded per NEC.~~

~~2.10 GROUNDING RINGS~~

~~A. When required, grounding rings shall be installed using bare copper cable with ground rods at a maximum of 25 feet intervals using thermoweld connecting means as indicated on Plans in accordance with NEC requirements. Ring shall be located a minimum of 10' from the building.~~

~~2.11 CONCRETE ENCASED ELECTRODE~~

~~A. Two Concrete Encased Electrodes shall be installed in all new structures whether specified on the plans or not. Concrete Encased Electrodes shall be installed using bare copper cable bonded to the rebar. Conductor shall be located in the footings of the building and installed in conformance with NEC requirements. If unspecified on the plans the cable length shall be 60 feet each and shall be bonded in at least 6 locations.~~

PART 3 -- EXECUTION

3.1 INSTALLATION

A. It is the intent of these Contract Documents that all device and equipment grounds shall be run as a separate conductor in the conduit from the equipment to the distribution panels or system ground. Wireways and enclosures shall be properly bonded and grounded, and ground conductors shall be run for all circuits.

B. Equipment cases and devices shall be grounded. Ground rods shall be driven, and concrete encased conduits installed, before a building or structure is built, and ground conductors brought through the concrete to accessible points for grounding equipment. These systems shall be installed at each structure, where transformers, switchboards, panelboards, and MCC's are installed.

C. Ductbanks shall contain a bare copper ground conductor. The system ground conductors shall run continuously in ductbanks, through handholes and other raceway boxes. The system ground shall be connected to the structure grounding systems to provide a continuous grounding system. Each metallic raceway, panel, switchboard, and other metallic devices associated with the electrical and control systems shall be bonded to this grounding system.

D. Ground rods shall be installed not less than 6 inches below grade. Equipment, neutral, and surge arrester ground wires shall be connected to the ground grid as indicated.

3.2 TESTS

A. Pre-Energization Tests — Pre-energization tests shall include, but shall not be limited to, tests required to perform under paragraph "GENERAL REQUIREMENTS." No part

of the electrical system shall be energized until all station grounding system components have been tested and demonstrated to comply with the requirements specified, and until associated test reports have been submitted and approved.

B. Ground-Resistance Measurements — Ground-resistance measurements of each ground rod shall be taken and certified by the Contractor to the Engineer. No part of the electrical distribution system shall be energized prior to the resistance testing of that system's ground rods and grounding system and submission of test results to the Engineer. Test reports shall indicate the location of the ground rod and grounding system and the resistance and the soil conditions at the time the test was performed. When the building water service is used as a ground or part of the grounding system, ground-resistance measurements shall also be made of this connection. Ground-resistance measurements shall be made in normally dry weather, not less than 48 hours after rainfall, and with the ground under test isolated from other grounds. The resistance to ground shall be measured using the fall-of-potential method described in IEEE Std 142 and Std 81.

3.3 TEST RESULTS

A. The Contractor shall perform the above tests and submit a certified test report to the Engineer prior to energizing the equipment.

- END OF SECTION -

SECTION 16190 - SUPPORTING DEVICES

PART 1 -- GENERAL

1.1 SCOPE OF WORK

A. Supports, anchors, sleeves, and seals, are indicated on the Plans, schedules, and specified in other sections of these Specifications.

B. Types of supports, anchors, sleeves and seals specified in this section include the following:

1. One-hole Conduit Straps
2. One-Hole Conduit Straps with Clamp Backs
3. Two-Hole Conduit Straps
4. Conduit Hangers
5. I-beam Clamps
6. Channel Clamps
7. Round Steel Rods
8. Drop-in Anchors
9. Wedge Type Anchor Bolts
10. Lead Expansion Anchors
11. Toggle Bolts
12. Wall and Floor Seals
13. Cable Supports
14. U-Channel Strut System
15. Sleeves

1.2 SUBMITTALS

A. Products shall be submitted in accordance with Section 16000 General Electrical Requirements, and elsewhere in the Contract Documents, prior to installation.

PART 2 -- PRODUCTS

2.1 MANUFACTURERS

A. Acceptable Manufacturers: Subject to compliance with requirements, manufacturers offering products which may be incorporated in the work include, but are not limited to, the following: Abbeon Cal Inc., Ackerman Johnson Fastening Systems Inc., Elcen Metal

Products Co., Ideal Industries, Inc., Josyln Mfg and Supply Co., McGraw Edison Co., Rawlplug Co. Inc., Star Expansion Co., U.S. Expansion Bolt Co., Allied Tube and Conduit Corp., B-Line Systems, Inc., Greenfield Mfg Co., Inc., Midland-Ross Corp., O-Z/Gedney Div; General Signal Corp., Power-Strut Div.; Van Huffel Tube Corp., and Unistrut Div; GTE Products Corp., and Robroy Industries.

2.2 GENERAL

A. Provide supporting devices that comply with manufacturer standard materials, design, and construction, in accordance with published product information, and as required for complete installations, and as specified herein.

2.3 SUPPORTS

A. Provide supporting devices of types, sizes, and materials indicated, and having the following construction features:

1. One-Hole Conduit Straps: For supporting electrical metallic tubing, and liquid tight flexible conduit; zinc plated steel, stainless steel or galvanized steel; snap-on, heavy duty.

2. One-Hole Conduit Straps with Clamp Backs: For supporting rigid metal conduit, and intermediate metal conduit; cast galvanized steel.

3. Two-Hole Conduit Straps: For supporting electrical metallic tubing, rigid metal conduit, and intermediate metal conduit; zinc plated steel, stainless steel or galvanized steel.

4. Conduit Hangers: For supporting electrical metallic tubing, rigid metal conduit, and intermediate metal conduit; zinc plated steel, stainless steel or galvanized steel.

5. I-Beam Clamps: Electroplated zinc or hot dipped galvanized malleable iron.

6. Channel Clamps: Electroplated zinc or hot dipped galvanized steel.

7. Round Steel Rod: National coarse thread, electroplated.

2.4 ANCHORS

A. Provide anchors of types, sizes, and materials indicated, with the following construction features:

1. Lead Expansion Anchors: For CMU walls, 1/4”-20 threads, set tool required.

2. Toggle Bolts: Electroplated steel, size as required.

3. Drop-in Anchors: Stainless steel, size as required.

4. Anchor Bolts: Stainless steel, size as required.

5. Lag Bolts: Stainless steel, size as required.

6. Half-round head, non-removable anchor bolts shall not be used.

7. Self-Tapping screws shall not be used.

2.5 SEALS

A. Provide seals of types, sizes and materials indicated; with the following construction features:

1~~1. Wall and Floor Seals: Provide factory-assembled watertight wall and floor seals, of types and sized indicated; suitable for sealing around conduit, pipe, or tubing passing through concrete floors and walls. Construct seals with steel sleeves, malleable iron body, neoprene sealing grommets and rings, metal pressure rings, pressure clamps, and cap screws.~~

~~2~~. Conduit sealing bushings shall be manufactured by O-Z/Gedney, Model CSMI, or equal.

2~~3~~. The conductor sealing bushings shall be manufactured by O-Z/Gedney, Model CSBG, or equal.

2.6 CONDUIT CABLE SUPPORTS

A. Provide cable supports with insulating wedging plug for non-armored type electrical cables in risers; construct 2" rigid metal conduit; 3-wires, type wire as indicated; construct body of malleable-iron casting with hot-dip galvanized finish.

2.7 U-CHANNEL STRUT SYSTEM

A. Provide U-channel strut system for supporting electrical equipment, 12-gage hot-dip galvanized steel, of types and sizes indicated; construct with 9/16" dia. holes, 8" o.c. on top surface, with the following fittings that mate and match with U-Channel:

1. Fixture hangers
2. Channel hangers
3. End caps
4. Beam clamps
5. Wiring stud
6. Thinwall conduit clamps
7. Rigid conduit clamps
8. Post Bases
9. U-bolts

B. Approved for use with the following types of conduit:

1. EMT
2. IMT
3. GRS

4. PVC (where above conduits are approved for the same location.)

2.8 PIPE SLEEVES

A. Provide pipe sleeves from the following:

1. Steel Pipe: Fabricate from Schedule 40 galvanized steel pipe; remove burrs.

2.9 PVC COATED U-CHANNEL STRUT SYSTEM

A. Provide PVC Coated U-channel strut system for supporting electrical equipment, 20 mil PVC coated steel, of types and sizes indicated; construct with 9/16" dia. holes, 8" o.c. on top surface, with all Stainless Steel hardware, and the following fittings that mate and match with PVC Coated U-Channel:

1. PVC Coated Strut nut

2. PVC Coated Pipe straps

3. Touch up compound (Gray)

B. Approved for use with the following types of conduit:

1. PVC Coated GRS

2. Aluminum

3~~4~~. PVC

2.10 STAINLESS STEEL U-CHANNEL STRUT SYSTEM

A. Provide Stainless Steel U-channel strut system for supporting electrical equipment, of types and sizes indicated; construct with 9/16" dia. holes, 8" o.c. on top surface, with all stainless steel hardware, and the following stainless steel fittings that mate and match with Stainless Steel U-Channel:

1. Fixture hangers

2. Channel hangers

3. End caps

4. Beam clamps

5. Wiring stud

6. Post bases

7. Rigid conduit clamps

8. U-bolts

B. Approved for use with the following types of conduit:

1. PVC Coated GRS

2. PVC

PART 3 -- EXECUTION

3.1 INSTALLATION

A. Install hangers, anchors, sleeves and seals as indicated, in accordance with manufacturer's written instructions and with recognized industry practices to insure supporting devices comply with requirements. Comply with requirements of NECA and NEC for installation of supporting devices.

B. Coordinate with other electrical work, including raceway and wiring work, as necessary to interface installation of supporting devices with other work.

C. Install hangers, supports, clamps and attachments to support piping properly from building structure. Arrange for grouping of 2 or more parallel runs of conduits to be supported together on channel type hangers where possible. Install supports with spacing indicated and in compliance with NEC requirements.

D. Torque sleeve seal nuts, complying with manufacturer recommended values. Ensure that sealing grommets expand to form watertight seal.

E. Comply with manufacturer’s recommendations for touch up of field cut ends or damaged PVC coated U-channel and fittings.

F. Remove burrs and apply a cold zinc galvanizing paint to field cut galvanized U-channel strut prior to installation.

G. Provide a minimum of two anchors per piece of u-channel. Maximum spacing of anchors shall be 12”.

- END OF SECTION -

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SECTION 16476 - LOW VOLTAGE CIRCUIT BREAKERS

PART 1 -- GENERAL

1.1 SCOPE OF WORK

A. The Contractor shall furnish and install, low voltage circuit breakers, as indicated on the Drawings and specified herein.

1.2 SUBMITTALS

A. Products shall be submitted in accordance with Section 16000 General Electrical Requirements, and elsewhere in the Contract Documents, prior to installation.

1.3 QUALITY ASSURANCE

A. The breaker manufacturer's facilities shall be ISO 9001 certified.

PART 2 -- PRODUCTS

2.1 GENERAL

A. Circuit breakers shall be as manufactured by Square D, Cutler-Hammer, Allen-Bradley, General Electric, or equal.

B. Circuit breaker frame, trip, short circuit, and interruption ratings shall be as indicated on the Drawings, except that they shall be coordinated with the ratings of the equipment actually furnished, and shall be modified where necessary to suit the equipment. Circuit breakers to be used in motor control centers shall be as indicated on the Drawings. Where no indication of type is given on the Drawings circuit breakers protecting motors shall be motor circuit protectors, and other circuit breakers shall be molded case type.

C. Circuit breaker for mounting in motor control centers, or for separate mounting shall be of the air-break type, quick-make and quick-break, 600 volt, with number of poles as indicated on the Drawings.

D. Each pole of the circuit breaker shall provide inverse time delay, and instantaneous circuit protection.

E. The breakers shall be operated by a handle, and shall have a switching mechanism that is mechanically trip free from the handle, so that the contacts cannot be held closed against short circuits, and abnormal currents. Tripping due to overload, or short circuit shall be clearly indicated by the handle automatically assuming a position between the manual ON and OFF positions. Latch surfaces shall be ground and polished. Poles shall be constructed so that they open, close, and trip simultaneously.

F. Breakers must be completely enclosed in a molded case. Non-interchangeable trip breakers shall have their covers sealed; interchangeable trip breakers shall have the trip unit sealed to prevent tampering. Ampere ratings shall be clearly visible. Contacts shall be non-welding silver alloy. Arc extinction must be accomplished by means of arc chutes. The minimum interrupting ratings of the circuit breakers shall be at least equal to the available short circuit current at the line terminals.

G. Circuit breakers shall conform to the applicable requirements of NEMA Standards Publication No. AB1.

H. Molded case circuit breakers shall be ambient temperature compensating that provides inverse time delay overload and instantaneous short circuit protection by means of a thermal magnetic element. Compensation shall be accomplished by a secondary bi-metal that will allow the breaker to carry rated current between 25 degrees C and 50 degrees C with tripping characteristics that are approximately the same throughout this temperature range.

I. On breakers with interchangeable, thermal, adjustable magnetic trip, the accessibility and position of the adjustment knob shall not be changed from those on the standard breaker.

J. Unless mounted in a switchboard, or panelboard, circuit breakers shall be housed in a NEMA rated enclosure as described elsewhere in these specifications.

K. Provide circuit breakers with shunt trip mechanisms where shown on the Drawings.

PART 3 -- EXECUTION

3.1 INSTALLATION

A. Circuit breakers shall be installed as indicated on the Drawings and per manufacturer's instructions.

- END OF SECTION -

SECTION 16477 - 600 V FUSES

PART 1 -- GENERAL

1.1 SCOPE OF WORK

A. Extent of fuse work required by this section is indicated by drawings, and by requirements of this section.

B. Types of fuses specified in this section include the following:

1. Class L time-delay.

2. Class L fast-acting.

3. Class RK1 time-delay.

4. Class RK1 and Class J current limiting.

5. Class RK5 time-delay.

6. Class K5 time-delay, non-current limiting.

7. Class T current-limiting.

1.2 QUALITY ASSURANCE

A. Manufacturer's Qualifications: Firms regularly engaged in manufacture of fuses of types and sizes required, whose products have been in satisfactory use in similar service for not less than 5 years.

1.3 CODES AND STANDARDS

A. UL Compliance and Labeling: Comply with applicable provisions of UL 198D, "High-Interrupting-Capacity Class K Fuses". Provide over-current protective devices which are UL-listed and labeled.

B. NEC Compliance: Comply with NEC as applicable to construction and installation of fusible devices.

C. ANSI Compliance: Comply with applicable requirements of ANSI C97.1 "Low-Voltage Cartridge Fuses 600 Volts or Less".

1.4 SUBMITTALS

A. Product Data: Submit manufacturer's technical product data on fuses, including specifications, electrical characteristics, installation instructions, furnished specialties and accessories in accordance with Section 16000 General Electrical Requirements, and the Contract Documents. In addition, include voltages and current ratings, interrupting ratings, current limitation ratings, time-current trip characteristic curves, and mounting requirements.

1.5 MANUFACTURERS

A. Subject to compliance with requirements, manufacturers offering fusible devices which may be incorporated in the work include, but are not limited to, the following: Bussmann, Gould-Shawmut, Reliance, or equal.

PART 2 -- PRODUCTS

2.1 GENERAL

A. Except as otherwise indicated, provide fuses of types, sizes, ratings, and average time-current and peak let-through current characteristics indicated, which comply with manufacturer's standard design, materials, and constructed in accordance with published product information, and with industry standards and configurations.

2.2 Class L Time-Delay Fuses

A. Provide UL Class L time-delay fuses rated 600-volts, 60 Hz, with 200,000 RMS symmetrical interrupting current rating for protecting transformers, motors, and circuit-breakers.

2.3 Class L Fast-Acting Fuses

A. Provide UL Class L fast-acting fuses rated 600-volts, 60 Hz, with 200,000 RMS symmetrical interrupting current rating for protecting service entrances and main feeder circuit-breakers.

2.4 Class RK1 Time-Delay Fuses

A. Provide UL Class RK1 time-delay fuses rated 600-volts, 60 Hz, with 200,000 RMS symmetrical interrupting current rating for protecting motors and circuit-breakers.

2.5 Class RK1 Current-Limiting Fuses

A. Provide UL Class RK1 current-limiting fuses rated 250-volts, 60 Hz, with 200,000 RMS symmetrical interrupting current rating for protecting circuit-breakers.

2.6 Class J Current-Limiting Fuses

A. Provide UL Class J current-limiting fuses rated 600-volts, 60 Hz, with 200,000 RMS symmetrical interrupting current rating.

2.7 Class RK5 Time-Delay Fuses

A. Provide UL Class RK5 time-delay fuses rated 600-volts, 60 Hz, with 200,000 RMS symmetrical interrupting current rating for protecting motors.

2.8 Class K5 One-Time Fuses

A. Provide UL Class K5 one-time fuses rated 250-volts, 60 Hz, with 100,000 RMS symmetrical interrupting current rating for protecting non-inductive loads.

2.9 Class T Fuses

A. Provide UL Class T fuses rated 600-volts, 60 Hz, with 200,000 RMS symmetrical interrupting current rating for protection of physically small devices.

PART 3 -- EXECUTION

3.1 INSTALLATION

A. Fuse types and sizes shall be as indicated on the Plans. Fuses shall be installed in accordance with the National Electric Code (NEC) requirements and the manufacturer's written instructions.

B. Install fuses in proper fuse holders.

C. Where fuses are installed in the motor starters, fuses shall be sized to match the actual motor full load current.

D. Where fuses are installed in disconnect switches at HVAC units, the fuse sizes shall be sized to meet the HVAC manufacturer's requirements.

E. Fuses for control transformers shall be sized in accordance with the National Electrical Code.

F. Fuses shall be installed with the labels clearly visible.

3.2 FIELD QUALITY CONTROL

A. Prior to energizing fusible devices, test devices for circuit continuity and for short-circuits.

3.3 SPARE PARTS

A. Furnish 10% of installed fuses or 3 sets whichever is greater for each type and ampere rating. The set shall equal the number of poles in the appropriate equipment.

B. Furnish a spare fuse cabinet equal to Bussmann for storing spare fuses. Mount on wall in Electrical room as directed by the Engineer.

- END OF SECTION -

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SECTION 16480 - MOTOR CONTROLLERS

PART 1 -- GENERAL

1.1 SCOPE OF WORK

A. A motor controller is any device or group of devices normally used to start and stop a motor by making and breaking the motor circuit current. The motor controller and devices that make up the motor controller shall be governed by items indicated on the Plans, or elsewhere within these specifications.

B. Types of motor controllers specified in this section include the following:

1. Combination.

2. Fractional HP manual.

3. Solid-state reduced voltage.

4. Autotransformer reduced voltage.

5. Variable Frequency Drive (See also VFD Specification)

C. This section applies to motor controllers rated 480 V and below.

1.2 CODE AND STANDARDS

A. Electrical Code Compliance: Comply with applicable local electrical code requirements of the authority having jurisdiction and NEC Articles 220, 250, and 430, as applicable to installation, and construction of motor controllers.

B. NFPA Compliance: Comply with applicable requirements of NFPA 70E, "Standard for Electrical Safety requirements for Employee Workplaces."

C. UL Compliance: Comply with applicable requirements of UL 486A and B, and UL 508, pertaining to installation of motor controllers. Provide controllers and components which are UL-listed and labeled.

D. IEEE Compliance: Comply with recommended practices contained in IEEE Standard 241, "Recommended Practice for Electrical Power Systems in Commercial Buildings," pertaining to motor controllers.

E. NEMA Compliance: Comply with applicable requirements of NEMA Standard ICS 2, "Industrial Control Devices, Controllers and Assemblies," and Pub No. 250, "Enclosures for Electrical Equipment (1000 Volts Maximum)," pertaining to motor controllers and enclosures.

1.3 MAINTENANCE DATA

A. Submit maintenance data and parts list for each motor controller and component; including troubleshooting maintenance guide. Also, provide product data and shop drawings in a maintenance manual, in accordance with requirements of the Contract Documents.

1.4 SUBMITTALS

A. Product Data: Submit manufacturer's data and installation instructions on motor controllers.

B. Shop Drawings: Submit shop drawings of motor controllers showing accurately scaled equipment locations and spatial relationships to associated motors and equipment.

C. Wiring Diagrams: Submit power and control wiring diagrams for motor controllers showing connections to electrical power panels, feeders, and equipment.

D. Submittal documents shall be provided in accordance with Section 16000 General Electrical Requirements, and other requirements of the Contract Documents.

PART 2 -- PRODUCTS

2.1 GENERAL

A. Except as otherwise indicated, provide motor controllers and ancillary components that comply with manufacturer's standard materials, design and construction in accordance with published product information, and as required for a complete installation.

2.2 COMBINATION CONTROLLERS

A. Provide full-voltage alternating-current combination controllers, consisting of controller and circuit breaker disconnect switch mounted in a common enclosure, of types, sizes, rating, and NEMA sizes indicated on the Plans. Equip controllers with overload relays, control relays, and auxiliary contacts as required on the plans. Provide lockable operating handle for disconnect switch mechanisms, mechanically interlocked with enclosure door. Provide NEMA rated enclosure type as shown on the Plans.

B. Circuit breaker disconnect shall be molded case, motor circuit protector type (MCP), sized per NEC.

C. Provide control power transformer sized properly to accommodate device loads. The control power transformer shall have two (2) primary, and one (1) secondary fuse sized according to NEC.

D. Multi-speed and reversing starters shall have mechanical and electrical interlock.

E. Furnish controller with control and indicating devices as indicated on the plans. Auxiliary contacts, and field connections shall be connected to terminal strips for field connection.

F. Controllers shall be as manufactured Allen-Bradley, General Electric, Square D, Cutler-Hammer, or equal.

2.3 OVERLOAD PROTECTION

A. Overload Protection shall be provided with the motor starters. The unit shall detect overcurrent, phase current imbalance, phase loss.

B. The overload relay shall be Class 10, 600 Volt rated, and shall have a trip indicator. The unit shall have a manual reset feature, and a normally closed contact for control.

C. Each module shall provide individual trip indication and reset for each trip condition, visible without opening the motor control center compartment door. Provide a normally open auxiliary contact for remote trip indication.

D. Overloads shall be as manufactured by Allen-Bradley, Square D, Cutler-Hammer, General Electric, or equal.

2.4 MAGNETIC MOTOR STARTERS

A. Starters, Size 2 and larger, shall have arc quenchers on all load breaking contacts. All starters shall be NEMA rated for the horsepower ratings specified. The Contractor shall verify the motor ratings, and coordinate the starter and overload trip ratings with the actual horsepower ratings of the motors installed. Extended overload reset buttons shall be mounted so as to be accessible for operation without opening the door of the enclosure.

B. Magnetic contactors shall be factory adjusted and shall be chatter free.

C. Starters shall be furnished complete with a 120-volt control power transformer. Control circuit fuses shall be furnished both on the primary and secondary of the control circuit transformer. Control power shall be disconnected with the motor circuit protector.

D. Starters shall be designed to operate in ambient temperatures up to 40º C.

E. The minimum size starter shall be NEMA Size 1.

F. Magnetic Motor Starters shall be manufactured by Allen-Bradley, Square D, Cutler-Hammer, General Electric, or equal.

2.5 MANUAL STARTERS

A. Manual starters shall be rated for the motor load, and shall be equipped with built-in overloads.

B. Manual starters shall be provided with enclosures as indicated on the Plans, lockable handles that clearly indicate ON, OFF, and TRIPPED positions, pilot light, and positive, quick-make, quick-break mechanisms.

C. Manual Starters shall be manufactured by Allen-Bradley, Square D, Cutler-Hammer, General Electric, or equal.

2.6 MOTOR PHASE FAILURE RELAY

A. The relay shall detect voltage values below an adjustable value, loss of phase, and phase reversal. The unit shall automatically de-energize the control circuits of the motors to be protected, when one or all three phase voltages drop below the set point. The unit shall have a nominal trip delay time of two seconds and a reset time of two seconds. The relay shall automatically reset upon restoration of the line voltage. Relays shall be MotorSaver, Time Mark Corporation, or equal. Relays shall be installed if indicated on the drawings.

2.7 MOTOR PROTECTION RELAY

A. The motor protection relay, where shown on drawings, shall be capable of the following as a minimum:

1. Phase loss

2. Low voltage (adjustable)

3. Phase reversal

4. Phase unbalance

B. The motor protection relay shall be equipped with the following as a minimum:

1. Adjustable trip delay (2 to 20 seconds)

2. Automatic reset

3. Transient protection (2500 volts for 10 ms)

C. Motor protection relays shall be set during the project startup according to the individual motor characteristics and application parameters. The motor protection relays for the motors with variable frequency drives shall be set as to prevent low voltage tripping.

D. The motor protection relays shall be MotorSaver Model 777, Time Mark Model 264, or equal.

PART 3 -- EXECUTION

A. Install motor controllers in accordance with equipment manufacturer's written instructions, and with recognized industry practices. Comply with applicable requirements of NEC, UL, and NEMA standards, to insure that products fulfill requirements.

B. Tighten connectors and terminals, including screws and bolts, in accordance with equipment manufacturer's published torque values for equipment connectors. Where manufacturer's torque requirements are not indicated, tighten connectors and terminals to comply with tightening torques specified in UL Standards 486A and B, and the National Electrical Code.

C. Install fuses, of sizes indicated, in each fusible disconnect switch, if any. Install overload heaters sized to approximately 115% of motor full load current as shown on each, individual motor nameplate.

D. Prior to energizing motor controller equipment, check with ground resistance tester, phase-to phase and phase-to-ground insulation resistance levels to ensure requirements are fulfilled.

E. Prior to energizing, check circuitry for electrical continuity, and for short-circuits.

F. Check rotation of each motor for proper direction.

G. Upon completion of installation of motor controller equipment and electrical circuitry, energize controller circuitry and demonstrate functioning of equipment in accordance with requirements. Where possible, correct malfunctioning units at site, then retest to demonstrate compliance; otherwise, remove and replace with new units, and retest to demonstrate compliance.

- END OF SECTION –

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SECTION 16611 - STATIC UNINTERRUPTIBLE POWER SUPPLY

PART 1 - GENERAL

1.1 SCOPE OF WORK

A. This section covers the requirements for uninterruptible power supplies (UPS's) to be provided as shown on the Plans.

1.2 SUBMITTALS

B. Products shall be submitted in accordance with Section 16000 General Electrical Requirements, and the Contract Documents, prior to installation.

1.3 REFERENCES

C. National Electrical Code (NEC) Article 250

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS

A. The UPS equipment shall be manufactured by Powerware, or equal.

B. The UPS shall be sized for a minimum of 30 minutes of backup power for its connected load.

C. The UPS shall be a line-interactive type, consisting of a ferroresonant or linear transformer, battery charger, batteries, inverter, and microprocessor control. The batteries shall be maintenance free, premium type.

D. The UPS shall pass lightning and surge protection ANSI/IEEE C62.41 standards, Category A and B. The UPS shall be UL 1449 listed.

E. The output waveform shall be a pure sine-wave with less than 5% total harmonic distortion on the inverter.

F. The UPS shall have a digital display for load-dependent runtime, volts in, volts out, battery voltage, percent loading, and alarm codes.

G. The UPS shall operate between 0 and 40 degrees C, at a minimum of 95% efficiency on-line.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install the UPS equipment in accordance with the manufacturers' recommendations.

B. The UPS shall be provided with a 2 year parts and factory service warranty.

- END OF SECTION -

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SECTION 16902 - ELECTRICAL CONTROLS, RELAYS, AND ALARMS

PART 1 -- GENERAL

1.1 SCOPE OF WORK

A. This Section includes the following:

1. Pushbutton and Selector Switches
2. Relays
3. Alarms
4. Intrinsic Safety Barriers
5. Wire-ways
6. Watt-hour Transducers
7. Elapsed Time Meters and Time Clocks

1.2 RELATED SECTIONS

A. Section 16000 General Electrical Requirements

B. Section 16160 Enclosures

1.3 REFERENCES

A. NEMA ICS 1 - General Standards for Industrial Control Systems.

B. NEMA ICS 2 - Standards for Industrial Control Devices, Controllers and Assemblies.

C. NEMA ICS 6 - Enclosures for Industrial Controls and Systems.

D. NEMA ST 1 - Standard for Specialty Transformers (except General Purpose Type).

1.4 SUBMITTALS

A. Data - a complete list of equipment and material including manufacturer's descriptive data and technical literature, performance charts, catalog cuts and installation instructions, spare parts data for each of the different items of equipment specified. The data shall include a complete Bill of Materials.

B. Drawings - containing complete wiring and schematic diagrams, control diagrams, and any other details required to demonstrate that the system has been coordinated and will properly function as a unit. Drawings shall show proposed layout, anchorage, support and appurtenances of equipment and equipment relationship to other parts of the work including clearances for maintenance and operations.

C. Submit shop drawings in accordance with the Contract Documents, and NEMA ICS 1 specifications indicating control panel layouts, dimensions, support points, wiring connections and diagrams.

1.5 PROJECT RECORD DOCUMENTS

A. Submit record documents in accordance with the Contract Documents.

B. Accurately record actual locations of control equipment. Revise diagrams included in Drawings to reflect actual control device connections.

1.6 OPERATION AND MAINTENANCE DATA

A. Submit operation data in accordance with the Contract Documents.

B. Include instructions for adjusting and resetting time delay relays, timers, and counters.

C. Submit maintenance data in accordance with the Contract Documents.

D. Include recommended preventative maintenance procedures and materials.

PART 2 -- PRODUCTS

2.1 PUSHBUTTONS AND SELECTOR SWITCHES

A. Pushbuttons, pilot lights and selector switches shall be of the full size, heavy-duty industrial, oil tight, 120 volt, with interchangeable pilot lights, plug-in construction, double break silver contacts, chrome plated lock rings, with modular contacts, and NEMA rating equal to that of the enclosure on which devices are installed. All components shall be flush mounted on front of panel, unless otherwise noted.

B. Provide individual legend plates for indication of switch, pushbutton, and light function (e.g., Open, Closed, Hand-Off-Auto). A list shall be submitted for review and approval.

C. Pilot lights shall be high intensity LED type. Pilot lights shall have clear lenses and LED lamps colored as shown on the Plans. Common, remote push-to-test circuitry shall be provided for each control panel to simultaneously test all indicating lights on the panel using a single pushbutton when there are 10 or more lights on the panel. Control panels with less than 10 lights shall utilize individual push-to-test lights and control circuitry.

D. Pushbuttons shall be maintained as shown on the Drawings. Momentary requirements shall be followed. Provide extended head pushbutton for all stop functions, mushroom head for emergency stop functions, and flush head pushbuttons for all other functions. Where indicated on the Drawings pushbuttons shall be illuminated type. Provide locking mechanism for all lock out functions. Selector switches shall have black knob operator, be maintained contact type unless noted otherwise. The number and arrangement will be able to perform intended functions specified but not less than one double pole, double throw, double break contact per switch. Contact rating shall be compatible with AC or DC throughput current of devices simultaneously operated by the switch contact but not less than 10 amperes resistive at 120 volts AC or DC continuous.

E. Potentiometers shall be provided with operators and resistive elements of the type. The quantity will be indicated on the Drawings and as required with legend plates indicating percent of span.

F. The above devices shall be manufactured by Square D, Allen Bradley, General Electric, or equal.

2.2 RELAYS

A. TIMING RELAYS shall be heavy duty, 300V A.C., 10 amps, solid state design, poles as required per application, -10°C to +60°C, have timing repeatability of ±2.0% of setting, and be UL listed. The range shall be determined from the control descriptions and or schematic drawings. Provide mounting accessories, as required. The timing relays shall be manufactured by Allen Bradley, Square D, Cutler Hammer, or equal.

B. CONTROL RELAYS shall be of the plug-in socket base type with dust-proof plastic enclosures, with silver-cadmium oxide contacts rated 300-volt, 10 amperes, with contact arrangement and operating coils of the proper voltage as required by the control circuit sequence. Relays shall have indicating lamp to show energized state. Each relay shall have a minimum of two double pole, double throw contacts, or as required. Control relays shall be Allen Bradley, Square D, Cutler Hammer, or equal.

C. ALTERNATING RELAYS shall be UL listed, 120 VAC, with contacts rated for 10 amperes at 120 VAC, life expectancy of 100,000 operations, load indicating LED's, and switch for load locking and load selecting options. Alternating relays shall be manufactured by TimeMark models 261, 271, and 471, and Diversified Electronics model ARA for duplex, triplex, and quadplex alternators.

2.3 ALARMS

A. AUDIBLE ALARMS shall be UL listed, 120 VAC, with solid state circuitry, vibrating horn, non-metallic corrosion resistant housing, with required mounting hardware, suitable for outdoor use capable of producing 100 dB at 10 feet. The audible alarm shall be manufactured by Federal Signal model 350, Edwards model 870-EX, or equal.

B. ROTATING BEACONS for interior and/or exterior locations shall be UL listed, 120 VAC, with motor and cooling fan, rotating lights at 60 times per minute minimum, capable of producing 36000 candlepower with required mounting hardware. Lens color shall be verified at the time of construction. The rotating beacons shall be manufactured by Federal Signal model 371L or equal.

~~C. ROTATING BEACONS for corrosive and/or hazardous locations shall be UL listed, 120 VAC, with solid state circuitry, rotating lights at 60 times per minute minimum, suitable for outdoor use capable of producing 36000 candlepower with required mounting hardware. Lens color shall be verified at the time of construction. The rotating beacons shall be manufactured by Edwards model 52EX or equal.~~

~~D. STROBE BEACONS shall be UL listed, NEMA 4X, 120 VAC, flashing at 80 times per minute minimum, producing peak candlepower of 520,000, effective candlepower of 165, with required mounting hardware. Lens color shall be verified at the time of construction. The rotating beacons shall be manufactured by Federal Signal model 151XST, Edwards model 92EX, or equal.~~

2.4 INTRINSIC SAFETY BARRIERS

A. INTRINSIC SAFETY BARRIERS shall permit connection of devices located in a hazardous area to other devices located in a safe area. Intrinsic safety barriers shall be EMC compliant, 10 to 35 V dc, 35 mA output current, hazardous area terminals identified by blue labels, terminals accommodating conductors up to 12 AWG, ambient temperature rating of –20 to +60°C. The intrinsic safety barriers shall be manufactured by MTL Inc., Ronan Engineering Co., Phoenix Contact, R. Stahl Inc., or equal.

2.5 WIREWAYS

A. WIRE-WAYS shall be PVC, snap-in slot design, with non-slip cover. Safe area wire-ways shall be light gray and marked “Safe Area Wiring.” Hazardous area wire-ways shall be intrinsic blue and marked “Hazardous Area Wiring.” The wire-ways shall be manufactured by Panduit Corporation, or equal.

2.6 WATT-HOUR TRANSDUCERS

A. WATT-HOUR TRANSDUCERS for active or reactive power shall be DIN rail and surface mount, single phase or three phase with balanced or unbalanced load, electrically isolated input and output signals, 4 to 20 mA output signal, 0-10 mA to 0-10 A input current, 0-10 V to 0-600 VAC input voltage, 16-500 Hz selectable frequency. The watt-hour transducers shall be manufactured by Sineax model PQ502, or equal.

2.7 ELAPSED TIME METERS AND TIME CLOCKS

A. ELAPSED TIME METERS shall be self powered, non-reset, solid state counter which provides silent, accurate and noise immune operation. Elapsed time meters shall require no external power, five year minimum battery life, 120 VAC power, accessories for panel mounting, nameplate below LCD display reading “HOURS”, liquid crystal display with 6 digits approximately 2 inches high with 50,000 hour minimum display life and indication of sufficient battery power. The elapsed time meters shall be manufactured by Durant, Automatic Timing and Controls a Division of Sycon Corp., or equal.

B. TIME CLOCKS shall be microprocessor based, have 24 hour time control, up to 24 operations per day, programmable from panel face keys, skip-a-day feature allowing schedule to be skipped for one to seven days, SPDT switch contact rated at 15 amps at 120 V AC, with battery carryover to maintain time and program during power outage for 275 hours. The time clocks shall be manufactured by Tork, Paragon Electric Company, or equal.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Fasteners shall be type 304 stainless steel.

B. Install devices in strict accordance with NEC requirements and per manufacturer’s recommendation.

C. Coordinate with other trades as necessary during installation of these devices.

3.2 ACCEPTANCE

A. All installations are subject to evaluation in accordance with NEC requirements and manufacturers recommendations. Contractor shall remove the unacceptable work and correct work at no charge to Owner.

- END OF SECTION -

SECTION 16903 - PROGRAMMABLE LOGIC CONTROLLERS

PART 1 – GENERAL

1.1 SCOPE OF WORK

A. This section covers the programmable logic controller (PLC) used for control and monitoring, as indicated on Plans. The Contractor will provide PLC programming unless otherwise indicated on the drawings.

B. Provide one full version copy of RSLogix 5000 with RSLinx programming software, and support and debugging time for a period of fifteen (15) days after start-up of the equipment under PLC control.

C. Provide one full version copy of Operator interface software if operator interface is provided for this project.

1.2 SUBMITTALS

A. Submittals shall include the following:

1. Manufacturer's data on electrical characteristics, capabilities and physical properties.

2. Wiring diagrams showing connections to all devices; input and output (I/O), analog and discrete. The wiring diagrams shall indicate the I/O address point to be used in the PLC programs.

1.3 MANUFACTURERS

A. The PLC shall be manufactured by Allen Bradley and shall be a CompactLogix or ControlLogix series, no equal.

PART 2 – PRODUCTS

2.1 PROGRAMMABLE LOGIC CONTROLLER

A. PLCs shall be furnished with hardware and software necessary to monitor and control equipment, as listed in the specifications, and shown on the Plans. Each field input and output shown as an I/O Point shall be connected as per the manufacturers' recommendations. Additionally, the Contractor shall provide the hardware, software, and installation necessary for connecting additional future equipment as indicated on the Plans. The type of field input and output shall be defined as follows unless specified on the plans:

1. Analog inputs and outputs (4-20 mA DC).

2. Discrete inputs (dry contact).

3. Discrete outputs (24 VDC, form "C" relay)

B. Vendor supplied PLC's shall be programmed and factory tested by the Vendor. Programming of PLC's ~~and OIT's~~ shall be per Section~~Sections~~ 17700~~ and 17701~~.

C. Contractor supplied PLC's~~ and OIT's~~ shall be programmed as noted in section 1.01 of this specification. The programming of Contractor supplied PLC's ~~and OIT's~~ shall be per Section~~Sections~~ 17700~~ and 17701~~ if required.

D. The programmable controllers shall be supplied with Ethernet/IP communication modules or have the Ethernet/IP communication port directly on the processor, and with a TOD clock and battery back as shown on the Plans.

2.2 CENTRAL PROCESSING UNIT (CPU)

A. The PLC CPU shall be a microprocessor based industrial controller with a temperature rating of 0 to 60 degrees C, and a humidity rating of 5 to 85% non-condensing, minimum. The CPU shall have internal memory of a minimum 768 kbytes for user-programmed instructions and 64 megabytes of CompactFlash non-volatile memory available.

B. The PLC shall have tag-based memory which shall retain information on power failure. Each tag shall be capable of storing 32 bits of data. This information shall represent process set points, timer and counter presets, accumulated values, positions, or other measured process variables.

C. Program control and logic functions shall be solved sequentially during each CPU scan. The scanning tasks shall include, at a minimum:

1. Update of time reference from a built-in real-time clock.

2. Diagnostic self-test of PLC to include input and output.

3. Reset watchdog timer which shall be used to verify correct functioning of the PLC and which shall be preset to 100 to 250 milliseconds.

D. The CPU shall have an I/O capacity of 500 points, 64 analog loops, and be capable of addressing a minimum of 3 local and remote I/O racks.

E. LED indicators shall display RUN, LAN ACT, and LAN ST status information.

F. A network interface module, mounted on the base, or integral port within the CPU, shall be provided for TCP/IP and IPX protocols.

2.3 INPUT/OUTPUT MODULES

A. Input and output bases shall have screw-in type terminals.

B. Analog inputs and outputs shall have a minimum of 12 bits resolution. Analog modules shall be configurable for 4 to 20 mA DC, or 1 to 5 Volt DC signals. Provide external, or user power, as needed.

C. Each discrete output module shall be fused and shall have interposing relays, with fuse blown indicators on each module. Indicator lights shall also be provided on each I/O point to indicate status of each signal. Each individual input or output point shall be optically isolated to protect the controller I/O circuitry from high voltage transients.

D. The power supply shall provide power for the processor, and I/O modules. The power supply shall have built-in over-voltage and under-voltage detection circuitry, protection against overcurrent conditions, and automatic power-up sequence that enables outputs only when proper operating tolerances are reached. Power requirements shall be 24 VDC.

E. The I/O system shall be field expandable to the maximum I/O capacity of the CPU, without modifications of the processor. Provide 25% blank, or empty base space for future bases.

F. The PLC system shall be provided with base type I/O, connected to the CPU via a dedicated remote I/O bus port, and be able to communicate over a shielded twisted pair cable at rate of one million bits per second, or greater.

2.4 STORAGE AND DOWNLOADING OF PLC PROGRAMS

A. The PLC shall be programmable through an RS-232 port, or Network Port, connected to a personal computer through a standard cable. The PLC programming software shall be provided

with the user's manuals, original CDs, and licensing agreement for registration by the Owner. Cables, adapters, connectors, or other hardware required to connect a PC to the PLC, shall be provided to the Owner.

B. The PLC programming software shall enable the user to write the PLC program on-line or off-line. The software shall include utilities to manage PLC program files, document and print the programs, configure the programming environment, monitor and force the PLC addresses while on-line, and configure the PLC memory and addressing structure.

2.5 OPERATOR INTERFACE

A. The operator interface shall communicate over the buss structure or Ethernet. The operator interface if not specified on the plans shall be an 10" color touch screen. The contractor shall supply the owner with a copy of the programming software and required programming cables for the operator interface. The operator interface shall have 64 MB of memory minimum and shall be powered by 24V DC. The following manufacturers will be acceptable if not specified on the plans:

1. Allen Bradley Panel View Plus 1000

2. Modicon Magelis XBGT5330

PART 3 - EXECUTION

3.1 INSTALLATION

A. PLC shall be installed as indicated on the Plans and according to the manufacturer's instructions.

3.2 START UP AND TESTING

A. Upon completion of the installation, start-up shall be performed by a factory-trained manufacturer representative. Operating and maintenance instruction books shall be supplied upon delivery of the unit and procedures explained to operating personnel.

B. The PLC program and I/O shall be thoroughly tested. Each input and output signal shall be tested for correct indication and control function. The Contractor shall demonstrate operation of the PLC inputs and outputs with simulated signals, and then tested with the Owners programmer and the control logic before the entire system is started, and run in automatic mode.

3.3 TRAINING

A. Provide four (4) hours of training on the control system. Instruction shall include a description of the control system hardware operation and equipment troubleshooting.

3.4 SPARES

A. Furnish a minimum of one (1) spare I/O base of each type, one (1) spare processor, One (1) spare Modbus Option Adapter, and one (1) power supply module.

B. Furnish twelve (12) fuses of each type and size, used in the power supply and I/O modules.

- END OF SECTION -

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SECTION 16950 - ELECTRICAL TESTING

PART 1 – GENERAL

1.1 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. American National Standards Institute (ANSI):

a. 450, Recommended Practice for Maintenance, Testing, and Replacement of Large Lead Storage Batteries for Generator Stations and Substations.

b. C2, National Electric Safety Code.

c. C37.20.1, Metal-Enclosed Low Voltage Power Circuit Breaker Switchgear.

d. C37.20.2, Metal-Clad and Station-Type Cubicle Switchgear.

e. C37.20.3, Metal-Enclosed Interrupter Switchgear.

f. C62.33, Standard Test Specifications for Varistor Surge Protective Devices.

2. American Society for Testing and Materials (ASTM):

a. D665, Standard Test Method for Rust Preventing Characteristics of Inhibited Mineral Oil in the Presence of Water.

b. D877, Standard Test Method for Dielectric Breakdown Voltage of Insulating Liquids Using Disk Electrodes.

c. D923, Standard Test Method for Sampling Electrical Insulating Liquids.

d. D924, Standard Test Methods for A-Class Characteristics and Relative Permittivity (Dielectric Constant) of Electrical Insulating Liquids.

e. D971, Standard Test Method for Interfacial Tension of 0.1 against Water by the Ring Method.

f. D974, Standard Test Method for Acid and Base Number by Color-Indicator Titration.

g. D1298, Standard Test Method for Density, Relative Density (Specific Gravity), or API Gravity of Crude Petroleum and Liquid Petroleum Products by Hydrometer Method.

h. D1500, Standard Test Method for ASTM Color of Petroleum Products.

i. D1524, Standard Test Method for Visual Examination of Used Electrical Insulating Oils of Petroleum Origin in the Field.

j. D1533, Standard Test Methods for Water in Insulating Liquids.

k. D1816, Standard Test Method for Dielectric Breakdown Voltage on Insulating Oils of Petroleum Origin Using VDE Electrodes.

l. D2285, Standard Test Method for Interfacial Tension of Electrical Insulating Oils of Petroleum Origin against Water by the Drop-Weight Method.

3. Institute of Electrical and Electronics Engineers (IEEE):

a. 43, Recommended Practice for Testing Insulating Resistance of Rotating Machinery.

b. 48, Standard Test Procedures and Requirements for High-Voltage Alternating-Current Cable Terminators.

c. 81, Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Ground System.

d. 95, Recommended Practice for Insulation Testing of Large AC Rotating Machinery with High Direct Voltage.

e. 118, Standard Test Code for Resistance Measurement.

f. 400, Guide for Making High-Direct-Voltage Tests on Power Cable Systems in the Field.

4. National Electrical Manufacturers Association (NEMA):

a. AB 4, Guideline for Inspection and Preventive Maintenance of Molded Case Circuit Breakers Used in Commercial and Industrial Applications.

b. PB 2, Deadfront Distribution Switchboards.

c. WC 7, Cross-Linked-Thermosetting-Polyethylene-Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy.

d. WC 8, Ethylene-Propylene-Rubber-Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy.

5. International Electrical Testing Association (NETA): ATS, Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems.

6. National Fire Protection Association (NFPA):

a. 70, National Electrical Code (NEC).

b. 70E, Standard for Electrical Safety Requirements for Employee Workplaces.

1.2 SUBMITTALS

A. Administrative Submittals: Submit 30 days prior to performing inspections or tests:

1. Schedule for performing inspection and tests.

2. List of references to be used for each test.

3. Sample copy of equipment and materials inspection form(s).

4. Sample copy of individual device test form.

5. Sample copy of individual system test form.

B. Quality Control Submittals: Submit within 14 days after completion of test:

1. Test or inspection reports and certificates for each electrical item tested.

C. Contract Closeout Submittals:

1. Operation and Maintenance Data:

a. In accordance with references elsewhere in these specifications.

b. After test of inspection reports and certificates have been reviewed by ENGINEER and returned, insert a copy of each in operation and maintenance manual.

1.3 QUALITY ASSURANCE

A. Test equipment shall have an operating accuracy equal to, or greater than, requirements established by NETA ATS.

B. Test instrument calibration shall be in accordance with NETA ATS.

1.4 SEQUENCING AND SCHEDULING

A. Perform inspection and electrical tests after equipment has been installed.

B. Perform tests with apparatus de-energized whenever feasible.

C. Inspection and electrical tests on energized equipment are to be:

1. Scheduled with OWNER prior to de-energization.

2. Minimized to avoid extended period of interruption to the operating plant equipment.

D. Notify OWNER at least 24 hours prior to performing tests on energized electrical equipment.

PART 2 – PRODUCTS (NOT USED)

PART 3 – EXECUTION

3.1 GENERAL

A. Tests specified in this section are to be performed in accordance with the requirements elsewhere in these specifications.

B. Tests and inspection shall establish that:

1. Electrical equipment is operational within industry and manufacturer's tolerances.

2. Installation operates properly.

3. Equipment is suitable for energization.

4. Installation conforms to requirements of Contract Documents and NFPA 70, NFPA 70E, and ANSI C2.

C. Perform inspection and testing in accordance with NETA ATS, industry standards, and manufacturer's recommendations.

D. Adjust mechanisms and moving parts for free mechanical movement.

E. Adjust adjustable relays and sensors to correspond to operating conditions, or as recommended by manufacturer.

F. Verify nameplate data for conformance to Contract Documents.

G. Realign equipment not properly aligned and correct un-levelness.

H. Properly anchor electrical equipment found to be inadequately anchored.

I. Tighten accessible bolted connections, including wiring connections, with calibrated torque wrench to manufacturer's recommendations, or as otherwise specified.

J. Clean contaminated surfaces with cleaning solvents as recommended by manufacturer.

K. Provide proper lubrication of applicable moving parts.

L. Inform OWNER of working clearances not in accordance with NFPA 70.

M. Investigate and repair or replace:

1. Electrical items that fail tests.

2. Active components not operating in accordance with manufacturer's instructions.

3. Damaged electrical equipment.

N. Electrical Enclosures:

1. Remove foreign material and moisture from enclosure interior.

2. Vacuum and wipe clean enclosure interior.

3. Remove corrosion found on metal surfaces.

4. Repair or replace, as determined by OWNER, door and panel sections having dented surfaces.

5. Repair or replace, as determined by OWNER, poor fitting doors and panel sections.

6. Repair or replace improperly operating latching, locking, or interlocking devices.

7. Replace missing or damaged hardware.

8. Finish:

a. Provide matching paint and touch up scratches and mars.

b. If required due to extensive damage, as determined by OWNER, refinish the entire assembly.

O. Replace fuses and circuit breakers that do not conform to size and type required by the Contract Documents.

3.2 LOW VOLTAGE CABLES, 600 VOLTS MAXIMUM

A. Visual and Mechanical Inspection:

1. Inspect Each Individual Exposed Power Cable No. 4 and Larger For:

a. Physical damage.

b. Proper connections in accordance with single-line diagram.

c. Cable bends that do not conform with manufacturer's minimum allowable bending radius where applicable.

d. Color coding conformance with specifications.

e. Proper circuit identification.

2. Mechanical Connections For:

a. Proper lug type for conductor material.

b. Proper lug installation.

c. Bolt torque level in accordance with NETA ATS, Table 10.1, unless otherwise specified by manufacturer.

3. Shielded Instrumentation Cables For:

a. Proper Shield grounding.

b. Proper terminations.

c. Proper circuit identification.

4 Control Cables For:

a. Proper termination.

b. Proper circuit identification.

5. Cables Terminated Through Window Type CTs: Verify that neutrals and grounds are terminated for correct operation of protective devices.

B. Electrical Tests:

1. Insulation Resistance Tests:

a. Applied megohm-meter dc voltage in accordance with NETA ATS, Table 10.2.

b. Phase-to-phase and phase-to-ground for 1 minute on each pole.

c. Insulation resistance values equal to, or greater than ohm values established by manufacturer.

d. Provide test reports to Engineer and Owner that show where test measurements were taken and the results

2. Contact Resistance Tests:

a. Contact resistance in micro-ohms across each switch blade and fuse holder.

b. Investigate deviation of 50% or more form adjacent poles or similar switches.

3.3 MOLDED CASE CIRCUIT BREAKERS

A. General: Inspection and testing limited to circuit breakers rated 400 amperes and larger.

B. Visual and Mechanical Inspection:

1. Proper mounting.

2. Proper conductor size.

3. Feeder designation according to nameplate and one-line diagram.

4. Cracked casings.

5. Connection bolt torque level in accordance with NETA ATS, Table 10.1.

6. Operate frame size and trip setting with circuit breaker schedules or one-line diagram.

7. Compare frame size and trip setting with circuit breaker schedules or one-line diagram.

8. Verify that terminals are suitable for 75 degrees C rated insulated conductors.

C. Electrical Tests:

1. Insulation Resistance Tests:

a. Utilize 1,000-volt dc megohm-meter for 480- and 600-volt circuit breakers.

b. Pole-to-pole and pole-to-ground with breaker contacts opened for 1 minute.

c. Pole-to-pole and pole-to-ground with breaker contacts closed for 1 minute.

d. Test values to comply with NETA ATS, Table 10.2.

2. Contact Resistance Tests:

a. Contact resistance in micro-ohms across each pole.

b. Investigate deviation of 50% or more from adjacent poles and similar breakers.

3.4 INSTRUMENT TRANSFORMERS

A. Visual and Mechanical Inspection:

1. Visually Check Current, Potential, and Control Transformers for:

a. Cracked insulation.

b. Broken leads or defective wiring.

c. Proper connections

d. Adequate clearances between primary and secondary circuit wiring.

2. Verify Mechanically that:

a. Grounding and shorting connections have good contact.

b. Withdrawal mechanism and grounding operation, when applicable, operate properly.

3. Insulation resistance measurement on instrument transformer shall not be less than that shown in NETA ATS, Table 7.1.1.

3.5 METERING

A. Visual and Mechanical Inspection:

1. Verify meter connections in accordance with appropriate diagrams.

2. Verify meter multipliers.

3. Verify that meter types and scales conform to Contract Documents.

4. Check calibration of meters at cardinal points.

5. Check calibration of electrical transducers.

3.6 GROUNDING SYSTEMS

A. Visual and Mechanical Inspection:

1. Equipment and circuit grounds in motor control centers and panelboards assemblies for proper connection and tightness.

2. Ground bus connections in motor control centers and panelboards assemblies for proper termination and tightness.

3. Effective transformer core and equipment grounding.

4. Accessible connections to grounding electrodes for proper fit and tightness.

5. Accessible exothermic-weld grounding connections to verify that molds were fully filled and proper bonding was obtained.

6. Test ground system using 3 point fall of potential test equipment. Ground system must provide less than 5 ohms to ground resistance. Provide test reports to Engineer and Owner that show where test measurements were taken and the results. System must be tested at all ground rods, concrete encased electrodes, ground busses and service entrance locations.

3.7 AC INDUCTION MOTORS

A. General: Inspection and testing limited to motors rated 10 hp and larger.

B. Visual and Mechanical Inspection:

1. Proper electrical and grounding connections.

2. Shaft alignment.

3. Blockage of ventilating air passageways.

4. Operate Motor and Check for:

a. Excessive mechanical and electrical noise.

b. Overheating.

c. Correct rotation.

d. Check vibration detectors, resistance temperature detectors, or motor inherent protectors for proper operation.

e. Excessive vibration.

5. Check operation of space heaters.

C. Electrical Tests:

1. Insulation Resistance Tests:

a. In accordance with IEEE 43 at test voltages established by NETA ATS, Table 10.2 for:

1) Motors above 200 hp for 10-minute duration with resistances tabulated at 30 seconds, 1 minute, and 10 minutes.

2) Motors 200 hp and less for 1-minute duration with resistances tabulated at 30 and 60 seconds.

b. Insulation resistance values equal to, or greater than, ohm values established by manufacturers.

2. Calculate polarization index ratios for motors above 200 hp. Investigate index ratios less than 1.5 for Class A insulation and 2.0 for Class B insulation.

3. Insulation resistance test on insulated bearings in accordance with manufacturer's instructions.

4. Measure running current and voltage, and evaluate relative to load conditions and nameplate full-load amperes.

5. Provide test reports to Engineer and Owner that show where test measurements were taken and the results

3.8 LOW VOLTAGE MOTOR CONTROL

A. Visual and Mechanical Inspection:

1. Proper barrier and shutter installation and operation.

2. Proper operation of indicating and monitoring devices.

3. Proper overload protection for each motor.

4. Improper blockage of air cooling passages.

5. Proper operation of draw out elements.

6. Integrity and contamination of us insulation system.

7. Check Door and Device Interlocking System By:

a. Closure attempt of device when door is in OFF or OPEN position.

b. Opening attempt of door when device is in ON or CLOSED position.

8. Check Nameplates for Proper Identification Of:

a. Equipment title and tag number with latest one-line diagram.

b. Pushbuttons.

c. Control switches.

d. Pilot lights.

e. Control relays.

f. Circuit breakers.

g. Indicating meters.

9. Verify that fuse and circuit breaker sizes and types conform to Contract Documents.

10. Verify that current and potential transformer ratios conform to Contract Documents.

11. Check Bus Connections for High Resistance by Low Resistance Ohmmeter and Calibrated Torque Wrench Applied to Bolted Joints:

a. Ohm value to be zero.

b. Bolt torque level in accordance with NETA ATS, Table 10.1, unless otherwise specified by manufacturer.

12. Check Operation and Sequencing of Electrical and Mechanical Interlock Systems by:

    a. Closure attempt for locked open devices.

    b. Opening attempt for locked closed devices.

13. Verify performance of each control device and feature furnished as part of the motor control center.

14. Control Wiring:

    a. Compare wiring to local and remote control, and protective devices with elementary diagrams.

    b. Check for proper conductor lacing and bundling.

    c. Check for proper conductor identification.

    d. Check for proper conductor lugs and connections.

15. Exercise active components.

16. Inspect Contactors For:

    a. Correct mechanical operations.

    b. Correct contact gap, wipe, alignment, and pressure.

    c. Correct torque of all connections.

17. Compare overload heater rating with full-load current for proper size.

18. Compare fuse, motor protector, and circuit breaker with motor characteristics for proper size.

19. Perform phasing check on double-ended motor control centers to ensure proper bus phasing from each source.

B. Electrical Tests:

1. Insulation Resistance Tests:

    a. Applied megohm-meter dc voltage in accordance with NETA ATS, Table 10.2.

    b. Bus section phase-to-phase and phase-to-ground for 1 minute on each phase.

    c. Contactor phase-to-ground and across open contacts for 1 minute on each phase.

    d. Starter section phase-to-phase and phase-to-ground on each phase with starter contacts closed and protective devices open.

    e. Test values to comply with NETA ATS, Table 10.2.

2. Current Injection through Overload Unit at 300% of Motor Full-Load Current and Monitor Trip Time:

   a. Trip time in accordance with manufacturer's published data.

   b. Investigate values in excess of 120 seconds.

3. Control Wiring Tests:

   a. Apply secondary voltage to control power and potential circuits.

   b. Check voltage levels at each point on terminal boards and each device terminal.

   c. Insulation resistance test at 1,000 volts dc on control wiring except that connected to solid state components.

   d. Insulation resistance to be 1 megohm minimum.

e. Operational test by initiating control devices to affect proper operation.

f. Provide test reports to Engineer and Owner that show where test measurements were taken and the results

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Attachment K-2

Water Treatment Facility

Please note that the WTP specifications are not provided at this time because design of the facility has been suspended until the NPDES permit is finalized.