Appendix C

Energy Calculations

Aliso Creek Lift Station Improvements Project

11/8/2024

Compression-Ignition Engine Brake-Specific Fuel Consumption (BSFC) Factors **[1]**:

HP: 0 to 100	0.0588		HP: Greater than 100	0.0529

Values above are expressed in gallons per horsepower-hour/BSFC.

CONSTRUCTION EQUIPMENT

Construction Equipment	#	Hours per Day	Horsepower	Load Factor	Construction Phase	Fuel Used (gallons)
Concrete/Industrial Saws	1	8	33	0.73	Demolition	362
Tractors/Loaders/Backhoes	1	6	84	0.37	Demolition	351
Cranes	1	8	367	0.29	Demolition	1,440
Excavators	1	8	36	0.38	Demolition	206
Generator Sets	1	8	14	0.74	Demolition	156
Pressure Washers	1	8	14	0.3	Demolition	63
Skid Steer Loaders	1	8	71	0.37	Demolition	395
Bore/Drill Rigs	1	8	83	0.5	Site Preparation	59
Plate Compactors	1	8	8	0.43	Site Preparation	5
Excavators	4	8	84	0.38	Site Preparation	180
Generator Sets	2	8	36	0.74	Site Preparation	75
Skid Steer Loaders	1	8	148	0.37	Site Preparation	69
Tractors/Loaders/Backhoes	1	7	84	0.37	Grading	77
Generator Sets	1	8	14	0.74	Grading	29
Tractors/Loaders/Backhoes	1	8	84	0.37	Building Construction	4,676
Cranes	1	4	367	0.29	Building Construction	7,201
Cement and Mortar Mixers	1	8	10	0.56	Building Construction	842
Plate Compactors	1	8	8	0.43	Building Construction	518
Excavators	1	8	36	0.38	Building Construction	2,058
Generator Sets	1	8	14	0.74	Building Construction	1,559
Welders	1	8	46	0.45	Building Construction	3,114
Pumps	1	8	11	0.74	Building Construction	1,225
Cement and Mortar Mixers	1	6	10	0.56	Paving	32
Concrete/Industrial Saws	1	8	33	0.73	Paving	181
Plate Compactors	1	8	8	0.43	Paving	26
Generator Sets	1	8	14	0.74	Paving	78
Paving Equipment	1	8	89	0.36	Paving	241
Skid Steer Loaders	1	8	71	0.37	Paving	198
Generator Sets	1	8	14	0.74	Architectural Coating	78
					Total Fuel Used	**25,492 (Gallons)**

Construction Phase	Days of Operation
Demolition	32
Site Preparation	3
Grading	6
Building Construction	320
Paving	16
Architectural Coating	16
Total Days	393

WORKER TRIPS

Constuction Phase	MPG [2]	Trips	Trip Length (miles)	Fuel Used (gallons)
Demo	24.1	**17.5**	**18.5**	430
Site Preparation	24.1	**12.5**	**18.5**	29
Grading	24.1	**5**	**18.5**	23
Building Construction	24.1	**0.08**	**18.5**	20
Paving	24.1	**5**	**18.5**	61
Architectural Coating	24.1	**0.02**	**18.5**	0
				563

HAULING AND VENDOR TRIPS

HAULING TRIPS

Constuction Phase	MPG [2]	Trips	Trip Length (miles)	Fuel Used (gallons)
Demo	7.5	1	9.0	38.02
Grading	7.5	8	9.0	57.60
			Total Fuel Used	**95.62**

VENDOR TRIPS

Constuction Phase	MPG [2]	Trips	Trip Length (miles)	Fuel Used (gallons)
Building Construction	7.5	0	10.2	17.41
			Total Fuel Used	**17.41**

Total Gasoline Consumption (gallons)	**563**
Total Diesel Consumption (gallons)	**25,605**

Sources:

[1] United States Environmental Protection Agency. 2021. *Exhaust and Crankcase Emission Factors for Nonroad Compression-Ignition Engines in MOVES3.0.2* . September. Available at: https://www.epa.gov/system/files/documents/2021-08/420r21021.pdf.

[2] United States Department of Transportation, Bureau of Transportation Statistics. 2021. *National Transportation Statistics* . Available at: https://www.bts.gov/topics/national-transportation-statistics.

Appendix D

Geotechnical Exploration Report

Geotechnical Exploration Report
El Toro Water District
Aliso Creek Lift Station Improvements
24091 Avenida Sevilla
Laguna Woods, California

Prepared for:

Tetra Tech, Inc.
17885 Von Karman Avenue, Suite 500
Irvine, California 92614

Prepared by:

Verdantas Inc.
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Verdantas Project No. 036.0000023477

September 25, 2024

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September 25, 2024

Project No. 23477

Mr. Tom Epperson, PE
Tetra Tech, Inc.
17885 Von Karman Avenue, Suite 500
Irvine, California 92614

Subject: **Geotechnical Exploration Report**
El Toro Water District
Aliso Creek Lift Station Improvements
24091 Avenida Sevilla, Laguna Woods, California

In response to your request, Verdantas Inc. (formerly Leighton Consulting, Inc.) has conducted a geotechnical engineering exploration as a subconsultant to Tetra Tech for the El Toro Water District Aliso Creek Lift Station reconstruction project in the city of Laguna Woods, California. The purpose of our services was to explore the subsurface conditions at the site and develop geotechnical recommendations to aid in design and construction of the project.

Based on our field exploration program, the project site is capped by an approximately 10-foot-thick mantle of clayey artificial fill overlying alluvial deposits and claystone of the Miocene Monterey Formation. Groundwater was encountered in our boring during drilling at a depth of approximately 23 feet below ground surface and was measured at a stabilized depth of 19 feet below the ground surface within the installed monitoring well.

Based upon the results of this geotechnical exploration, the proposed project is feasible from a geotechnical standpoint. Specific recommendations for the geotechnical aspects of the project are presented in this report.

We appreciate the opportunity to be of service to you on this project. If you have any questions or if we can be of further service, please contact us at your convenience.

Respectfully submitted,

VERDANTAS INC.

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EMH/DJC/lr

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1.0 Introduction

1.1 Site Location and Proposed Project

The project site is a 0.13-acre, rectangular parcel of land located in a gated residential neighborhood in Laguna Woods, immediately northeast of Avenida Sevilla and northwest of the Aliso Creek Channel. The site is surrounded by perimeter block walls and currently occupied by an existing lift station consisting of below-ground dry pit housing submersible pumps, a wet well, a separate electrical building, an emergency diesel trailer mounted pump, an emergency diesel generator, a Southern California Edison (SCE) transformer, and a stairwell for access to the dry pit. The approximate site location (N 33.5989, W 117.7089) and surrounding vicinity is shown in Figure 1, *Site Location Map*.

We understand the existing lift station will be replaced with a new lift station consisting of a 12-foot-diameter, 30-foot-deep precast concrete wet well with three submersible pumps. We anticipate that construction of the proposed new lift station will include an excavation of approximately 30 feet below ground surface, requiring temporary shoring and dewatering.

Ancillary improvements will include a valve vault, a meter vault, a new electrical building, and conversion of the lower level of the existing dry pit to emergency storage. The existing block wall along the easterly site boundary will be demolished and replaced with a new wall. The double leaf swing gate entrance to the site will be moved to the west and replaced with a new rolling gate.

1.2 Purpose and Scope of Exploration

The purpose of our services was to explore the subsurface conditions at the site and provide geotechnical recommendations to aid in design and construction of the project.

The scope of this exploration included the following tasks:

- *Background Review* – A background review was performed of readily available, relevant geotechnical and geological literature pertinent to the site. References used in preparation of this report are listed in Section 6.0.

- *Pre-Field Exploration Activities* – Boring locations were marked and DigAlert and the District were notified to locate and mark existing underground utilities prior to our subsurface exploration.

- *Exploratory Boring* – On August 12, 2024, we advanced one hollow-stem auger boring to a depth of 51½ feet below existing grade. The boring was logged and sampled using Standard Penetration Test (SPT) and California Ring samplers at selected intervals following ASTM D 1586 and ASTM D 3550 for SPT and split-barrel sampling of soil. The SPT and Ring samplers were driven into the soil with a 140-pound hammer, free falling 30 inches. The number of blows was noted for every 6 inches of sampler penetration. Relatively undisturbed samples were collected from the boring using the Ring sampler. In addition to driven samples, a representative bulk soil sample was also collected from the boring. Each soil sample collected was described in general conformance with the Unified Soil Classification System (USCS). The samples were sealed, packaged, and transported to our in-house geotechnical laboratory for testing. Soil descriptions and sample depths are noted on the boring log included in

Appendix A, *Boring Log*. Soil cuttings from the boring were containerized in 55-gallons drums and disposed of at an appropriate offsite receiving facility based on the results of soil analytical testing. The approximate location of the hollow-stem boring is shown in Figure 2, *Boring Location Map*.

- *Groundwater Well Installation* – After drilling and sampling were complete, the boring was reamed to 10-inches in diameter and converted into a groundwater monitoring well (LB-1/MW-1). The well was installed to a depth of 40 feet and screened with 4-inch diameter, 0.020-inch slotted, PVC casing from 5 to 40 feet. Filter pack consisting of #3 Monterey Sand was placed in the annulus of the well to a depth of 2 feet above the screen interval. Hydrated bentonite was placed above the filter pack followed by a sanitary seal consisting of bentonite-cement grout. The well was surface completed with a traffic-rated well box encased in concrete.

- *Well Development* – The installed groundwater well was developed by swabbing/surging, bailing and pumping following well completion.

- *Pumping test* – Limited pumping tests were performed in well LB-1/MW-1 on September 3, 2024 utilizing a variable speed Grundfos submersible pump and submerged transducers. Purge water was containerized in 55-gallon drums and stored onsite pending water quality analysis results and offsite disposal at an appropriate receiving facility. Specifics regarding the pumping test are discussed in Section 3.0.

- *Groundwater Samples* – Groundwater samples were collected from the pumping test well at the completion of the pump test. The groundwater samples were submitted to a NELAP certified laboratory for analyses required to select an appropriate offsite facility for disposal of purge water. The results of water quality sampling are provided in Appendix C, *Limited Water Quality Analytical Results.*

- *Geotechnical Laboratory Tests* – Laboratory tests were performed on selected soil samples obtained during our field exploration. The laboratory testing program was designed to evaluate the physical and engineering characteristics of the onsite soils. Tests performed during this exploration include:

  - In situ moisture content and dry density (ASTM D 2216 and ASTM D 2937);
  - Atterberg Limits (ASTM D 4318);
  - Direct Shear (ASTM D 3080); and
  - Corrosivity Suite – pH, Sulfate, Chloride, and Resistivity (California Test Methods 417, 422, and 532/643).

  Test results of the in-situ moisture content and dry density are presented on the boring log in Appendix A. Other laboratory test results are presented in Appendix B, *Laboratory Test Results*.

- *Engineering Analysis* – The data obtained from our background review, field exploration, and laboratory testing program were evaluated and analyzed to develop the conclusions and recommendations for the proposed project.

- *Hydraulic Analysis* – The pumping test data was analyzed to determine the aquifer properties of transmissivity and hydraulic conductivity. Results of the analysis combined with a summary

of local hydrogeology conditions will aid an experienced licensed dewatering contractor in development of a construction dewatering plan.

- *Report Preparation* – The results of our exploration are summarized in this report presenting our findings, conclusions, and recommendations.

2.0 Geotechnical Findings

2.1 Geologic Setting

The subject site is located within the northwest trending Peninsular Ranges geomorphic province in southern California. The Peninsular Ranges province is bounded by the Transverse Ranges province on the north, by the Colorado Desert province to the east and extends about 900 miles to the south into Baja, California. The project site lies on the northern flanks of the San Joaquin Hills, which is a northwest trending topographic structure located along coastal southern California. The San Joaquin Hills extend from Newport Beach southerly to Dana Point. Regional tectonic activity has uplifted the San Joaquin Hills into an elongated arched fold (anticlinorium) trending to the northwest from San Juan Capistrano to Huntington Mesa. This anticlinal folding has occurred as this entire section of the southern California coast was uplifted by the San Joaquin Hills blind thrust fault (Grant et al., 1999; Mueller et al., 1998). The Peninsular Ranges region and the offshore areas of Southern California also contain several major northwest trending active faults.

The project site area is regionally mapped to be underlain by Tertiary age marine bedrock of the Monterey formation age (Morton and Miller, 2006; Vedder et al., 1957). The overlying surficial deposits mapped in the area include artificial fill materials and Holocene age alluvium. The mapped geologic units in the vicinity of the project site are presented in Figure 3, *Regional Geology Map*.

2.2 Regional Hydrogeologic Setting

The site is located within the greater South Coast Hydrologic Region, an area that encompasses approximately 11,000 square miles and extends from Ventura County in the north, Riverside and San Bernardino on the east, the Mexico Border on the South, and the Pacific Ocean to the west (DWR, 2020). The Region has 17 groundwater basins and numerous subbasins. While not located above a mapped groundwater basin, the project site is situated in the San Joaquin Hills between the Coastal Plain of Orange County Basin (Basin 8-001) to the north and the San Juan Valley Basin (Basin 9-001) to the southeast.

2.3 Subsurface Soil Conditions

Our subsurface investigation encountered an approximately 10-foot-thick mantle of artificial fill capping the project site. Underlying the artificial fill, Quaternary-aged young alluvial deposits were encountered overlying claystone of the Miocene Monterey Formation. A summary of the subsurface conditions encountered during the current subsurface investigation are described below. Detailed descriptive lithologies are included in the boring log presented in Appendix A.

2.3.1 Artificial Fill (Afu)

Artificial fill was encountered during our subsurface investigation to a depth of approximately 10 feet. In general, the encountered artificial fill material consists of olive brown to dark brown silty clay and lean clay. Because of the subterranean nature of the existing lift station, deeper fill is possible in areas not explored.

2.3.2 Quaternary Young Alluvial Valley Deposits (Qya)

Quaternary-aged alluvial deposits were encountered below the artificial fill and extend to a depth of approximately 35 feet. The alluvial deposits consist predominately of olive brown to gray, lean clay, elastic silt, and fat clay. In general, the consistency of the alluvial deposits was found to be very stiff.

2.3.3 Miocene Monterey Formation (Tm)

Bedrock of the Miocene Monterey Formation was encountered at a depth of approximately 35 feet. As encountered, the Monterey Formation consists of medium stiff, olive brown to dark brown, thinly bedded to laminated, claystone.

2.4 Collapse and Compressibility Potential

Collapse is settlement of soils upon wetting. Soil compressibility refers to settlement potential of soils when subjected to increased loads, such as from a fill surcharge or structure loads.

Based on the soil types and properties encountered during the field exploration, the soils have low collapse potential and low compressibility potential under the expected loads of the proposed structures.

2.5 Soil Corrosivity

In general, soil environments that are detrimental to concrete have high concentrations of soluble sulfates and/or pH values of less than 5.5. Soils with chloride content greater than 500 parts per million (ppm) per California Test 422 are considered corrosive to steel, either in the form of reinforcement protected by concrete cover or plain steel substructures, such as steel pipes. Additionally, soils with a minimum resistivity of less than 1,500 Ohm-cm are considered corrosive to ferrous metal. Based on the laboratory test results, the subsurface soils at the site generally have low soluble sulfate contents and neutral pH values. However, the test results indicate that the onsite soils have high corrosion potential to buried ferrous metals in direct contact with the soils. The test results are included in Appendix B of this report.

2.6 Groundwater

Groundwater was encountered in our borings at a depth of approximately 23 feet below the ground surface and was measured to a stabilized depth of 19 feet below the ground surface on September 3, 2024. The groundwater contour map in the *Seismic Hazard Zone Report for the San Juan Capistrano 7.5-Minute Quadrangle* (California Geological Survey, 2001) indicates that the historically high groundwater table in the area is about 10 feet below the existing grade.

Fluctuations of the groundwater level, localized zones of perched water, and an increase in soil moisture should be anticipated during and following the rainy seasons or periods of locally intense rainfall or stormwater runoff. As such, the actual depth of groundwater may vary and should be verified during construction.

2.7 Primary Seismic Hazard

Our review of available in-house literature indicates that the project site is not located within an Alquist-Priolo (AP) Earthquake Fault Zone (Hart and Bryant, 2007). The principal seismic hazard that could affect the site is ground shaking resulting from an earthquake occurring along any one of several major active faults in the region. The known regional faults that could produce the most significant ground shaking at the project site include the San Joaquin Hills Thrust fault, the Newport-Inglewood fault zone, and the Elsinore fault located approximately 1.3 miles, 8.1 miles, and 17.0 miles from the site, respectively. A map of the regional faults with surface traces is shown in Figure 4, *Regional Fault and Historic Seismicity Map*.

The intensity of ground shaking at a given location depends primarily upon the earthquake magnitude, the distance from the source, and the site response characteristics. Peak horizontal ground accelerations are generally used to evaluate the intensity of ground motion. Using the ATC Hazard by Location (https://hazards.atcouncil.org/) to obtain seismic design parameter values from the United States Geological Survey (USGS), the peak ground acceleration for the Maximum Considered Earthquake (MCE_G) adjusted for the Site Class effects (PGA_M) is 0.558g. Based on the USGS online unified hazard tool program (USGS, 2022a), the modal seismic event is Moment Magnitude (M_W) 6.89 at a distance of 2.1 miles.

2.8 Secondary Seismic Hazards

Secondary seismic hazards in the region could include soil liquefaction and the associated surface manifestation, earthquake-induced landsliding and flooding, and tsunamis. A site-specific evaluation of these potential hazards is discussed in the following sections.

2.8.1 Liquefaction

Liquefaction is a seismic phenomenon in which loose, saturated, granular soils behave similarly to a fluid when subjected to high-intensity ground shaking. Liquefaction occurs when three general conditions exist: 1) shallow groundwater; 2) low density, fine, clean sandy soils; and 3) strong ground motion. Effects of liquefaction can include sand boils, settlement, and bearing capacity failures below structural foundations.

Review of the *Seismic Hazard Zone Map for the San Juan Capistrano Quadrangle* (CGS, 2001) indicates the lift station site is located within an area that has been identified by the State of California as being potentially susceptible to the occurrence of liquefaction.

Based on our boring and laboratory test results, the onsite soils consisted mainly of clay and silt with high plasticity (Plasticity Indices of 30 and 54), underlain by bedrock consisting of claystone. These types of soils are not considered susceptible to liquefaction. Therefore, the liquefaction potential at the site is considered to be low.

Seismically induced settlement consists of dry dynamic settlement (above groundwater) and liquefaction-induced settlement (below groundwater). These settlements occur primarily within loose to medium dense sandy soil due to reduction in volume during, and shortly after, an earthquake event. Since the onsite soils consisted mainly of clay and elastic silt, seismically induced settlement is expected to be negligible.

2.8.2 Seismically Induced Landslides

Review of the *Seismic Hazard Zone Map for the San Juan Capistrano Quadrangle* (CGS, 2001) indicate the subject site is not located within an area that has been identified by the State of California as being potentially susceptible to the occurrence of seismically induced landslides.

2.8.3 Earthquake-Induced Flooding

Earthquake-induced flooding can be caused by failure of dams or other water-retaining structures as a result of earthquakes. According to the California Division of Safety of Dams (DSOD), the project site is not located within a mapped dam inundation zone. Due to the absence of nearby water retaining structures, the potential for earthquake-induced flooding of the site is considered low.

2.8.4 Tsunamis

Tsunamis are waves generated in large bodies of water by fault displacement or major ground movement. Based on the inland location of the site, tsunami risk at the site is considered negligible.

3.0 Groundwater and Pumping Test

As noted in section 2.6 of this report, groundwater was encountered at a depth of 23 feet during drilling with stabilized groundwater levels measured at approximately 19 feet in the well. The rise of groundwater levels following well completion suggests groundwater is under partially confined conditions.

A limited constant rate pumping test was performed within the installed well to gain an understanding and estimation of the hydraulic parameters of the saturated zone within the planned excavations for the proposed lift station replacement. The hydraulic parameters will aid the dewatering contractor in designing a temporary dewatering system during construction. A description of well construction details is provided in section 1.2 of this report.

3.1 Pumping Test

The limited constant-rate pumping test was performed on September 3, 2024. The pumping test was performed by installing a submersible pump inside the 4-inch casing of well LB-1/MW-1. Groundwater depth readings were measured electronically at 30 second intervals by a transducer submerged inside the well to document the drawdown of water levels induced by pumping at a near constant flow rate. Manual readings of groundwater depths were also collected to verify and supplement the digitally recorded data. Prior to initialization of the pumping test, baseline static groundwater levels were measured in the well. Measured static groundwater levels are shown in the following table.

Table 1 – Static Groundwater level Before Pumping

Well Name	Depth (feet)	Elevation (feet)
LB-1/MW-1	19	286

Two limited pumping tests were conducted on May 10, 2024. A variable flowrate Grundfos submersible pump was installed at a depth of approximately 38 feet and adjusted to achieve an approximate flow rate of 1 gallon per minute (gpm). A groundwater transducer was secured at ground surface and set at depth of approximately 36 feet inside the well.

The initial pumping test was initiated at 9:32 am and the pump was frequently adjusted to maintain an approximate flowrate of 1 gpm. The pump was allowed to run until groundwater levels were drawn down to approximately 36 feet below ground surface (2 feet above pump elevation) before being shut down. Electrical issues related to overheating occurred approximately 17 minutes into the pumping test and the pump was cycled on and off. The target pumping flow rate was reinitiated at approximately 22 minutes into the test. The total duration of time required to achieve a groundwater drawdown of 17 feet was documented as approximately 48 minutes, including the roughly 5 minutes when flow rates were inconsistent due to the electrical issues. Data collected during this initial limited pump test is not considered indicative of actual site hydraulic conditions. Therefore, hydraulic parameters (T -Transmissivity and K - Hydraulic Conductivity) calculated from this initial test are not presented.

After the conclusion of the initial pumping test, groundwater rebound levels were recorded at intervals of 30 seconds. The groundwater level in the well rebounded to approximately 90 percent of initial pump test water level (20.5 feet) in approximately 75 minutes.

A second pumping test was performed after groundwater levels rebounded to approximately 20.5 feet below ground surface. The pump was started at 11:37 am and adjusted to maintain a flowrate of approximately 1 gpm. This second pump test was performed without interference from electrical issues and the pump was allowed to run continuously until water levels were drawn down to a depth approximately 36 feet. After approximately 34 minutes, a total drawdown of 15.5 feet was achieved. The hydraulic parameters presented in subsequent sections are based on the results of this second pumping test.

A graph showing the groundwater drawdown curve for LB-1/MW-1 is plotted on a semi-log scale and presented in Figure 5, *Drawdown during Pumping Test*. A summary of maximum drawdown and the corresponding groundwater level elevation are shown in the following table.

Table 2 – Maximum Drawdown during Pumping

Well Name	Test	Ground Surface Elevation (feet)	Stabilized Groundwater Depth (feet)	Avg. Flow Rate (gpm)	Duration (Mins)	Maximum Drawdown Depth (feet)	Maximum Drawdown Elevation (feet)
LB-1/ MW-1	1*	305	19.01	1.02	48	17	289
LB-1/ MW-1	2	305	20.5	1.03	34	15.5	289

*Not Utilized in analysis for Hydraulic Parameters

3.2 Pumping Test Analyses

Groundwater level changes versus time can be used to calculate hydraulic parameters of the aquifer using various empirical methods. The method chosen for this investigation was developed by Cooper and Jacob (1946) and uses a graphical plot of drawdown changes versus time on a semi-log scale.

The groundwater level was recorded at set intervals using well sounding equipment during the duration of all the pumping and recovery periods for each well. The groundwater level readings were tabulated and graphed for use during analysis. The data represents groundwater level measurements recorded during the drawdown (pumping) phase and recovery phase of the pumping test, and were used to construct Figure 5, demonstrating groundwater level changes over time in the well using a semi-log scale. Figure 5 were used to calculate the aquifer's hydraulic parameters based on the results from the second pumping test.

Since all measurements were collected from the pumping test well itself, it should be noted that, due to turbulence caused by the pump, these values are only approximations of the onsite hydraulic values for transmissivity and hydraulic conductivity.

Transmissivity, T, was calculated from the pumping rate and the slope of the time-drawdown graph using the following equation:

$$T = 264Q/\Delta s$$

where, Q = pumping rate in gpm; and
Δs = slope of the time drawdown graph over the period of one log cycle.

Hydraulic conductivity was calculated using the value of transmissivity, aquifer thickness, and the following equation:

$$K = T/b$$

where, T = calculated transmissivity value in gallons per day/square foot (gpd/ft^2); and
b = saturated thickness of the aquifer.

The thickness of the aquifer was assumed to be the static groundwater column height in the pumping well. The calculated hydraulic parameters for the second pump test performed on LB-1/MW-1 are summarized in the following table.

Table 3 – Approximate Transmissivity and Hydraulic Conductivity

Monitoring Well Name	Approximate Pumping Rate during Testing (gpm)	Transmissivity (gpd/ft)	Hydraulic Conductivity	
			gpd/ft^2	feet/day
LB-1/MW-1	1.03	1.8	9.0×10^{-2}	1.2×10^{-2}

4.0 Design Recommendations

Geotechnical recommendations for the proposed project are presented in the following sections. Construction considerations are discussed in Section 4.0 of this report. These recommendations are based upon the exhibited geotechnical engineering properties of the soils and their anticipated response both during and after construction as well as proper field observation and testing during construction. These recommendations are considered minimal and may be superseded by more conservative requirements of the civil engineer, building code, and local agencies. All earthwork should be performed in accordance with the recommendations below, unless specifically revised or amended by future review of project plans.

4.1 Earthwork

4.1.1 Site Preparation

Vegetation, debris, and other deleterious materials should be removed and disposed of offsite prior to the commencement of grading operations. Existing underground improvements, including utility lines, should be identified prior to the start of grading and abandoned or relocated, as necessary. Utility lines to remain functional should be protected in place or rerouted. Trenches resulting from removal of existing improvements should be excavated to competent materials and properly backfilled under the observation and testing of the geotechnical engineer.

4.1.2 Overexcavation and Recompaction

Excavation bottom for the proposed wet well at approximately 30 feet below grade is expected to expose very stiff, high plastic clay. The excavation bottom should be observed by the geotechnical engineer prior to placement of any improvements. If loose soils are exposed or if the excavation bottom is disturbed, the soils should be removed to competent materials and recompacted. If the loose/disturbed soils are too wet to achieve proper compaction, they may be air dried or replaced with aggregate base or crushed rock.

Foundation for at-grade structures should be underlain by compacted fill to provide a uniform support and reduce potential for differential settlement. The compacted fill should extend a minimum of 3 feet below bottom of the foundation and a minimum 3 feet beyond outside edges of the foundation. Existing improvements may limit the lateral extent of overexcavation. Such condition should be evaluated by the geotechnical engineer on a case-by-case basis.

Foundations for appurtenant structures, such as block walls up to 6 feet high, planter walls or trash enclosures, which will not be tied to the proposed building or wet well, may be supported on conventional foundations underlain by a minimum of 12 inches of newly placed engineered fill that extends laterally at least 12 inches beyond the foundation edges. Where excavation and proper compaction cannot be performed, the foundations may be supported in competent undisturbed alluvial soils, which may require deepening of the foundations to maintain a minimum of 12-inch embedment into the recommended bearing materials. If the soils exposed in the excavation bottom are soft or loose, compaction of the soils will be required prior to placing steel or concrete. Pavement areas, driveways, and concrete flatwork should be underlain by a minimum of 1 foot of compacted fill.

Local conditions may be encountered which may require additional removals and recompaction. The exact extent of removals can best be determined during grading by the geotechnical engineer when direct observation and evaluation of materials are possible.

4.1.3 Subgrade Preparation

Prior to placing fill materials, the subgrade should be scarified to a minimum depth of 6 inches, moisture conditioned, and proofrolled. Any soft and/or unsuitable materials encountered at the bottom of the excavations should be removed and replaced with fill material.

4.1.4 Fill Placement and Compaction

The onsite soils to be used as compacted structural fill should be free of organic material, construction debris or oversized material larger than 6 inches. Imported fill soils, if any, should be approved by the geotechnical engineer prior to placement as fill. Fill soils should be placed in loose lifts not exceeding 8 inches, moisture conditioned as necessary to slightly percent above moisture optimum and compacted to a minimum of 90 percent of the maximum dry density as determined by ASTM D 1557.

4.2 Foundation Design Parameters

4.2.1 Allowable Bearing Capacity

An allowable bearing capacity of 2,000 psf and a modulus of subgrade reaction of 115 pounds per cubic inch (pci) may be considered for design of mat foundation for the wet well. A reduction factor for the modulus of subgrade reaction of $[(1+B)/(2B)]^2$ should be applied for foundation width (B) greater than 1 foot. The mat foundation should have a minimum embedment of 12 inches below the lowest adjacent grade.

Shallow foundations such as continuous and/or spread footings may be used to support the loads of proposed at-grade structures. Footings should have a minimum embedment depth of 18 inches and a minimum width of 12 inches. An allowable bearing pressure of 2,000 psf may be used based on the minimum embedment depth and width. The allowable bearing value may be increased by 250 psf per foot increase in depth or width to a maximum allowable bearing pressure of 3,000 psf.

The allowable bearing pressures are for the total dead load and frequently applied live loads and may be increased by one third when considering loads of short duration, such as those imposed by wind and seismic forces. The allowable bearing pressures are net values; the weight of the footing may be neglected for design purposes. It is essential that a geotechnical engineer observes footing excavations before reinforcing steel is placed.

The recommended allowable bearing capacity for shallow footings is generally based on a total allowable static settlement of 1 inch. The differential settlement may be taken as approximately ½ inch over 30 feet. These settlement estimates should be reviewed by Verdantas when final foundation plans and loads for the proposed structures become available.

4.2.2 Lateral Load Resistance

Resistance to lateral loads will be provided by a combination of friction between the soils and foundation interface and passive pressure acting against the vertical portion of the foundation. A friction coefficient of 0.30 may be used at the soil-concrete interface for calculating the sliding resistance. A passive pressure based on an equivalent fluid pressure of 360 pounds per cubic foot (pcf) may be used for calculating the lateral passive resistance. The lateral passive resistance can be taken into account only if it is ensured that the soils against embedded structures will remain intact with time. The above values do not contain an appreciable factor of safety, so the structural engineer should apply the applicable factors of safety and/or load factors during design.

4.3 Slab-On-Grade

Concrete slabs-on-grade subjected to special loads should be designed by the structural engineer. Where conventional light floor loading conditions exist, the following minimum recommendations for conventional slabs-on-grade should be used. More stringent requirements may be required by local agencies, the structural engineer, the architect, or the CBC.

- A minimum slab thickness of 5 inches. Slab reinforcement should be designed by the structural engineer but as a minimum should consist of No. 3 rebar placed at 18 inches on center in each direction and provided with adequate concrete cover.
- A vapor barrier, 10-mil or thicker, should be placed below slabs where moisture-sensitive floor coverings or equipment is planned. The vapor barrier should be properly sealed at all joints and any penetrations.
- To reduce the potential for excessive cracking, concrete slabs-on-grade should be provided with construction or weakened plane joints at frequent intervals. Joints should be laid out to form approximately square panels.
- The subgrade soils should be wetted prior to placing the vapor barrier, steel, or concrete.

Exterior concrete slabs that are not subject to vehicular loading, such as patio slabs and sidewalks, should be at least 4 inches thick. We suggest that the exterior concrete slabs be reinforced using No. 3 rebar, 18 inches on center in both directions, placed at mid-thickness and provided with construction or weakened plane joints at frequent intervals.

Our experience indicates that use of reinforcement in slabs can generally reduce the potential for drying and shrinkage cracking. Some cracking should be expected as the concrete cures. Minor cracking is considered normal; however, it is often aggravated by a high water/cement ratio, high concrete temperature at the time of placement, small nominal aggregate size, and rapid moisture loss due to hot, dry, and/or windy weather conditions during placement and curing. Cracking due to temperature and moisture fluctuations can also be expected. The use of low slump concrete can reduce the potential for shrinkage cracking.

4.4 Seismic Design Parameters

Moderate to strong ground shaking due to seismic activity is expected at the site during the life span of the project. The 2022 CBC code-based seismic design parameters are summarized in the table below.

Table 4 – Code-Based 2022 CBC Seismic Design Parameters

Categorization/Coefficients	Design Value[1]
Site Latitude	33.59885°
Site Longitude	-117.70879°
Site Class	D
Mapped Spectral Response Acceleration at 0.2s Period, S_S	1.206
Mapped Spectral Response Acceleration at 1s Period, S_1	0.435
Short Period Site Coefficient at 0.2s Period, F_a	1
Long Period Site Coefficient at 1s Period, F_v	1.865
Adjusted Spectral Response Acceleration at 0.2s Period, S_{MS}	1.227
Adjusted Spectral Response Acceleration at 1s Period, S_{M1}	0.811[1]
Design Spectral Response Acceleration at 0.2s Period, S_{DS}	0.818
Design Spectral Response Acceleration at 1s Period, S_{D1}	0.541[1]
Design Peak Ground Acceleration, PGA_M	0.558

[1]A ground motion hazard analysis is not required where the value of the parameter S_{M1} determined by Eq. (11.4-2) is increased by 50% for all applications of S_{M1} in ASCE 7-16 Supplement 3. The resulting value of the parameter S_{D1} determined by Eq. (11.4-4) shall be used for all applications of S_{D1} in ASCE 7-16 Supplement 3.

4.5 Lateral Earth Pressures

The following recommendations may be used for design and construction of retaining structures at the site. We recommend that any permanent earth retaining structures be backfilled with onsite or import soil with Expansion Index (EI) of not greater than 50 (per ASTM D 4829).

Table 5 – Equivalent Fluid Pressures

Condition	Level Backfill Drained (psf/foot)	Level Backfill Undrained (psf/foot)
Active	37	80
At-Rest	57	90
Passive	360 (Maximum of 3,600 psf)	235 (Maximum of 2,350 psf)

*Sloping ground in front of wall

Walls retaining more than 6 feet of soil should consider a seismic earth pressure increment of 12 pcf with an inverted triangular distribution in addition to the active earth pressure provided above.

The above values do not contain an appreciable factor of safety, so the structural engineer should apply the applicable factors of safety and/or load factors during design. Retaining walls should be provided with a drainage system behind the wall to prevent build-up of hydrostatic pressure. If no drainage is provided, the undrained values in Table 5 should be used.

Cantilever walls that are designed for a deflection at the top of the wall of at least 0.001H, where H is equal to the wall height, may be designed using the active earth pressure condition. Rigid walls that are not free to rotate, walls that are braced at the top, and walls that provide indirect support for foundations should be designed using the at-rest condition.

Lateral load resistance will be provided by the sliding resistance at the base of the foundation and the passive pressure developed along the front of the foundation. A frictional resistance coefficient of 0.30 may be used at the concrete and soil interface.

In addition to the above lateral forces due to retained earth, the appropriate loads due to surcharges should be considered in the design of retaining structures. For lateral surcharge conditions, we recommend utilizing a horizontal load equal to 30 percent and 50 percent of the vertical load for active and at-rest conditions, respectively.

4.6 Cement Type and Corrosion Protection

Based on the results of laboratory testing, concrete structures in contact with the onsite soil are expected to have negligible exposure to water-soluble sulfates in the soil. Common Type II cement may be used for concrete construction onsite and the concrete should be designed in accordance with CBC requirements. However, Type V cement should be used for concrete expected to be in contact with recycled water.

Based on our laboratory testing, the onsite soil is considered corrosive to ferrous metals in direct contact with the soils. Ferrous pipe should be avoided by using high-density polyethylene (HDPE) or other non-ferrous pipe when possible. Ferrous pipe, if used, should be protected by polyethylene bags, tape or coatings, di-electric fittings or other means to separate the pipe from onsite soils. The corrosion information presented in this report should be provided to your underground utility subcontractors.

4.7 Pavement

New pavement for the site may consist of 4 inches of asphalt concrete (AC) over 6 inches of aggregate base (AB). Portland cement concrete (PCC) pavement, if used, should be a minimum 6 inches thick, underlain by 6 inches of aggregate base and provided with crack-control joints spaced no more than 10 feet on-center each way to control where cracks develop. As a minimum, we suggest concrete pavement be reinforced using No. 3 rebar, 18 inches on center in both directions, placed at mid-thickness. Concrete reinforcement should be designed by the structural engineer for appropriate loading conditions.

All pavement construction should be performed in accordance with the *Standard Specifications for Public Works Construction*. Field inspection and periodic testing, as needed during placement of the base course materials, should be undertaken to ensure that the requirements of the standard specifications are fulfilled. Prior to placement of aggregate base, disturbed/weathered subgrade soil should be processed to a minimum depth of 8 inches, moisture-conditioned, as necessary, and recompacted to a minimum of 90 percent relative compaction.

Aggregate base should be moisture conditioned, as necessary, and compacted to a minimum of 95 percent relative compaction.

Aggregate base and asphalt materials should conform to Sections 200-2 and 203, respectively, of the *Standard Specifications for Public Works Construction*. PCC should conform to Section 201 of the *Standard Specifications for Public Works Construction*.

5.0 Construction Considerations

5.1 Temporary Excavations

All temporary excavations should be performed in accordance with project plans, specifications, and all OSHA requirements. Excavations 5 feet or deeper should be laid back or shored in accordance with OSHA requirements before personnel are allowed to enter. During construction, the soil conditions should be regularly evaluated to verify that conditions are as anticipated. The contractor should be responsible for providing the "competent person" required by OSHA, standards to evaluate soil conditions. Close coordination between the competent person and the geotechnical engineer should be maintained to facilitate construction while providing safe excavations.

Based on our boring, the soils at the site should be readily excavated using conventional excavating equipment in good working condition.

5.2 Temporary Dewatering

Temporary dewatering will be required during construction of the wet well. Groundwater levels within the test well were able to be drawn down with relative ease to a depth of approximately 36 feet under a near constant flow rate of 1 gpm, within a duration of 34 minutes. Analysis of drawdown data indicates the transmissivity (T) and hydraulic conductivity (K) for the underlying water bearing units are 1.8 gallons per day/foot (gpd/ft) and 9.0×10^{-2} gallons per day/foot^2 (gpd/ft^2), respectively.

The proposed excavation can conceptually be dewatered by a combination of dewatering wells equipped with suitable submersible pumps and perimeter trenches installed along the base of the excavation walls. Dewatering wells and perimeter trenches should extend to a sufficient depth below the planned bottom of the excavation in order to achieve groundwater drawdown a minimum of 5 feet below the proposed excavation depth to ensure a firm working pad elevation. Saturated soils should be expected and may require bottom stabilization. The trench bottoms should be gently sloped (minimum of 1%) to direct water flow towards strategically placed sump pumps where groundwater can be pumped out. Inside the trench, a drain system should be installed consisting of a perforated pipe (perforations down) contained within at least 1 cubic foot per lineal foot of uniformly graded free-draining fine aggregate wrapped in a filter fabric.

Coordination between shoring design and dewatering design will need to take place to ensure the integrity of the shoring remains intact and is not compromised by the addition of a dewatering system.

Appendix D, *Temporary Construction Dewatering Specifications* provides general construction dewatering specifications for the proposed construction. While the dewatering concept provided in this report is conceptual and subject to revision or modification by an experienced and licensed dewatering contractor, at a minimum, the dewatering contractor shall implement and comply with the general specifications provided in the appendix.

We recommend that dewatering operations be performed by a specialist dewatering subcontractor. If dewatering is performed as anticipated in this analysis, it is important that the contractor understands their responsibilities and executes the work competently. The contractor

should be required to prepare a detailed submittal in the form of a Temporary Dewatering Plan in advance of the work to demonstrate understanding of the project needs. Discharge of groundwater during excavation should comply with all environmental regulations.

In addition, prior to implementing the dewatering program or construction excavation, a site survey should be conducted to document the existing condition and elevation of all structures, flatwork, and improvements nearby and adjacent to the planned excavation. Dewatering can be costly both in time and money. Unforeseen conditions can lead to expensive redesign and contactor claims. Dewatering of the site should be made the sole responsibility of the contractor. The contractor should select the dewatering method and be made responsible for its design and operation. Given the relatively low permeability of the underlying clayey alluvial soils and to minimize the potential for impacting the surrounding improvements, localized sump pumps within the excavation may be considered to remove the groundwater that enters the excavation. Additional investigation should be performed by the contactor as they feel is necessary to gain a better understanding of subsurface conditions. **Final dewatering design specifics should be provided by an experienced and licensed dewatering contractor.**

5.3 Shoring Design

Trench excavations may be supported by several methods including cross-braced hydraulic shoring, conventional shields, sheet piles, even possibly soldier piles with wood lagging. The choice should be left to the contractor's judgment since economic considerations and/or the individual contractor's construction experience may determine which method is more economical and/or appropriate. The contractor and shoring designer should also perform additional geotechnical studies as necessary to refine the means-and-methods of shoring construction. Shoring may be desired or even necessary to reduce excavation quantities, reduce pavement restoration quantities, keep traffic lanes open and/or protect existing adjacent utilities and/or other improvements.

Proper protection of existing surface and subsurface improvements, including existing utility lines and pavement, and support of all adjacent existing structures without distress are the contractor's responsibility. In addition, it should be the contractor's responsibility to undertake a pre-construction survey with benchmarks and photographs of the adjacent properties.

Shoring systems should be designed by a California licensed civil or structural engineer. As preliminary design guidelines, we present the following geotechnical parameters for shoring design. Typical cantilever shoring should be designed based on the active fluid pressure indicated in Table 5. The use of the at-rest earth pressure is recommended if the shoring is not free to rotate to mobilize active earth pressure. If excavations are braced at the top and at specific design intervals, the earth pressure may be approximated by a rectangular soil pressure distribution with the pressure per foot of width equal to 24H, where H is equal to the depth of the excavation being shored. These values are for a level ground and drained condition behind the shoring system. If the retained soils are not drained, hydrostatic pressure should be considered in the shoring design.

Traffic surcharges, wherever applicable, are recommended to be included in the design as an additional uniform lateral surcharge of 100 psf and 150 psf for cantilever and braced shoring, respectively, applied to a depth of 20 feet of the shoring.

The total horizontal deflection inward (towards the excavation) of the shoring system should generally be less than ½ inch. Tetra Tech and Verdantas should be informed if the deflection exceeds ½ inch and excavation adjacent to the shoring should be halted immediately if the deflection exceeds one inch. The shoring design at that location should then be reevaluated by the shoring designer, Tetra Tech and Verdantas. Any movement more than one inch will require remedial shoring at the location of excessive deflection, to prevent additional movement prior to further construction in that area.

5.4 Additional Geotechnical Services

The geotechnical recommendations presented in this report are based on subsurface conditions as interpreted from limited available data. Verdantas should review the grading and foundation plans, when available, to comment on the geotechnical aspects. Our recommendations should be revised, as necessary, based on future plans and incorporated into the final design plans and specifications.

Geotechnical observation and testing should be provided during the following activities:

- Upon completion of site clearing, where applicable;
- During overexcavation and recompaction;
- Grading and excavation of the pipeline;
- Compaction of all fill materials;
- During installation of temporary shoring, wherever needed;
- Utility trench backfilling and compaction;
- After foundation excavations and prior to placement of concrete;
- Pavement subgrade and base preparation;
- Placement of asphalt concrete; and
- When any unusual conditions are encountered.

Verdantas should be retained to provide testing and observation services during construction to provide continuity of the geotechnical interpretation and to verify that the recommendations presented in this report are incorporated during site grading, foundation excavation, and construction of the proposed improvements. If another geotechnical firm is selected to perform the testing and observation services during construction operations, that firm should prepare a written acknowledgement of their concurrence with the recommendations presented in this report or provide revised recommendations concerning the geotechnical aspects of the proposed project. They should also perform additional analyses deemed necessary to assume the role of Geotechnical Engineer of Record.

6.0 Limitations

This report was based solely on data obtained from a limited number of geotechnical exploration, and soil samples and tests. Such information is, by necessity, incomplete. The nature of many sites is such that differing soil or geologic conditions can be present within small distances and under varying climatic conditions. Changes in subsurface conditions can and do occur over time. Therefore, the findings, conclusions, and recommendations presented in this report are only valid if Verdantas has the opportunity to observe subsurface conditions during grading and construction, to confirm that our preliminary data are representative for the site. Verdantas should also review the construction plans and project specifications, when available, to comment on the geotechnical aspects.

It should be noted that the recommendations in this report are subject to the limitations presented in this section. An information sheet prepared by GBC (Geotechnical Business Council) is also included at the rear of the text. We recommend that all individuals using this report read the limitations along with the attached information sheet.

Our professional services were performed in accordance with the prevailing standard of professional care as practiced by other geotechnical engineers in the area. The findings, conclusion, and recommendations included in this report are considered preliminary and are subject to verification. We do not make any warranty, either expressed or implied. The report may not be used by others or for other projects without the expressed written consent of our client and our firm.

7.0 References

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Important Information about This

Geotechnical-Engineering Report

Subsurface problems are a principal cause of construction delays, cost overruns, claims, and disputes.

While you cannot eliminate all such risks, you can manage them. The following information is provided to help.

The Geoprofessional Business Association (GBA) has prepared this advisory to help you – assumedly a client representative – interpret and apply this geotechnical-engineering report as effectively as possible. In that way, you can benefit from a lowered exposure to problems associated with subsurface conditions at project sites and development of them that, for decades, have been a principal cause of construction delays, cost overruns, claims, and disputes. If you have questions or want more information about any of the issues discussed herein, contact your GBA-member geotechnical engineer. Active engagement in GBA exposes geotechnical engineers to a wide array of risk-confrontation techniques that can be of genuine benefit for everyone involved with a construction project.

Understand the Geotechnical-Engineering Services Provided for this Report

Geotechnical-engineering services typically include the planning, collection, interpretation, and analysis of exploratory data from widely spaced borings and/or test pits. Field data are combined with results from laboratory tests of soil and rock samples obtained from field exploration (if applicable), observations made during site reconnaissance, and historical information to form one or more models of the expected subsurface conditions beneath the site. Local geology and alterations of the site surface and subsurface by previous and proposed construction are also important considerations. Geotechnical engineers apply their engineering training, experience, and judgment to adapt the requirements of the prospective project to the subsurface model(s). Estimates are made of the subsurface conditions that will likely be exposed during construction as well as the expected performance of foundations and other structures being planned and/or affected by construction activities.

The culmination of these geotechnical-engineering services is typically a geotechnical-engineering report providing the data obtained, a discussion of the subsurface model(s), the engineering and geologic engineering assessments and analyses made, and the recommendations developed to satisfy the given requirements of the project. These reports may be titled investigations, explorations, studies, assessments, or evaluations. Regardless of the title used, the geotechnical-engineering report is an engineering interpretation of the subsurface conditions within the context of the project and does not represent a close examination, systematic inquiry, or thorough investigation of all site and subsurface conditions.

Geotechnical-Engineering Services are Performed for Specific Purposes, Persons, and Projects, and At Specific Times

Geotechnical engineers structure their services to meet the specific needs, goals, and risk management preferences of their clients. A geotechnical-engineering study conducted for a given civil engineer will not likely meet the needs of a civil-works constructor or even a different civil engineer. Because each geotechnical-engineering study is unique, each geotechnical-engineering report is unique, prepared *solely* for the client.

Likewise, geotechnical-engineering services are performed for a specific project and purpose. For example, it is unlikely that a geotechnical-engineering study for a refrigerated warehouse will be the same as one prepared for a parking garage; and a few borings drilled during a preliminary study to evaluate site feasibility will not be adequate to develop geotechnical design recommendations for the project.

Do not rely on this report if your geotechnical engineer prepared it:

- for a different client;
- for a different project or purpose;
- for a different site (that may or may not include all or a portion of the original site); or
- before important events occurred at the site or adjacent to it; e.g., man-made events like construction or environmental remediation, or natural events like floods, droughts, earthquakes, or groundwater fluctuations.

Note, too, the reliability of a geotechnical-engineering report can be affected by the passage of time, because of factors like changed subsurface conditions; new or modified codes, standards, or regulations; or new techniques or tools. *If you are the least bit uncertain* about the continued reliability of this report, contact your geotechnical engineer before applying the recommendations in it. A minor amount of additional testing or analysis after the passage of time – if any is required at all – could prevent major problems.

Read this Report in Full

Costly problems have occurred because those relying on a geotechnical-engineering report did not read the report in its entirety. Do not rely on an executive summary. Do not read selective elements only. *Read and refer to the report in full.*

You Need to Inform Your Geotechnical Engineer About Change

Your geotechnical engineer considered unique, project-specific factors when developing the scope of study behind this report and developing the confirmation-dependent recommendations the report conveys. Typical changes that could erode the reliability of this report include those that affect:

- the site's size or shape;
- the elevation, configuration, location, orientation, function or weight of the proposed structure and the desired performance criteria;
- the composition of the design team; or
- project ownership.

As a general rule, *always* inform your geotechnical engineer of project or site changes – even minor ones – and request an assessment of their impact. *The geotechnical engineer who prepared this report cannot accept*

responsibility or liability for problems that arise because the geotechnical engineer was not informed about developments the engineer otherwise would have considered.

Most of the "Findings" Related in This Report Are Professional Opinions

Before construction begins, geotechnical engineers explore a site's subsurface using various sampling and testing procedures. *Geotechnical engineers can observe actual subsurface conditions only at those specific locations where sampling and testing is performed.* The data derived from that sampling and testing were reviewed by your geotechnical engineer, who then applied professional judgement to form opinions about subsurface conditions throughout the site. Actual sitewide-subsurface conditions may differ – maybe significantly – from those indicated in this report. Confront that risk by retaining your geotechnical engineer to serve on the design team through project completion to obtain informed guidance quickly, whenever needed.

This Report's Recommendations Are Confirmation-Dependent

The recommendations included in this report – including any options or alternatives – are confirmation-dependent. In other words, they are not final, because the geotechnical engineer who developed them relied heavily on judgement and opinion to do so. Your geotechnical engineer can finalize the recommendations *only after observing actual subsurface conditions* exposed during construction. If through observation your geotechnical engineer confirms that the conditions assumed to exist actually do exist, the recommendations can be relied upon, assuming no other changes have occurred. *The geotechnical engineer who prepared this report cannot assume responsibility or liability for confirmation-dependent recommendations if you fail to retain that engineer to perform construction observation.*

This Report Could Be Misinterpreted

Other design professionals' misinterpretation of geotechnical-engineering reports has resulted in costly problems. Confront that risk by having your geotechnical engineer serve as a continuing member of the design team, to:

- confer with other design-team members;
- help develop specifications;
- review pertinent elements of other design professionals' plans and specifications; and
- be available whenever geotechnical-engineering guidance is needed.

You should also confront the risk of constructors misinterpreting this report. Do so by retaining your geotechnical engineer to participate in prebid and preconstruction conferences and to perform construction-phase observations.

Give Constructors a Complete Report and Guidance

Some owners and design professionals mistakenly believe they can shift unanticipated-subsurface-conditions liability to constructors by limiting the information they provide for bid preparation. To help prevent the costly, contentious problems this practice has caused, include the complete geotechnical-engineering report, along with any attachments or appendices, with your contract documents, *but be certain to note conspicuously that you've included the material for information purposes only.* To avoid misunderstanding, you may also want to note that "informational purposes" means constructors have no right to rely on the interpretations, opinions, conclusions, or recommendations in the report. Be certain that constructors know they may learn about specific project requirements, including options selected from the report, *only* from the design drawings and specifications. Remind constructors that they may perform their own studies if they want to, and *be sure to allow enough time* to permit them to do so. Only then might you be in a position to give constructors the information available to you, while requiring them to at least share some of the financial responsibilities stemming from unanticipated conditions. Conducting prebid and preconstruction conferences can also be valuable in this respect.

Read Responsibility Provisions Closely

Some client representatives, design professionals, and constructors do not realize that geotechnical engineering is far less exact than other engineering disciplines. This happens in part because soil and rock on project sites are typically heterogeneous and not manufactured materials with well-defined engineering properties like steel and concrete. That lack of understanding has nurtured unrealistic expectations that have resulted in disappointments, delays, cost overruns, claims, and disputes. To confront that risk, geotechnical engineers commonly include explanatory provisions in their reports. Sometimes labeled "limitations," many of these provisions indicate where geotechnical engineers' responsibilities begin and end, to help others recognize their own responsibilities and risks. *Read these provisions closely.* Ask questions. Your geotechnical engineer should respond fully and frankly.

Geoenvironmental Concerns Are Not Covered

The personnel, equipment, and techniques used to perform an environmental study – e.g., a "phase-one" or "phase-two" environmental site assessment – differ significantly from those used to perform a geotechnical-engineering study. For that reason, a geotechnical-engineering report does not usually provide environmental findings, conclusions, or recommendations; e.g., about the likelihood of encountering underground storage tanks or regulated contaminants. *Unanticipated subsurface environmental problems have led to project failures.* If you have not obtained your own environmental information about the project site, ask your geotechnical consultant for a recommendation on how to find environmental risk-management guidance.

Obtain Professional Assistance to Deal with Moisture Infiltration and Mold

While your geotechnical engineer may have addressed groundwater, water infiltration, or similar issues in this report, the engineer's services were not designed, conducted, or intended to prevent migration of moisture – including water vapor – from the soil through building slabs and walls and into the building interior, where it can cause mold growth and material-performance deficiencies. Accordingly, ***proper implementation of the geotechnical engineer's recommendations will not of itself be sufficient to prevent moisture infiltration. Confront the risk of moisture infiltration*** by including building-envelope or mold specialists on the design team. ***Geotechnical engineers are not building-envelope or mold specialists.***

GEOPROFESSIONAL BUSINESS ASSOCIATION

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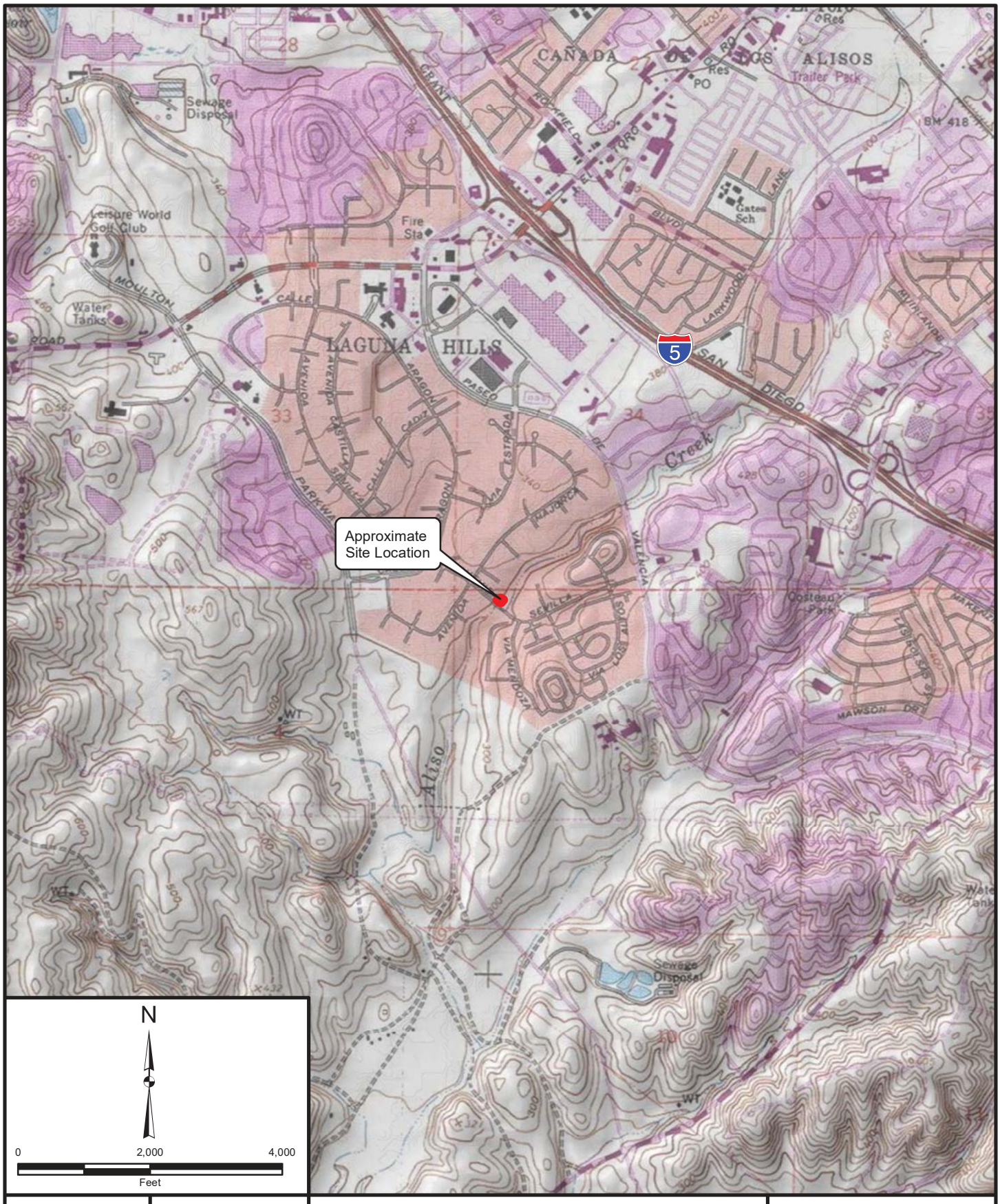


Project: 23477	Eng/Geol: DJC
Scale: 1 " = 2,000 '	Date: August 2024

Reference: Copyright:© 2013 National Geographic Society, i-cubed

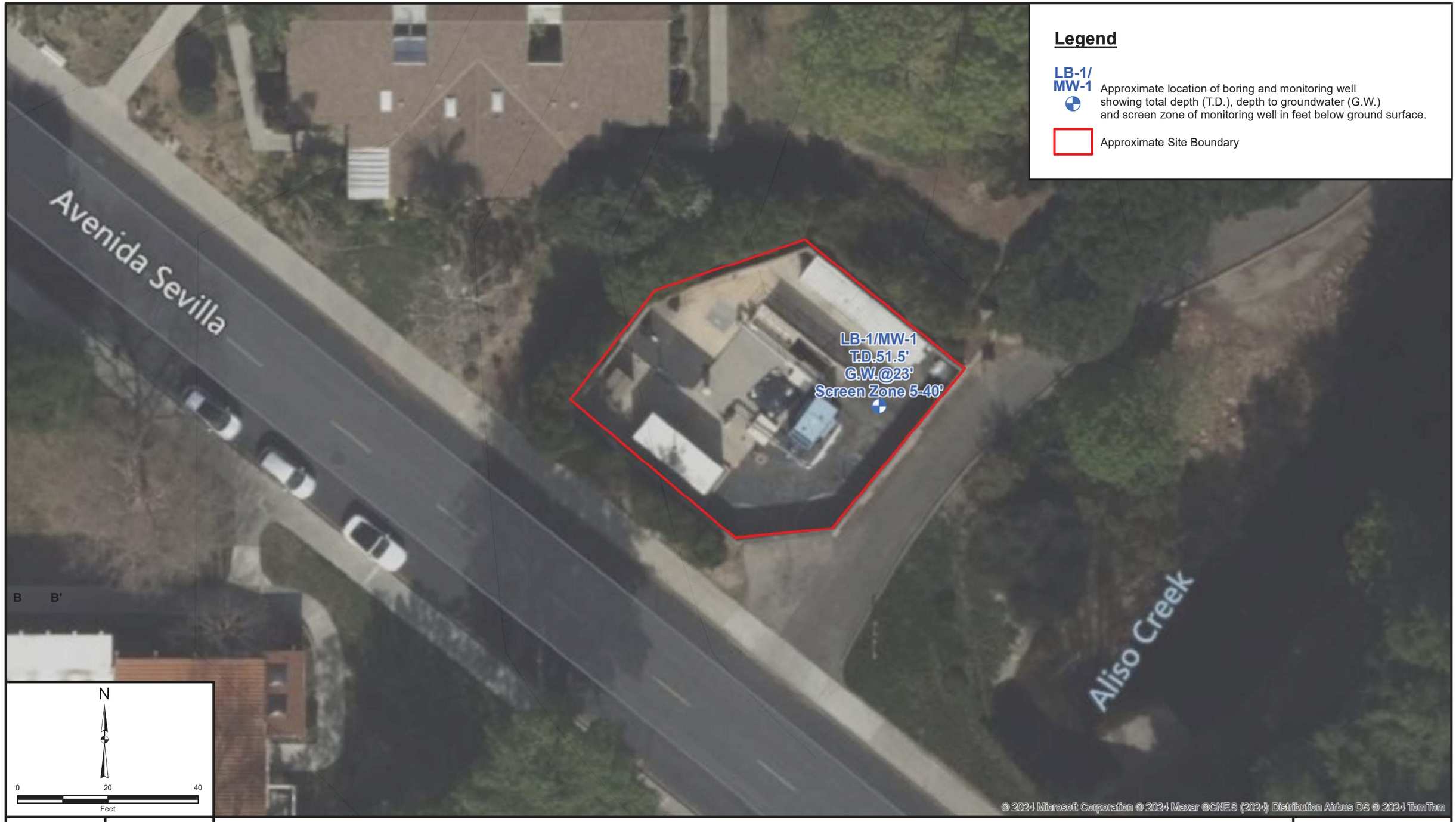
SITE LOCATION MAP

ETWD Aliso Creek Lift Station Improvements
24091 Avenida Sevilla
City of Laguna Woods, California

FIGURE 1

verdantas

Map Saved as Z:\Project Files\SA-TZ\TetraTech\23477 - ETWD Aliso Creek LS\GIS\Maps\23477_F01_SLM_2024-08-26.mxd on 8/26/2024 9:05:05 AM Author: KVM (btran)



Legend

LB-1/ MW-1 Approximate location of boring and monitoring well showing total depth (T.D.), depth to groundwater (G.W.) and screen zone of monitoring well in feet below ground surface.

Approximate Site Boundary

N

0 20 40

Feet

Project: 23477	Eng/Geol: DJC
Scale: 1 " = 20 '	Date: September 2024

Base Map: As Shown

Author: (btran)

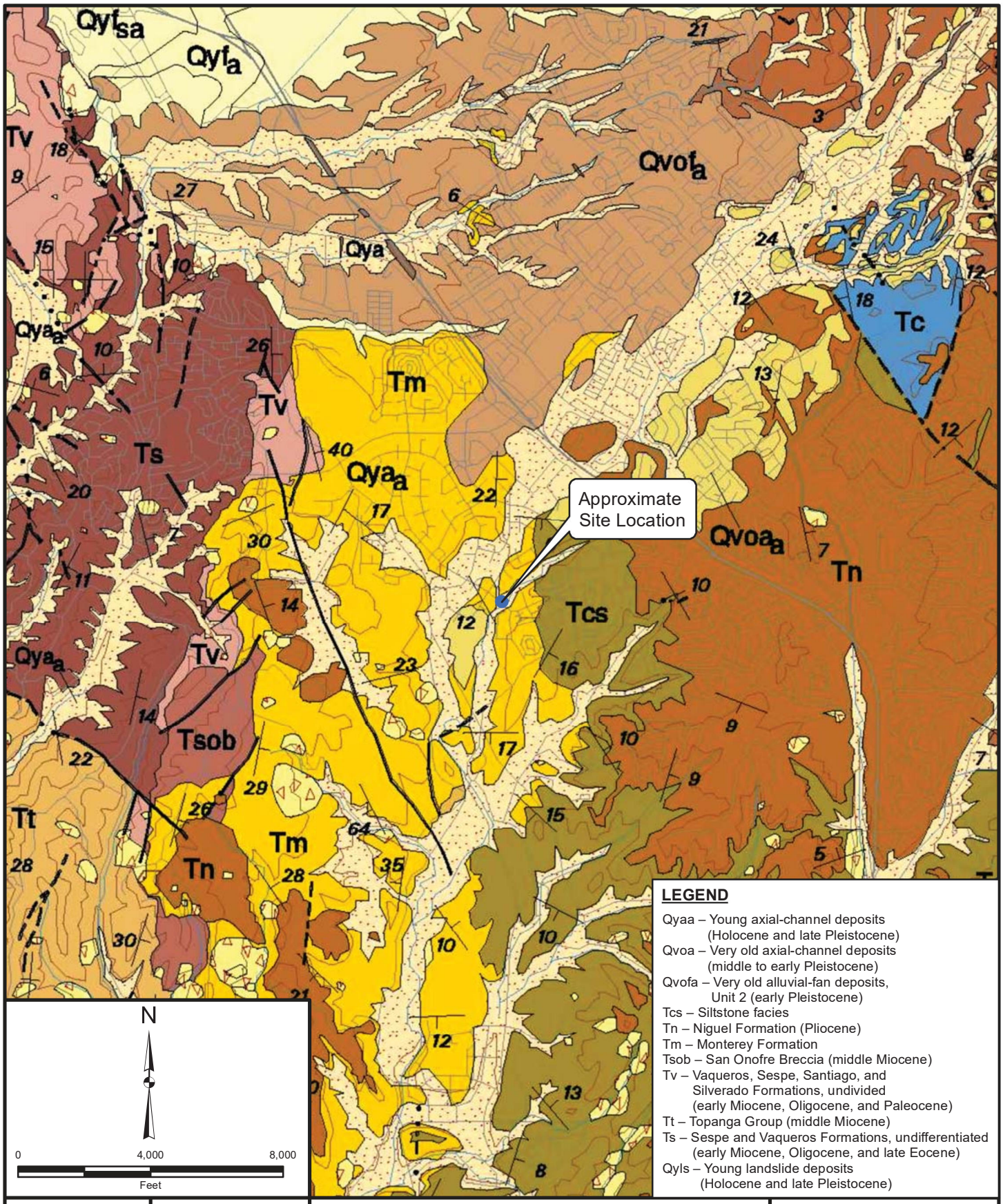
BORING LOCATION MAP

ETWD Aliso Creek Lift Station Improvements
24091 Avenida Sevilla
City of Laguna Woods, California

FIGURE 2

verdantas

Map Saved as Z:\Project Files\SA-TZ\TetraTech\23477 - ETWD Aliso Creek LS\GIS\Maps\23477_F02_BLM_2024-09-19.mxd on 9/18/2024 4:06:03 PM



LEGEND

Qyaa – Young axial-channel deposits (Holocene and late Pleistocene)
Qvoa – Very old axial-channel deposits (middle to early Pleistocene)
Qvofa – Very old alluvial-fan deposits, Unit 2 (early Pleistocene)
Tcs – Siltstone facies
Tn – Niguel Formation (Pliocene)
Tm – Monterey Formation
Tsob – San Onofre Breccia (middle Miocene)
Tv – Vaqueros, Sespe, Santiago, and Silverado Formations, undivided (early Miocene, Oligocene, and Paleocene)
Tt – Topanga Group (middle Miocene)
Ts – Sespe and Vaqueros Formations, undifferentiated (early Miocene, Oligocene, and late Eocene)
Qyls – Young landslide deposits (Holocene and late Pleistocene)

Project: 23477	Eng/Geol: DJC
Scale: 1 " = 4,000 '	Date: September 2024

Reference: Geologic Map of The San Bernardino and Santa Ana Quadrangles, California by Douglas Morton and Fred Miller, 2006

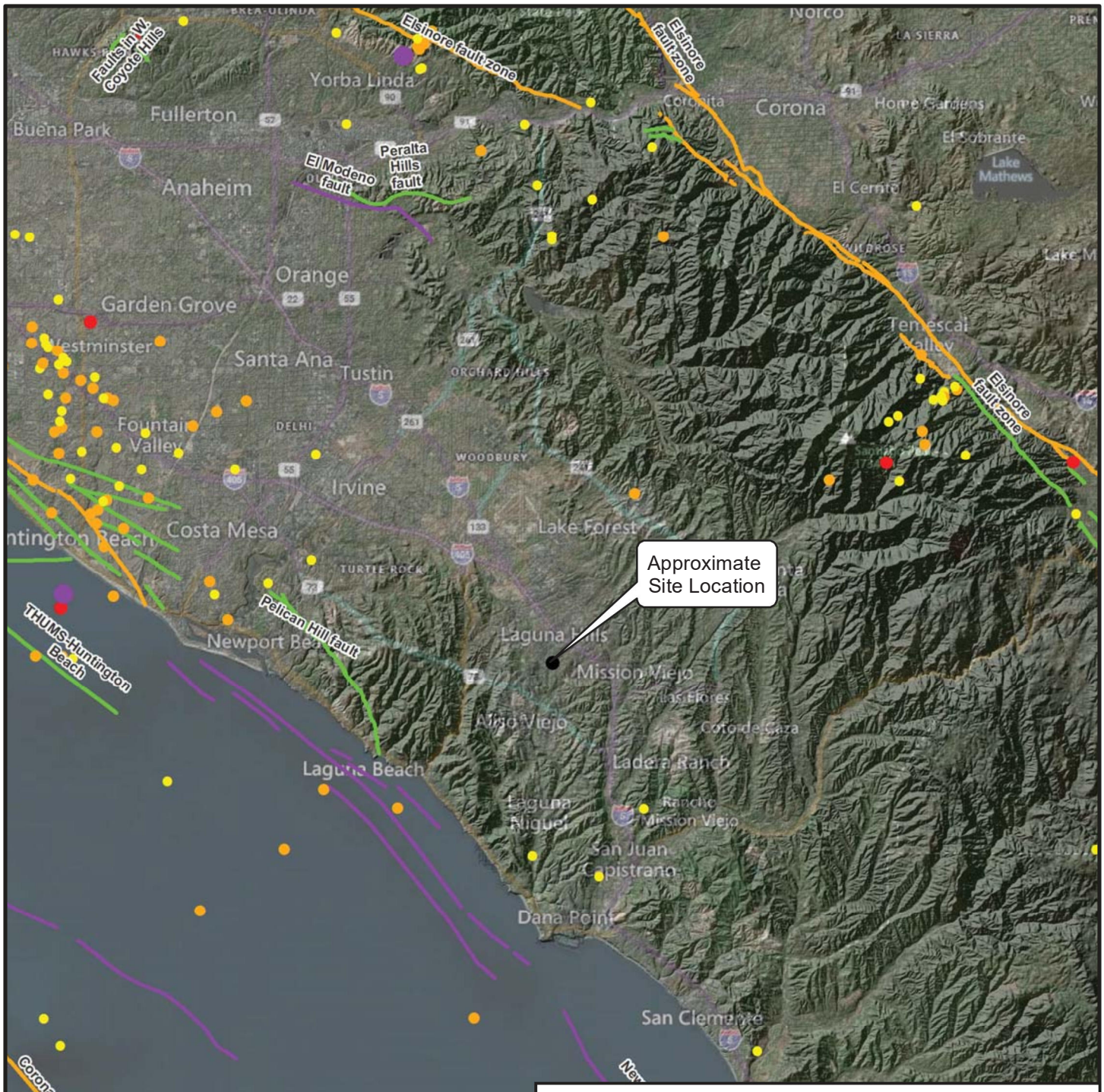
REGIONAL GEOLOGY MAP

ETWD Aliso Creek Lift Station Improvements
24091 Avenida Sevilla
City of Laguna Woods, California

FIGURE 3

verdantas

Map Saved as Z:\Project Files\SA-TZ\TetraTech\23477 - ETWD Aliso Creek LS\GIS\Maps\23477_F03_RGM_2024-09-19.mxd on 9/18/2024 4:18:38 PM Author: KVM (btran)



N

0 5 10

Miles

LEGEND

Fault activity

Recency of Movement

- Historic (<200 years)
- Holocene (<11,700 years)
- Late Quaternary (last 700,000 years)
- Quaternary (<1.6M years)

Historical Earthquakes (≥M3.5)

- 3.5 - 3.99
- 4.0 - 4.99
- 5.0 - 5.99
- 6.0 - 6.99

Project: 23477	Eng/Geol: DJC
Scale: 1 " = 5 miles	Date: August 2024

Basemap Reference: © 2024 Microsoft Corporation Earthstar Geographics SIO © 2024 TomTom
Seismicity Data Reference: maps.conservation.ca.gov

REGIONAL FAULT AND HISTORIC SEISMICITY MAP

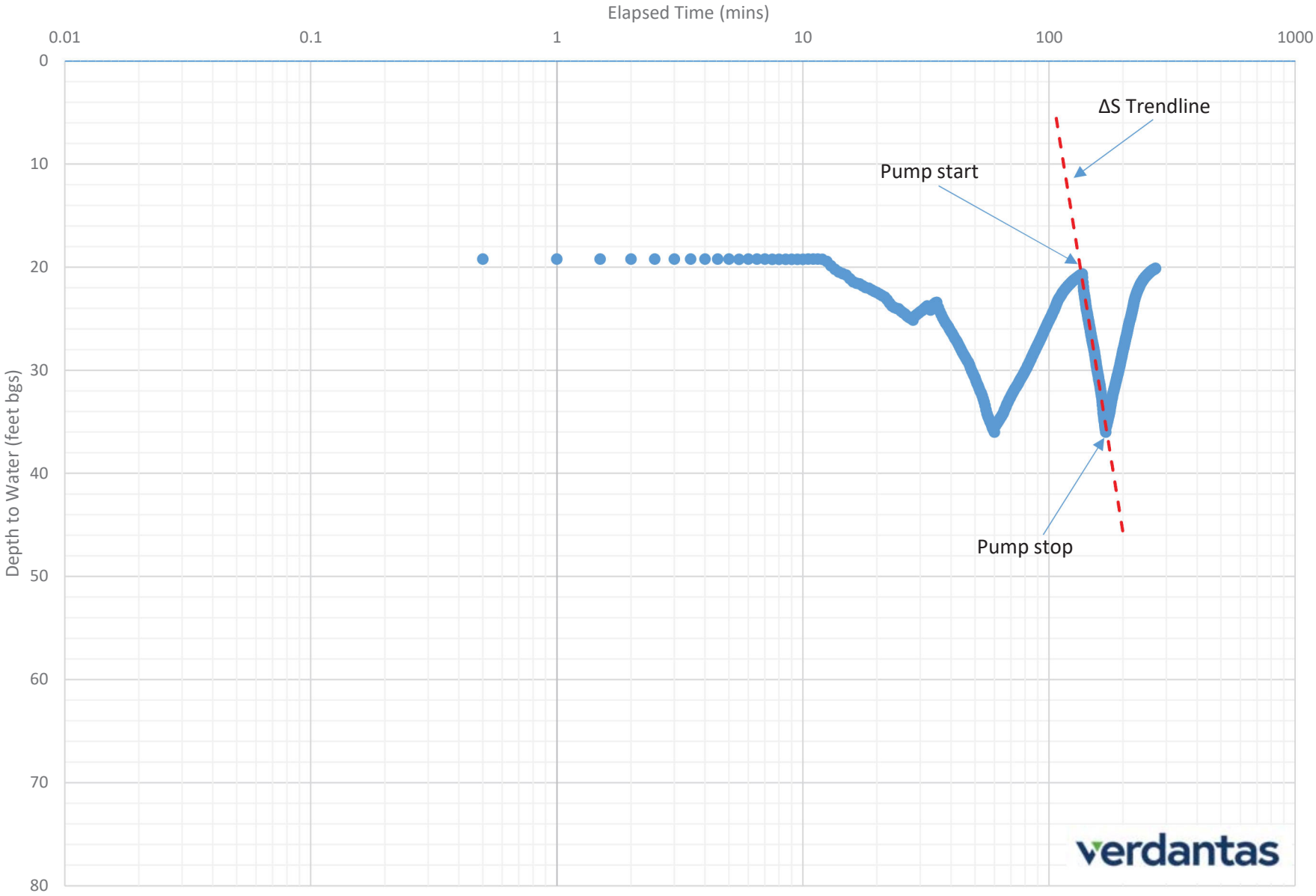
ETWD Aliso Creek Lift Station Improvements
24091 Avenida Sevilla
City of Laguna Woods, California

FIGURE 4

verdantas

Map Saved as Z:\Project Files\SA-TZ\TetraTech\23477 - ETWD Aliso Creek LS\GIS\Maps\23477_F04_RFHSM_2024-08-26.mxd on 8/26/2024 9:08:03 AM Author: KVM (btran)

Figure 5: Drawdown During Pumping Test (Average Flow Rate of 1.03 gpm)



Appendix A

Boring Log

GEOTECHNICAL BORING LOG LB-1

Project No.	23477	**Date Drilled**	8-12-24
Project	ETWD Aliso Creek Lift Station	**Logged By**	LRM
Drilling Co.	MR Drilling Inc.	**Hole Diameter**	8"
Drilling Method	Hollow Stem Auger - 140lb - Down Hole - 30" Drop	**Ground Elevation**	305'
Location	See *Figure 2 - Boring Location Map*	**Sampled By**	LRM

Elevation Feet	Depth Feet	Graphic Log (N / S)	Attitudes	Sample No.	Bulk / Driven	Blows Per 6 Inches	Dry Density pcf	Moisture Content, %	Soil Class. (U.S.C.S.)	SOIL DESCRIPTION	Type of Tests
										This Soil Description applies only to a location of the exploration at the time of sampling. Subsurface conditions may differ at other locations and may change with time. The description is a simplification of the actual conditions encountered. Transitions between soil types may be gradual.	
305	0									@0': 2" of Asphalt over 5" Base.	
				B-1					CL-ML	**Artificial Fill (Afu)** @0.5': Silty CLAY, olive brown, moist, low plasticity, some iron oxide specks, trace rootlets, trace medium gravel.	
									CL	@3.5': Lean CLAY, dark brown, low to medium pasticity, iron oxidation spotting.	
300	5			R-1		7 11 24	101	22		@4.5': Lean CLAY, mottled olive gray and orange, moist, low to medium plasticity. @5' Lean CLAY, hard, olive, moist, low to medium plasticity, with construction debris.	DS, CR
295	10			R-2		5 13 19	97	25	CL	**Quaternary-aged Young Axial-Channel Deposits (Qya)** @10': Lean CLAY, very stiff, olive brown, moist, low to medium plasticity, trace iron oxidation spotting. @12': very moist to wet cuttings.	
290	15			S-3		7 7 10		39	MH	@15': Elastic SILT, very stiff, motttled olive brown and light gray, moist, medium to high plasticity.	AL
285	20			R-4		7 7 12	79	37		@20': mottled olive brown and orange, very moist	
280	25			S-5		5 6 11		57	CH	@25': Fat CLAY, very stiff, light olive brown, very moist, high plasticity, trace shells and claystone fragments	AL
275	30										

SAMPLE TYPES:

B	BULK SAMPLE
C	CORE SAMPLE
G	GRAB SAMPLE
R	RING SAMPLE
S	SPLIT SPOON SAMPLE
T	TUBE SAMPLE

TYPE OF TESTS:

-200	% FINES PASSING	DS	DIRECT SHEAR	SA	SIEVE ANALYSIS
AL	ATTERBERG LIMITS	EI	EXPANSION INDEX	SE	SAND EQUIVALENT
CN	CONSOLIDATION	H	HYDROMETER	SG	SPECIFIC GRAVITY
CO	COLLAPSE	MD	MAXIMUM DENSITY	UC	UNCONFINED COMPRESSIVE STRENGTH
CR	CORROSION	PP	POCKET PENETROMETER		
CU	UNDRAINED TRIAXIAL	RV	R VALUE		

Leighton

GEOTECHNICAL BORING LOG LB-1

Project No.	23477	**Date Drilled**	8-12-24
Project	ETWD Aliso Creek Lift Station	**Logged By**	LRM
Drilling Co.	MR Drilling Inc.	**Hole Diameter**	8"
Drilling Method	Hollow Stem Auger - 140lb - Down Hole - 30" Drop	**Ground Elevation**	305'
Location	See *Figure 2 - Boring Location Map*	**Sampled By**	LRM

Elevation Feet	Depth Feet	Graphic Log (N / S)	Attitudes	Sample No.	Bulk / Driven	Blows Per 6 Inches	Dry Density pcf	Moisture Content, %	Soil Class. (U.S.C.S.)	SOIL DESCRIPTION	Type of Tests
275	30			R-6		5 8 10	57	68	CH	@30': Fat CLAY, very stiff, olive gray, saturated, medium to high plasticity, blocky structure, trace shells, some silt.	
270	35			S-7		7 10 10		63	CH	**Miocene Monterey Formation (Tm)** @35': CLAYSTONE, medium stiff, olive brown, moist, medium to high plasticity, thinly bedded, trace shells, trace iron oxide specks, wet sampler.	AL
265	40			S-8		9 12 15				@40':CLAYSTONE, medium stiff, dark brown, moist, medium to high plasticity, wet sampler.	
260	45			S-9		8 12 15					
255	50			S-10		10 13 17				@40':CLAYSTONE, medium stiff, dark brown, moist, medium to high plasticity	
250	55									**TOTAL DEPTH = 51.5'** **GROUNDWATER ENCOUNTERED AT 23' DURING DRILLING** **COVERTED TO A MONITORING WELL** **4-INCH DIAMETER SCHEDULE 40 PVC** **0.02-INCH SLOTTED SCREEN FROM 5 TO 40'** **GROUNDWATER STABILIZED AT 19' ON 9-3-2024**	
245	60										

This Soil Description applies only to a location of the exploration at the time of sampling. Subsurface conditions may differ at other locations and may change with time. The description is a simplification of the actual conditions encountered. Transitions between soil types may be gradual.

SAMPLE TYPES:

- B BULK SAMPLE
- C CORE SAMPLE
- G GRAB SAMPLE
- R RING SAMPLE
- S SPLIT SPOON SAMPLE
- T TUBE SAMPLE

TYPE OF TESTS:

- -200 % FINES PASSING
- AL ATTERBERG LIMITS
- CN CONSOLIDATION
- CO COLLAPSE
- CR CORROSION
- CU UNDRAINED TRIAXIAL
- DS DIRECT SHEAR
- EI EXPANSION INDEX
- H HYDROMETER
- MD MAXIMUM DENSITY
- PP POCKET PENETROMETER
- RV R VALUE
- SA SIEVE ANALYSIS
- SE SAND EQUIVALENT
- SG SPECIFIC GRAVITY
- UC UNCONFINED COMPRESSIVE STRENGTH

Leighton

Appendix B

Laboratory Test Results

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ATTERBERG LIMITS
ASTM D 4318

Project Name:	ETWD Aliso Creek Lift Station	Tested By:	J. Domingo	Date:	08/15/24
Project No. :	036.0000023477	Input By:	G. Bathala	Date:	08/20/24
Boring No.:	LB-1	Checked By:	A. Santos		
Sample No.:	S-3	Depth (ft.)	15.0		
Soil Identification:	Olive brown elastic silt (MH)				

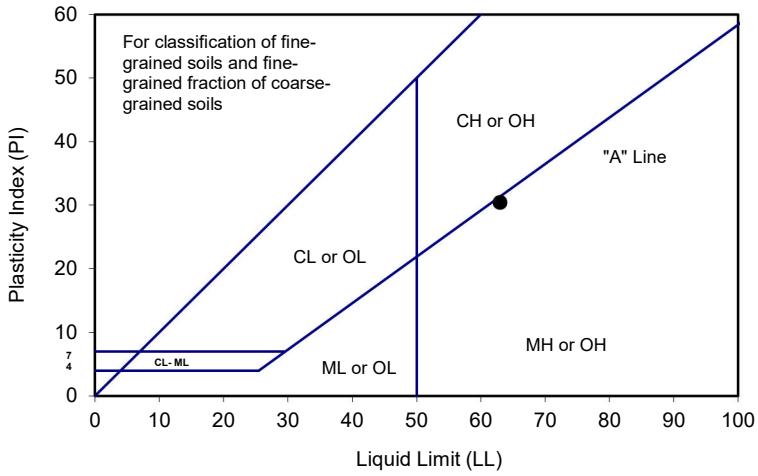
TEST	PLASTIC LIMIT		LIQUID LIMIT			
NO.	1	2	1	2	3	4
Number of Blows [N]			35	27	23	
Wet Wt. of Soil + Cont. (g)	9.48	9.53	20.48	20.10	20.61	
Dry Wt. of Soil + Cont. (g)	7.41	7.45	13.18	12.77	13.01	
Wt. of Container (g)	1.07	1.05	1.06	1.03	1.01	
Moisture Content (%) [Wn]	32.65	32.50	60.23	62.44	63.33	

Liquid Limit	**63**
Plastic Limit	**33**
Plasticity Index	**30**
Classification	**MH**

PI at "A" - Line = 0.73(LL-20) 31.39

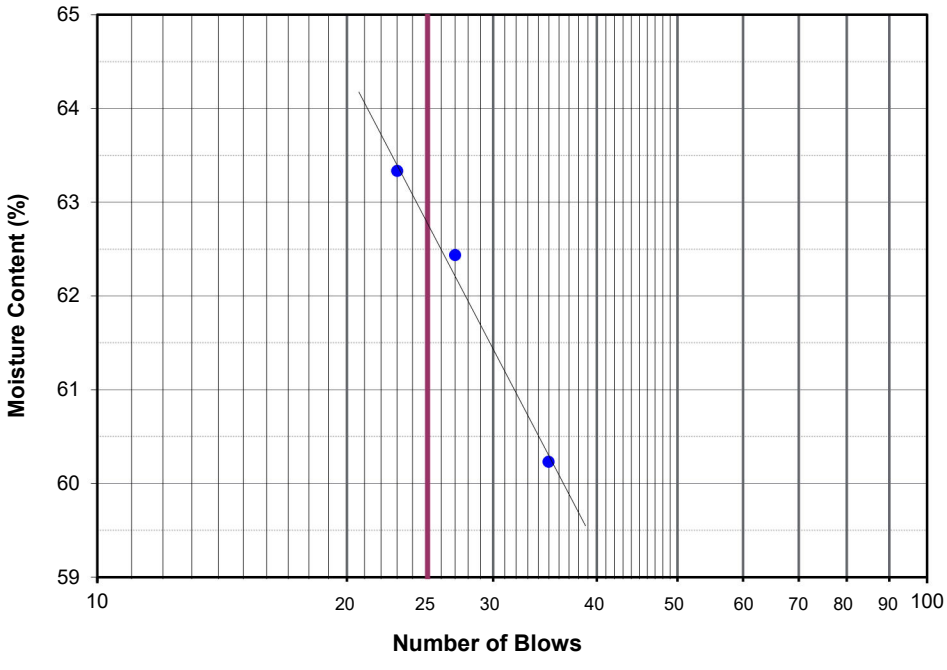
One - Point Liquid Limit Calculation

$LL = Wn(N/25)^{0.121}$



PROCEDURES USED

- [ ] Wet Preparation
  Multipoint - Wet
- [X] Dry Preparation
  Multipoint - Dry
- [X] Procedure A
  Multipoint Test
- [ ] Procedure B
  One-point Test



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ATTERBERG LIMITS
ASTM D 4318

Project Name:	ETWD Aliso Creek Lift Station	Tested By:	J. Domingo	Date:	08/15/24
Project No. :	036.0000023477	Input By:	G. Bathala	Date:	08/20/24
Boring No.:	LB-1	Checked By:	A. Santos		
Sample No.:	S-5	Depth (ft.)	25.0		
Soil Identification:	Light olive brown fat clay (CH)				

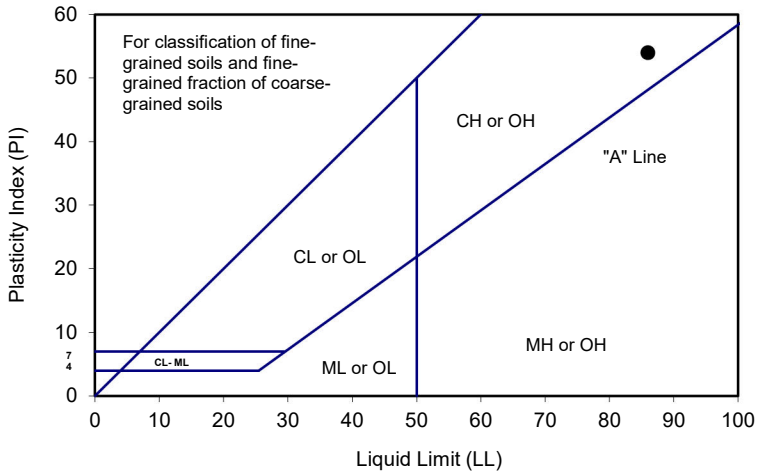
TEST	PLASTIC LIMIT		LIQUID LIMIT			
NO.	1	2	1	2	3	4
Number of Blows [N]			32	26	17	
Wet Wt. of Soil + Cont. (g)	9.13	9.21	23.34	23.67	23.04	
Dry Wt. of Soil + Cont. (g)	7.17	7.22	13.19	13.25	12.70	
Wt. of Container (g)	1.06	0.99	1.08	1.08	1.02	
Moisture Content (%) [Wn]	32.08	31.94	83.82	85.62	88.53	

Liquid Limit	**86**
Plastic Limit	**32**
Plasticity Index	**54**
Classification	**CH**

PI at "A" - Line = 0.73(LL-20) 48.18

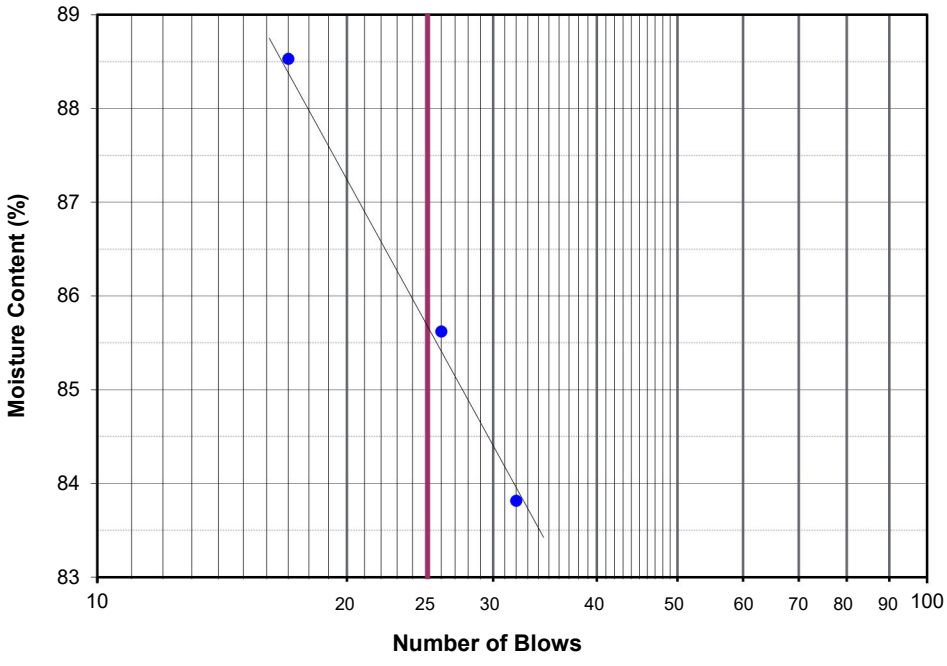
One - Point Liquid Limit Calculation

$LL = Wn(N/25)^{0.121}$



PROCEDURES USED

- [ ] Wet Preparation
  Multipoint - Wet
- [X] Dry Preparation
  Multipoint - Dry
- [X] Procedure A
  Multipoint Test
- [ ] Procedure B
  One-point Test



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ATTERBERG LIMITS
ASTM D 4318

Project Name:	ETWD Aliso Creek Lift Station	Tested By:	J. Domingo	Date:	08/16/24
Project No. :	036.0000023477	Input By:	G. Bathala	Date:	08/20/24
Boring No.:	LB-1	Checked By:	A. Santos		
Sample No.:	S-7	Depth (ft.)	35.0		
Soil Identification:	Olive brown fat clay (CH)				

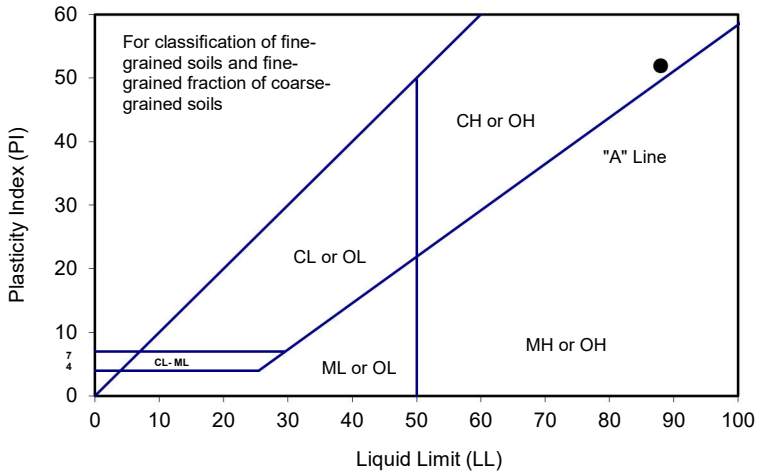
TEST	PLASTIC LIMIT		LIQUID LIMIT			
NO.	1	2	1	2	3	4
Number of Blows [N]			33	25	19	
Wet Wt. of Soil + Cont. (g)	9.25	9.17	16.75	16.04	16.32	
Dry Wt. of Soil + Cont. (g)	7.08	6.99	9.55	9.00	9.07	
Wt. of Container (g)	1.03	0.99	1.02	1.03	1.11	
Moisture Content (%) [Wn]	35.87	36.33	84.41	88.33	91.08	

Liquid Limit	**88**
Plastic Limit	**36**
Plasticity Index	**52**
Classification	**CH**

PI at "A" - Line = 0.73(LL-20) 49.64

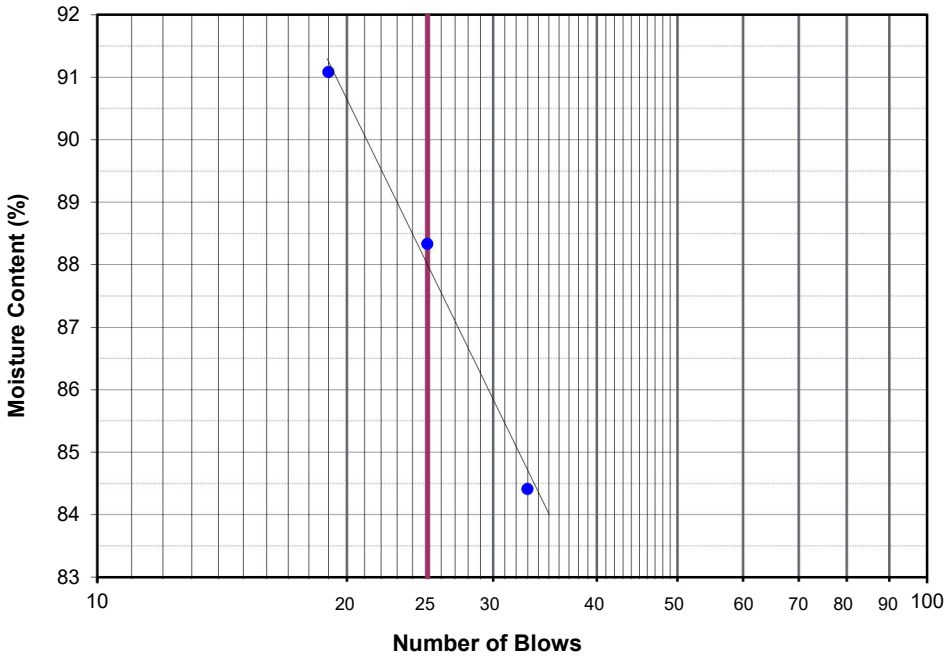
One - Point Liquid Limit Calculation

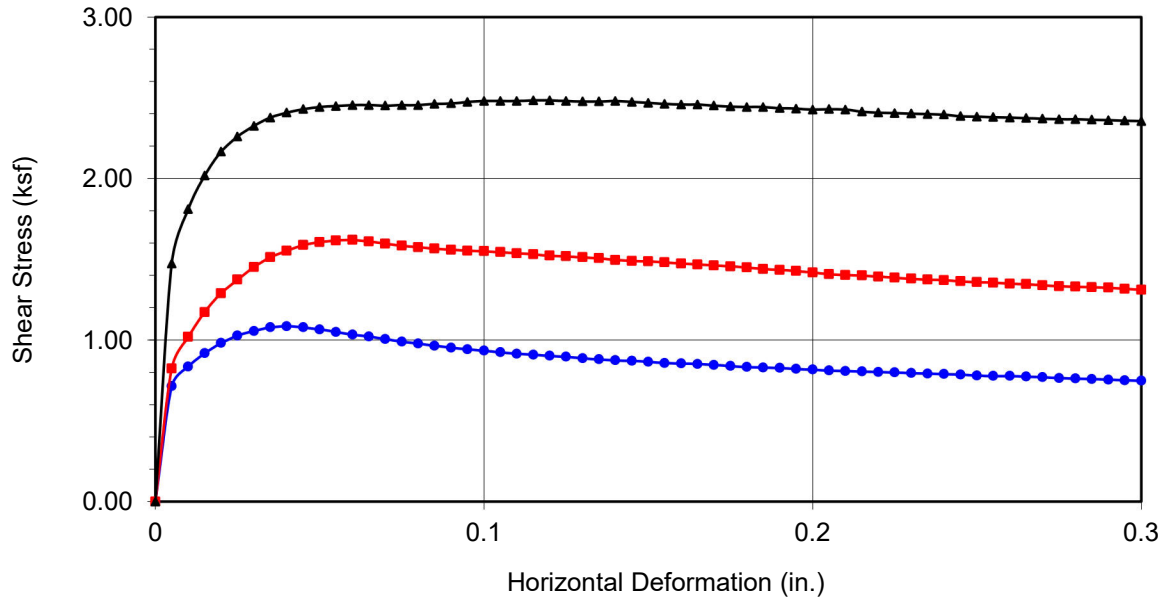
$LL = Wn(N/25)^{0.121}$

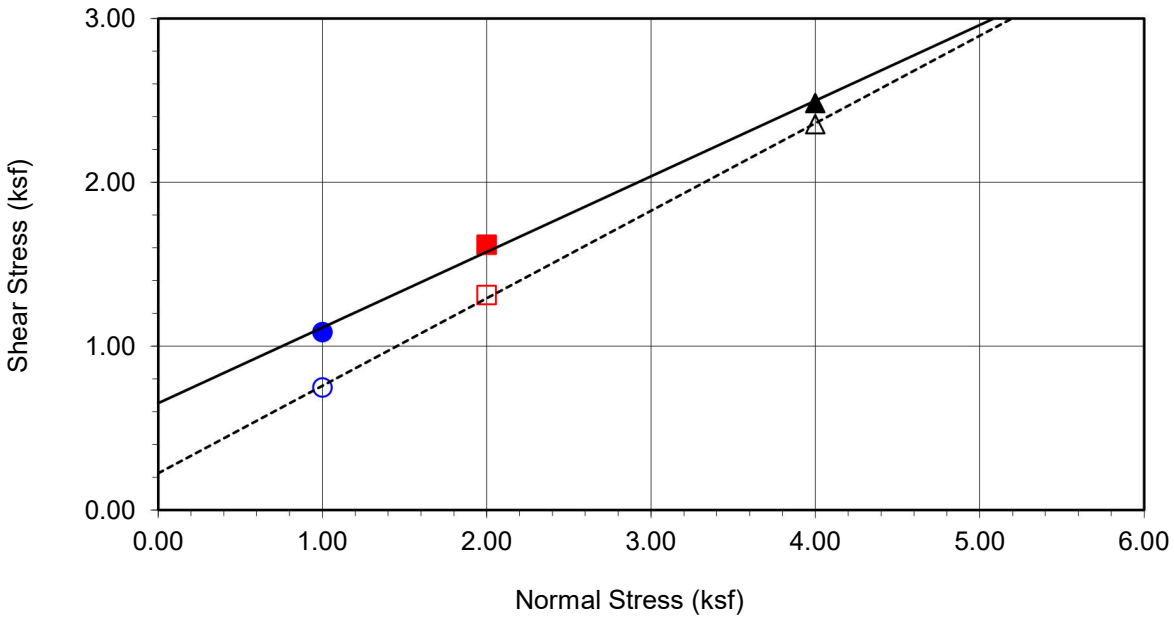


PROCEDURES USED

- [ ] Wet Preparation
  Multipoint - Wet
- [X] Dry Preparation
  Multipoint - Dry
- [X] Procedure A
  Multipoint Test
- [ ] Procedure B
  One-point Test







Boring No.	**LB-1**
Sample No.	**R-1**
Depth (ft)	**5**
Sample Type:	Ring
Soil Identification:	Olive lean clay (CL)

Strength Parameters

	C (psf)	ϕ (°)
Peak	653	25
Ultimate	226	28

Normal Stress (kip/ft²)	1.000	2.000	4.000
Peak Shear Stress (kip/ft²)	● 1.085	■ 1.619	▲ 2.484
Shear Stress @ End of Test (ksf)	○ 0.748	□ 1.311	△ 2.355
Deformation Rate (in./min.)	0.0017	0.0017	0.0017
Initial Sample Height (in.)	1.000	1.000	1.000
Diameter (in.)	2.415	2.415	2.415
Initial Moisture Content (%)	21.51	21.51	21.51
Dry Density (pcf)	99.0	102.1	102.8
Saturation (%)	82.6	89.2	90.7
Soil Height Before Shearing (in.)	N/A	0.9853	0.9919
Final Moisture Content (%)	30.5	26.7	20.9

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DIRECT SHEAR TEST RESULTS

Consolidated Drained - ASTM D 3080

Project No.: 036.0000023477

ETWD Aliso Creek Lift Station

08-24

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TESTS for SULFATE CONTENT
CHLORIDE CONTENT and pH of SOILS

Project Name: ETWD Aliso Creek Lift Station | Tested By : G. Berdy | Date: 08/20/24

Project No. : 036.0000023477 | Checked By: A. Santos | Date: 08/23/24

Boring No.	LB-1			
Sample No.	R-1			
Sample Depth (ft)	5.0			
Soil Identification:	Olive (CL)			
Wet Weight of Soil + Container (g)	0.00			
Dry Weight of Soil + Container (g)	0.00			
Weight of Container (g)	1.00			
Moisture Content (%)	0.00			
Weight of Soaked Soil (g)	100.12			

SULFATE CONTENT, DOT California Test 417, Part II

Beaker No.	9			
Crucible No.	305			
Furnace Temperature (°C)	860			
Time In / Time Out	6:00/6:45			
Duration of Combustion (min)	45			
Wt. of Crucible + Residue (g)	60.8782			
Wt. of Crucible (g)	60.8745			
Wt. of Residue (g) (A)	0.0037			
PPM of Sulfate (A) x 41150	152.26			
PPM of Sulfate, Dry Weight Basis	**152**			

CHLORIDE CONTENT, DOT California Test 422

ml of Extract For Titration (B)	15			
ml of AgNO3 Soln. Used in Titration (C)	0.5			
PPM of Chloride (C -0.2) * 100 * 30 / B	60			
PPM of Chloride, Dry Wt. Basis	**60**			

pH TEST, DOT California Test 643

pH Value	**8.30**			
Temperature °C	23.0			

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SOIL RESISTIVITY TEST

DOT CA TEST 643

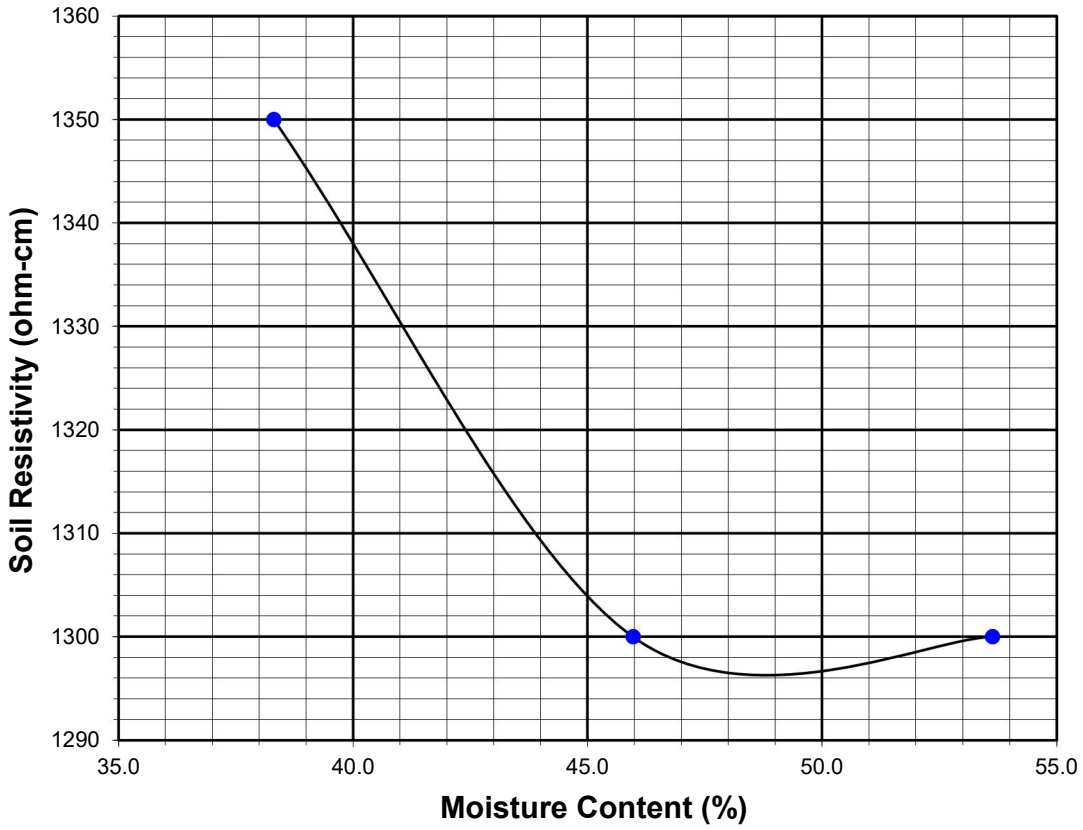
Project Name:	ETWD Aliso Creek Lift Station		Tested By :	G. Berdy	Date: 08/21/24
Project No. :	036.0000023477		Checked By:	A. Santos	Date: 08/23/24
Boring No.:	LB-1		Depth (ft.) :	5.0	
Sample No. :	R-1				
Soil Identification:*	Olive (CL)				

*California Test 643 requires soil specimens to consist only of portions of samples passing through the No. 8 US Standard Sieve before resistivity testing. Therefore, this test method may not be representative for coarser materials.

Specimen No.	Water Added (ml) (Wa)	Adjusted Moisture Content (MC)	Resistance Reading (ohm)	Soil Resistivity (ohm-cm)
1	50	38.31	1350	1350
2	60	45.97	1300	1300
3	70	53.63	1300	1300
4				
5				

Moisture Content (%) (MCi)	0.00
Wet Wt. of Soil + Cont. (g)	0.00
Dry Wt. of Soil + Cont. (g)	0.00
Wt. of Container (g)	1.00
Container No.	
Initial Soil Wt. (g) (Wt)	130.52
Box Constant	1.000
MC =(((1+Mci/100)x(Wa/Wt+1))-1)x100	

Min. Resistivity (ohm-cm)	Moisture Content (%)	Sulfate Content (ppm)	Chloride Content (ppm)	Soil pH	
				pH	Temp. (°C)
DOT CA Test 643		DOT CA Test 417 Part II	DOT CA Test 422	DOT CA Test 643	
1296	**49.0**	**152**	**60**	**8.30**	**23.0**



Appendix C

Water Quality Analytical Results

Enthalpy Analytical
931 West Barkley Ave
Orange, CA 92868
(714) 771-6900

enthalpy.com

Lab Job Number : 515240
Report Level : II
Report Date : 09/10/2024

Analytical Report *prepared for:*

Eric Holliday
Verdantas
2600 Michelson Dr
Suite 400
Irvine, CA 92612

Location: ETWD 03623477

Authorized for release by:

Patty Mata, Project Manager
patty.mata@enthalpy.com

This data package has been reviewed for technical correctness and completeness. Release of this data has been authorized by the Laboratory Manager or the Manager's designee, as verified by the above signature which applies to this PDF file as well as any associated electronic data deliverable files. The results contained in this report meet all requirements of NELAP and pertain only to those samples which were submitted for analysis. This report may be reproduced only in its entirety.

CA ELAP# 1338, NELAP# 4038, SCAQMD LAP# 18LA0518, LACSD ID# 10105

ENTHALPY ANALYTICAL

Sample Summary

Eric Holliday
Verdantas
2600 Michelson Dr
Suite 400
Irvine, CA 92612

Lab Job #:	515240
Location:	ETWD 03623477
Date Received:	09/03/24

Sample ID	Lab ID	Collected	Matrix
S-1	515240-001	09/03/24 12:51	Water

ENTHALPY ANALYTICAL

Case Narrative

Verdantas	Lab Job Number:	515240
2600 Michelson Dr		
Suite 400	Location:	ETWD
Irvine, CA 92612		03623477
Eric Holliday	Date Received:	09/03/24

This data package contains sample and QC results for one water sample, requested for the above referenced project on 09/03/24. The sample was received cold and intact.

TPH-Extractables by GC (EPA 8015B):
No analytical problems were encountered.

Volatile Organics by GC/MS (EPA 8260B):
No analytical problems were encountered.

Metals (EPA 6010B and EPA 7470A):
No analytical problems were encountered.

ENTHALPY ANALYTICAL

Detection Summary

Eric Holliday
Verdantas
2600 Michelson Dr
Suite 400
Irvine, CA 92612

Lab Job #: 515240
Location: ETWD 03623477
Date Received: 09/03/24

Sample ID: S-1 **Lab ID: 515240-001** **Collected: 09/03/24 12:51**
Matrix: Filtrate

515240-001 Analyte	Result	Qual	Units	RL
Method: EPA 6010B Prep Method: METHOD				
Barium	**0.078**		mg/L	0.010
Molybdenum	**0.063**		mg/L	0.010
Nickel	**0.023**		mg/L	0.010

Results for any subcontracted analyses are not included in this summary. Data qualifiers and additional information necessary for the interpretation of the test results are contained in the PDF file and may not be included in this summary.

ENTHALPY ANALYTICAL

Chain of Custody Record

Lab No: 515240

Page: _____ of _____

Turn Around Time (rush by advanced notice only)

Standard:		5 Day:		3 Day:	
2 Day:		1 Day:		Custom TAT:	

Enthalpy Analytical - Orange

931 W. Barkley Avenue, Orange, CA 92868

Phone 714-771-6900

Matrix: A = Air S = Soil/Solid W = Water DW = Drinking Wate SD = Sediment PP = Pure Product SEA = Sea Water SW = Swab T = Tissue WP = Wipe O = Other

Preservatives: 1 = $Na_2S_2O_3$ 2 = HCl 3 = HNO_3 4 = H_2SO_4 5 = NaOH 6 = Other

Sample Receipt Temp: 22.1 IR02 / 22.3 +0.2 (lab use only)

CUSTOMER INFORMATION		PROJECT INFORMATION	
Company:	Verdantas	Quote #:	
Report To:	Eric Holliday	Proj. Name:	ETWD
Email:	eholliday@verdantas.com	Proj. #:	0362347
Address:	2600 Michaelson Dr.	P.O. #:	
	Suite 400	Address:	
Phone:	(949) 282-3654	Global ID:	
Fax:		Sampled By:	G.Z.

	Sample ID	Sampling Date	Sampling Time	Matrix	Container No. / Size	Pres.	Title 22-CAM 6010B	TPH 8015M	8260 VOC	Test Instructions / Comments
1	S-1	9/3/24	12:51	Water	5 / VOA	N/A			✓	
2	S-1	9/3/24	12:51	Water	Amber/1	N/A		✓		
3	S-1	9/3/24	12:51	Water	Poly / 1		✓			Lab to filter and preserve
4										
5										
6										
7										
8										
9										
10										

	Signature	Print Name	Company / Title	Date / Time
[1] Relinquished By:		Gemma Zuniga	Verdantas	9/3/24 2:32 pm
[1] Received By:		JETH CO	ENTHALPY	9/3/24 14:33
[1] Relinquished By:				
[2] Received By:				
[3] Relinquished By:				
[3] Received By:				

SAMPLE RECEIPT CHECKLIST

Section 1: General Info
Date Received: 9/3/24 WO# 515240 Client: VERDANTAS

Section 2: Shipping / Custody **Are custody seals present?** ☐ Yes ☑ No
Custody seals intact on arrival? ☑ N/A ☐ Yes ☐ No ☐ On cooler / box ☐ On samples
Shipping Info: _____

Section 3a: Condition / Packaging ☑ **Outside 0.0 - 6.0°C (0.0 - 10.0°C for microbiology) (PM notified)**
Date Opened 9/3/24 By (initials) JKC Type of ice used : ☑ Wet ☐ Blue/Gel ☐ None
☑ Samples received on ice directly from the field; cooling process had begun. (if checked, skip temperatures)
☐ Sample matrix doesn't require cooling (e.g. air, bulk PCB). (if checked, skip temperatures)
If no cooler: Observed/Adjusted Temp (°C): _____ / _____ Thermometer/IR Gun: IR02 CF: +0.2
Cooler Temp (°C) #1: 22.1 / 22.3 #2: ____/____ #3: ____/____ #4: ____/____ #5: ____/____ #6: ____/____

Section 3b: Microbiology Samples ☑ **No microbiology samples submitted (skip 3b)**
☐ Within temp range 0.0 - 10.0°C or received on ice directly from field.
☐ Adequate headspace for microbiology analysis.

Section 3c: Air Samples ☑ **No air samples submitted (skip 3c)**
☐ 1.4L Canisters ☐ 6L Canisters ☐ Tedlar Bags ☐ MCE Cassettes ☐ Sorbent Tubes ☐ Other_____

Section 4: Containers / Labels / Samples	YES	NO	N/A
1) Were custody papers present, filled properly, and legible?	✓		
2) Is the sampler's name present on the CoC?	✓		
3) Were containers received in good condition (unbroken / unopened / uncompromised)?	✓		
4) Were the samples bagged? (required for microbiology samples; recommended for soil samples)			✓
5) Were all of, and only, the correct samples received?	✓		
6) Are sample labels present, legible, and in agreement with the CoC?	✓		
7) Does the container count match the CoC?	✓		
8) Was sufficient sample volume / mass received for the analyses requested?	✓		
9) Were samples received in proper containers for the analyses requested?	✓		
10) Were samples received with > 1/2 holding time remaining?	✓		
11) Are samples properly preserved as indicated by CoC / labels?	✓		
12) Unpreserved VOAs received - If necessary, was the hold time changed in LIMS?			✓
13) Are VOA vials free from headspace/bubbles > 6mm?	✓		

Section 5: Explanations / Comments ☐ **PM notified**

Date Logged 9/3/24 By (print) JETH CO (sign) JHW
Date Labeled 9/3/24 By (print) JETH CO (sign) JHW

ENTHALPY ANALYTICAL

Analysis Results for 515240

Eric Holliday
Verdantas
2600 Michelson Dr
Suite 400
Irvine, CA 92612

Lab Job #: 515240
Location: ETWD 03623477
Date Received: 09/03/24

Sample ID: S-1 **Lab ID: 515240-001** **Collected: 09/03/24 12:51**

515240-001 Analyte	Result	Qual	Units	RL	Matrix	DF	Batch	Prepared	Analyzed	Chemist
Method: EPA 6010B Prep Method: METHOD										
Antimony	ND		mg/L	0.030	Filtrate	1	349362	09/04/24	09/04/24	CAP
Arsenic	ND		mg/L	0.010	Filtrate	1	349362	09/04/24	09/04/24	CAP
Barium	**0.078**		mg/L	0.010	Filtrate	1	349362	09/04/24	09/04/24	CAP
Beryllium	ND		mg/L	0.0050	Filtrate	1	349362	09/04/24	09/04/24	CAP
Cadmium	ND		mg/L	0.0050	Filtrate	1	349362	09/04/24	09/04/24	CAP
Chromium	ND		mg/L	0.010	Filtrate	1	349362	09/04/24	09/04/24	CAP
Cobalt	ND		mg/L	0.0050	Filtrate	1	349362	09/04/24	09/04/24	CAP
Copper	ND		mg/L	0.010	Filtrate	1	349362	09/04/24	09/04/24	CAP
Lead	ND		mg/L	0.010	Filtrate	1	349362	09/04/24	09/04/24	CAP
Molybdenum	**0.063**		mg/L	0.010	Filtrate	1	349362	09/04/24	09/06/24	CAP
Nickel	**0.023**		mg/L	0.010	Filtrate	1	349362	09/04/24	09/04/24	CAP
Selenium	ND		mg/L	0.030	Filtrate	1	349362	09/04/24	09/04/24	CAP
Silver	ND		mg/L	0.0050	Filtrate	1	349362	09/04/24	09/04/24	CAP
Thallium	ND		mg/L	0.050	Filtrate	1	349362	09/04/24	09/04/24	CAP
Vanadium	ND		mg/L	0.010	Filtrate	1	349362	09/04/24	09/04/24	CAP
Zinc	ND		mg/L	0.050	Filtrate	1	349362	09/04/24	09/04/24	CAP
Method: EPA 7470A Prep Method: METHOD										
Mercury	ND		ug/L	0.40	Filtrate	1	349420	09/05/24	09/05/24	MLL
Method: EPA 8015B Prep Method: EPA 3510C										
TPH (C13-C28)	ND		mg/L	0.099	Water	0.99	349421	09/06/24	09/09/24	KMB
TPH (C29-C44)	ND		mg/L	0.30	Water	0.99	349421	09/06/24	09/09/24	KMB
Surrogates				**Limits**						
n-Triacontane	68%		%REC	35-130	Water	0.99	349421	09/06/24	09/09/24	KMB
Method: EPA 8260B Prep Method: EPA 5030B										
3-Chloropropene	ND		ug/L	5.0	Water	1	349188	09/03/24	09/03/24	HMN
Freon 12	ND		ug/L	5.0	Water	1	349188	09/03/24	09/03/24	HMN
Chloromethane	ND		ug/L	5.0	Water	1	349188	09/03/24	09/03/24	HMN
Vinyl Chloride	ND		ug/L	5.0	Water	1	349188	09/03/24	09/03/24	HMN
Bromomethane	ND		ug/L	5.0	Water	1	349188	09/03/24	09/03/24	HMN
Chloroethane	ND		ug/L	5.0	Water	1	349188	09/03/24	09/03/24	HMN
Trichlorofluoromethane	ND		ug/L	5.0	Water	1	349188	09/03/24	09/03/24	HMN
Acetone	ND		ug/L	100	Water	1	349188	09/03/24	09/03/24	HMN
Freon 113	ND		ug/L	5.0	Water	1	349188	09/03/24	09/03/24	HMN
1,1-Dichloroethene	ND		ug/L	5.0	Water	1	349188	09/03/24	09/03/24	HMN
Methylene Chloride	ND		ug/L	5.0	Water	1	349188	09/03/24	09/03/24	HMN
MTBE	ND		ug/L	5.0	Water	1	349188	09/03/24	09/03/24	HMN
trans-1,2-Dichloroethene	ND		ug/L	5.0	Water	1	349188	09/03/24	09/03/24	HMN
1,1-Dichloroethane	ND		ug/L	5.0	Water	1	349188	09/03/24	09/03/24	HMN

Results for any subcontracted analyses are not included in this section.

ENTHALPY ANALYTICAL

Analysis Results for 515240

515240-001 Analyte	Result	Qual	Units	RL	Matrix	DF	Batch	Prepared	Analyzed	Chemist
2-Butanone	ND		ug/L	100	Water	1	349188	09/03/24	09/03/24	HMN
cis-1,2-Dichloroethene	ND		ug/L	5.0	Water	1	349188	09/03/24	09/03/24	HMN
2,2-Dichloropropane	ND		ug/L	5.0	Water	1	349188	09/03/24	09/03/24	HMN
Chloroform	ND		ug/L	5.0	Water	1	349188	09/03/24	09/03/24	HMN
Bromochloromethane	ND		ug/L	5.0	Water	1	349188	09/03/24	09/03/24	HMN
1,1,1-Trichloroethane	ND		ug/L	5.0	Water	1	349188	09/03/24	09/03/24	HMN
1,1-Dichloropropene	ND		ug/L	5.0	Water	1	349188	09/03/24	09/03/24	HMN
Carbon Tetrachloride	ND		ug/L	5.0	Water	1	349188	09/03/24	09/03/24	HMN
1,2-Dichloroethane	ND		ug/L	5.0	Water	1	349188	09/03/24	09/03/24	HMN
Benzene	ND		ug/L	5.0	Water	1	349188	09/03/24	09/03/24	HMN
Trichloroethene	ND		ug/L	5.0	Water	1	349188	09/03/24	09/03/24	HMN
1,2-Dichloropropane	ND		ug/L	5.0	Water	1	349188	09/03/24	09/03/24	HMN
Bromodichloromethane	ND		ug/L	5.0	Water	1	349188	09/03/24	09/03/24	HMN
Dibromomethane	ND		ug/L	5.0	Water	1	349188	09/03/24	09/03/24	HMN
4-Methyl-2-Pentanone	ND		ug/L	5.0	Water	1	349188	09/03/24	09/03/24	HMN
cis-1,3-Dichloropropene	ND		ug/L	5.0	Water	1	349188	09/03/24	09/03/24	HMN
Toluene	ND		ug/L	5.0	Water	1	349188	09/03/24	09/03/24	HMN
trans-1,3-Dichloropropene	ND		ug/L	5.0	Water	1	349188	09/03/24	09/03/24	HMN
1,1,2-Trichloroethane	ND		ug/L	5.0	Water	1	349188	09/03/24	09/03/24	HMN
1,3-Dichloropropane	ND		ug/L	5.0	Water	1	349188	09/03/24	09/03/24	HMN
Tetrachloroethene	ND		ug/L	5.0	Water	1	349188	09/03/24	09/03/24	HMN
Dibromochloromethane	ND		ug/L	5.0	Water	1	349188	09/03/24	09/03/24	HMN
1,2-Dibromoethane	ND		ug/L	5.0	Water	1	349188	09/03/24	09/03/24	HMN
Chlorobenzene	ND		ug/L	5.0	Water	1	349188	09/03/24	09/03/24	HMN
1,1,1,2-Tetrachloroethane	ND		ug/L	5.0	Water	1	349188	09/03/24	09/03/24	HMN
Ethylbenzene	ND		ug/L	5.0	Water	1	349188	09/03/24	09/03/24	HMN
m,p-Xylenes	ND		ug/L	10	Water	1	349188	09/03/24	09/03/24	HMN
o-Xylene	ND		ug/L	5.0	Water	1	349188	09/03/24	09/03/24	HMN
Styrene	ND		ug/L	5.0	Water	1	349188	09/03/24	09/03/24	HMN
Bromoform	ND		ug/L	5.0	Water	1	349188	09/03/24	09/03/24	HMN
Isopropylbenzene	ND		ug/L	5.0	Water	1	349188	09/03/24	09/03/24	HMN
1,1,2,2-Tetrachloroethane	ND		ug/L	5.0	Water	1	349188	09/03/24	09/03/24	HMN
1,2,3-Trichloropropane	ND		ug/L	5.0	Water	1	349188	09/03/24	09/03/24	HMN
Propylbenzene	ND		ug/L	5.0	Water	1	349188	09/03/24	09/03/24	HMN
Bromobenzene	ND		ug/L	5.0	Water	1	349188	09/03/24	09/03/24	HMN
1,3,5-Trimethylbenzene	ND		ug/L	5.0	Water	1	349188	09/03/24	09/03/24	HMN
2-Chlorotoluene	ND		ug/L	5.0	Water	1	349188	09/03/24	09/03/24	HMN
4-Chlorotoluene	ND		ug/L	5.0	Water	1	349188	09/03/24	09/03/24	HMN
tert-Butylbenzene	ND		ug/L	5.0	Water	1	349188	09/03/24	09/03/24	HMN
1,2,4-Trimethylbenzene	ND		ug/L	5.0	Water	1	349188	09/03/24	09/03/24	HMN
sec-Butylbenzene	ND		ug/L	5.0	Water	1	349188	09/03/24	09/03/24	HMN
para-Isopropyl Toluene	ND		ug/L	5.0	Water	1	349188	09/03/24	09/03/24	HMN
1,3-Dichlorobenzene	ND		ug/L	5.0	Water	1	349188	09/03/24	09/03/24	HMN
1,4-Dichlorobenzene	ND		ug/L	5.0	Water	1	349188	09/03/24	09/03/24	HMN
n-Butylbenzene	ND		ug/L	5.0	Water	1	349188	09/03/24	09/03/24	HMN
1,2-Dichlorobenzene	ND		ug/L	5.0	Water	1	349188	09/03/24	09/03/24	HMN
1,2-Dibromo-3-Chloropropane	ND		ug/L	5.0	Water	1	349188	09/03/24	09/03/24	HMN
1,2,4-Trichlorobenzene	ND		ug/L	5.0	Water	1	349188	09/03/24	09/03/24	HMN
Hexachlorobutadiene	ND		ug/L	5.0	Water	1	349188	09/03/24	09/03/24	HMN
Naphthalene	ND		ug/L	5.0	Water	1	349188	09/03/24	09/03/24	HMN
1,2,3-Trichlorobenzene	ND		ug/L	5.0	Water	1	349188	09/03/24	09/03/24	HMN
cis-1,4-Dichloro-2-butene	ND		ug/L	5.0	Water	1	349188	09/03/24	09/03/24	HMN

Results for any subcontracted analyses are not included in this section.

ENTHALPY ANALYTICAL

Analysis Results for 515240

515240-001 Analyte	Result	Qual	Units	RL	Matrix	DF	Batch	Prepared	Analyzed	Chemist
trans-1,4-Dichloro-2-butene	ND		ug/L	5.0	Water	1	349188	09/03/24	09/03/24	HMN
Xylene (total)	ND		ug/L	5.0	Water	1	349188	09/03/24	09/03/24	HMN
Surrogates				**Limits**						
Dibromofluoromethane	107%		%REC	70-130	Water	1	349188	09/03/24	09/03/24	HMN
1,2-Dichloroethane-d4	94%		%REC	70-130	Water	1	349188	09/03/24	09/03/24	HMN
Toluene-d8	94%		%REC	70-130	Water	1	349188	09/03/24	09/03/24	HMN
Bromofluorobenzene	93%		%REC	70-130	Water	1	349188	09/03/24	09/03/24	HMN

ND Not Detected

Results for any subcontracted analyses are not included in this section.

ENTHALPY ANALYTICAL

Batch QC

Type:	**Blank**	**Lab ID:**	**QC1183517**	**Batch:**	**349362**
Matrix:	**Filtrate**	**Method:**	**EPA 6010B**	**Prep Method:**	**METHOD**

QC1183517 Analyte	Result	Qual	Units	RL	Prepared	Analyzed
Antimony	ND		mg/L	0.030	09/04/24	09/04/24
Arsenic	ND		mg/L	0.010	09/04/24	09/04/24
Barium	ND		mg/L	0.010	09/04/24	09/04/24
Beryllium	ND		mg/L	0.0050	09/04/24	09/04/24
Cadmium	ND		mg/L	0.0050	09/04/24	09/04/24
Chromium	ND		mg/L	0.010	09/04/24	09/04/24
Cobalt	ND		mg/L	0.0050	09/04/24	09/04/24
Copper	ND		mg/L	0.010	09/04/24	09/04/24
Lead	ND		mg/L	0.010	09/04/24	09/04/24
Molybdenum	ND		mg/L	0.010	09/04/24	09/04/24
Nickel	ND		mg/L	0.010	09/04/24	09/04/24
Selenium	ND		mg/L	0.030	09/04/24	09/04/24
Silver	ND		mg/L	0.0050	09/04/24	09/04/24
Thallium	ND		mg/L	0.050	09/04/24	09/04/24
Vanadium	ND		mg/L	0.010	09/04/24	09/04/24
Zinc	ND		mg/L	0.050	09/04/24	09/04/24

Type:	**Blank**	**Lab ID:**	**QC1183518**	**Batch:**	**349362**
Matrix:	**Filtrate**	**Method:**	**EPA 6010B**	**Prep Method:**	**METHOD**

QC1183518 Analyte	Result	Qual	Units	RL	Prepared	Analyzed
Antimony	ND		mg/L	0.030	09/04/24	09/04/24
Arsenic	ND		mg/L	0.010	09/04/24	09/04/24
Barium	ND		mg/L	0.010	09/04/24	09/04/24
Beryllium	ND		mg/L	0.0050	09/04/24	09/04/24
Cadmium	ND		mg/L	0.0050	09/04/24	09/04/24
Chromium	ND		mg/L	0.010	09/04/24	09/04/24
Cobalt	ND		mg/L	0.0050	09/04/24	09/04/24
Copper	ND		mg/L	0.010	09/04/24	09/04/24
Lead	ND		mg/L	0.010	09/04/24	09/04/24
Molybdenum	ND		mg/L	0.010	09/04/24	09/04/24
Nickel	ND		mg/L	0.010	09/04/24	09/04/24
Selenium	ND		mg/L	0.030	09/04/24	09/04/24
Silver	ND		mg/L	0.0050	09/04/24	09/04/24
Thallium	ND		mg/L	0.050	09/04/24	09/04/24
Vanadium	ND		mg/L	0.010	09/04/24	09/04/24
Zinc	ND		mg/L	0.050	09/04/24	09/04/24

ENTHALPY ANALYTICAL

Batch QC

Type: Lab Control Sample	Lab ID: QC1183524	Batch: 349362
Matrix: Filtrate	Method: EPA 6010B	Prep Method: METHOD

QC1183524 Analyte	Result	Spiked	Units	Recovery	Qual	Limits
Antimony	0.3904	0.4000	mg/L	98%		80-120
Arsenic	0.4049	0.4000	mg/L	101%		80-120
Barium	0.4245	0.4000	mg/L	106%		80-120
Beryllium	0.4017	0.4000	mg/L	100%		80-120
Cadmium	0.4246	0.4000	mg/L	106%		80-120
Chromium	0.4240	0.4000	mg/L	106%		80-120
Cobalt	0.4346	0.4000	mg/L	109%		80-120
Copper	0.4008	0.4000	mg/L	100%		80-120
Lead	0.4331	0.4000	mg/L	108%		80-120
Molybdenum	0.3595	0.4000	mg/L	90%		80-120
Nickel	0.4247	0.4000	mg/L	106%		80-120
Selenium	0.4156	0.4000	mg/L	104%		80-120
Silver	0.2008	0.2000	mg/L	100%		80-120
Thallium	0.4331	0.4000	mg/L	108%		80-120
Vanadium	0.4284	0.4000	mg/L	107%		80-120
Zinc	0.4435	0.4000	mg/L	111%		80-120

Type: Matrix Spike	Lab ID: QC1183525	Batch: 349362
Matrix (Source ID): Filtrate (515241-002)	Method: EPA 6010B	Prep Method: METHOD

QC1183525 Analyte	Result	Source Sample Result	Spiked	Units	Recovery	Qual	Limits	DF
Antimony	0.3031	ND	0.4000	mg/L	76%		75-125	1
Arsenic	0.3991	ND	0.4000	mg/L	100%		75-125	1
Barium	0.7228	0.3236	0.4000	mg/L	100%		75-125	1
Beryllium	0.3790	ND	0.4000	mg/L	95%		75-125	1
Cadmium	0.3878	ND	0.4000	mg/L	97%		75-125	1
Chromium	0.4060	0.001799	0.4000	mg/L	101%		75-125	1
Cobalt	0.4082	ND	0.4000	mg/L	102%		75-125	1
Copper	0.4296	ND	0.4000	mg/L	107%		75-125	1
Lead	0.3984	ND	0.4000	mg/L	100%		75-125	1
Molybdenum	0.3247	ND	0.4000	mg/L	81%		75-125	1
Nickel	0.3930	ND	0.4000	mg/L	98%		75-125	1
Selenium	0.3952	ND	0.4000	mg/L	99%		75-125	1
Silver	0.1860	ND	0.2000	mg/L	93%		75-125	1
Thallium	0.4025	ND	0.4000	mg/L	101%		75-125	1
Vanadium	0.4224	0.0009757	0.4000	mg/L	105%		75-125	1
Zinc	0.3922	ND	0.4000	mg/L	98%		75-125	1

ENTHALPY ANALYTICAL

Batch QC

Type:	**Matrix Spike Duplicate**	**Lab ID:**	**QC1183526**	**Batch:**	**349362**
Matrix (Source ID):	**Filtrate (515241-002)**	**Method:**	**EPA 6010B**	**Prep Method:**	**METHOD**

QC1183526 Analyte	Result	Source Sample Result	Spiked	Units	Recovery	Qual	Limits	RPD	RPD Lim	DF
Antimony	0.3060	ND	0.4000	mg/L	77%		75-125	1	20	1
Arsenic	0.3983	ND	0.4000	mg/L	100%		75-125	0	20	1
Barium	0.7251	0.3236	0.4000	mg/L	100%		75-125	0	20	1
Beryllium	0.3812	ND	0.4000	mg/L	95%		75-125	1	20	1
Cadmium	0.3860	ND	0.4000	mg/L	96%		75-125	0	20	1
Chromium	0.4029	0.001799	0.4000	mg/L	100%		75-125	1	20	1
Cobalt	0.4044	ND	0.4000	mg/L	101%		75-125	1	20	1
Copper	0.4251	ND	0.4000	mg/L	106%		75-125	1	20	1
Lead	0.3955	ND	0.4000	mg/L	99%		75-125	1	20	1
Molybdenum	0.3321	ND	0.4000	mg/L	83%		75-125	2	20	1
Nickel	0.3881	ND	0.4000	mg/L	97%		75-125	1	20	1
Selenium	0.3962	ND	0.4000	mg/L	99%		75-125	0	20	1
Silver	0.1866	ND	0.2000	mg/L	93%		75-125	0	20	1
Thallium	0.3987	ND	0.4000	mg/L	100%		75-125	1	20	1
Vanadium	0.4176	0.0009757	0.4000	mg/L	104%		75-125	1	20	1
Zinc	0.3869	ND	0.4000	mg/L	97%		75-125	1	20	1

Type:	**Blank**	**Lab ID:**	**QC1183687**	**Batch:**	**349420**
Matrix:	**Water**	**Method:**	**EPA 7470A**	**Prep Method:**	**METHOD**

QC1183687 Analyte	Result	Qual	Units	RL	Prepared	Analyzed
Mercury	ND		ug/L	0.40	09/05/24	09/05/24

Type:	**Blank**	**Lab ID:**	**QC1183688**	**Batch:**	**349420**
Matrix:	**Water**	**Method:**	**EPA 7470A**	**Prep Method:**	**METHOD**

QC1183688 Analyte	Result	Qual	Units	RL	Prepared	Analyzed
Mercury	ND		ug/L	0.40	09/05/24	09/05/24

Type:	**Blank**	**Lab ID:**	**QC1183689**	**Batch:**	**349420**
Matrix:	**Water**	**Method:**	**EPA 7470A**	**Prep Method:**	**METHOD**

QC1183689 Analyte	Result	Qual	Units	RL	Prepared	Analyzed
Mercury	ND		ug/L	0.40	09/05/24	09/05/24

Type:	**Lab Control Sample**	**Lab ID:**	**QC1183690**	**Batch:**	**349420**
Matrix:	**Water**	**Method:**	**EPA 7470A**	**Prep Method:**	**METHOD**

QC1183690 Analyte	Result	Spiked	Units	Recovery	Qual	Limits
Mercury	5.147	5.000	ug/L	103%		80-120

ENTHALPY ANALYTICAL

Batch QC

Type:	**Matrix Spike**	**Lab ID:**	**QC1183691**	**Batch:**	**349420**
Matrix (Source ID):	**Water (515367-007)**	**Method:**	**EPA 7470A**	**Prep Method:**	**METHOD**

QC1183691 Analyte	Result	Source Sample Result	Spiked	Units	Recovery	Qual	Limits	DF
Mercury	1,037	ND	1000	ug/L	104%		75-125	200

Type:	**Matrix Spike Duplicate**	**Lab ID:**	**QC1183692**	**Batch:**	**349420**
Matrix (Source ID):	**Water (515367-007)**	**Method:**	**EPA 7470A**	**Prep Method:**	**METHOD**

QC1183692 Analyte	Result	Source Sample Result	Spiked	Units	Recovery	Qual	Limits	RPD	RPD Lim	DF
Mercury	1,027	ND	1000	ug/L	103%		75-125	1	20	200

Type:	**Blank**	**Lab ID:**	**QC1183693**	**Batch:**	**349421**
Matrix:	**Water**	**Method:**	**EPA 8015B**	**Prep Method:**	**EPA 3510C**

QC1183693 Analyte	Result	Qual	Units	RL	Prepared	Analyzed
TPH (C13-C28)	ND		mg/L	0.10	09/05/24	09/10/24
TPH (C29-C44)	ND		mg/L	0.30	09/05/24	09/10/24
Surrogates				**Limits**		
n-Triacontane	66%		%REC	35-130	09/05/24	09/10/24

Type:	**Lab Control Sample**	**Lab ID:**	**QC1183694**	**Batch:**	**349421**
Matrix:	**Water**	**Method:**	**EPA 8015B**	**Prep Method:**	**EPA 3510C**

QC1183694 Analyte	Result	Spiked	Units	Recovery	Qual	Limits
Diesel C10-C28	0.8197	1.000	mg/L	82%		42-120
Surrogates						
n-Triacontane	0.01518	0.02000	mg/L	76%		35-130

Type:	**Lab Control Sample Duplicate**	**Lab ID:**	**QC1183695**	**Batch:**	**349421**
Matrix:	**Water**	**Method:**	**EPA 8015B**	**Prep Method:**	**EPA 3510C**

QC1183695 Analyte	Result	Spiked	Units	Recovery	Qual	Limits	RPD	RPD Lim
Diesel C10-C28	0.7807	1.000	mg/L	78%		42-120	5	36
Surrogates								
n-Triacontane	0.01466	0.02000	mg/L	73%		35-130		

ENTHALPY ANALYTICAL

Batch QC

Type:	**Lab Control Sample**	**Lab ID:**	**QC1183002**	**Batch:**	**349188**
Matrix:	**Water**	**Method:**	**EPA 8260B**	**Prep Method:**	**EPA 5030B**

QC1183002 Analyte	Result	Spiked	Units	Recovery	Qual	Limits
1,1-Dichloroethene	51.63	50.00	ug/L	103%		70-135
MTBE	50.60	50.00	ug/L	101%		70-130
Benzene	52.55	50.00	ug/L	105%		70-130
Trichloroethene	52.03	50.00	ug/L	104%		70-130
Toluene	48.34	50.00	ug/L	97%		70-130
Chlorobenzene	52.08	50.00	ug/L	104%		70-130
Surrogates						
Dibromofluoromethane	53.27	50.00	ug/L	107%		70-130
1,2-Dichloroethane-d4	46.04	50.00	ug/L	92%		70-130
Toluene-d8	47.21	50.00	ug/L	94%		70-130
Bromofluorobenzene	47.82	50.00	ug/L	96%		70-130

Type:	**Lab Control Sample Duplicate**	**Lab ID:**	**QC1183003**	**Batch:**	**349188**
Matrix:	**Water**	**Method:**	**EPA 8260B**	**Prep Method:**	**EPA 5030B**

QC1183003 Analyte	Result	Spiked	Units	Recovery	Qual	Limits	RPD	RPD Lim
1,1-Dichloroethene	50.83	50.00	ug/L	102%		70-135	2	30
MTBE	49.80	50.00	ug/L	100%		70-130	2	30
Benzene	52.24	50.00	ug/L	104%		70-130	1	30
Trichloroethene	53.19	50.00	ug/L	106%		70-130	2	30
Toluene	48.96	50.00	ug/L	98%		70-130	1	30
Chlorobenzene	53.01	50.00	ug/L	106%		70-130	2	30
Surrogates								
Dibromofluoromethane	51.77	50.00	ug/L	104%		70-130		
1,2-Dichloroethane-d4	44.60	50.00	ug/L	89%		70-130		
Toluene-d8	47.70	50.00	ug/L	95%		70-130		
Bromofluorobenzene	47.20	50.00	ug/L	94%		70-130		

ENTHALPY ANALYTICAL

Batch QC

Type:	**Blank**	**Lab ID:**	**QC1183006**	**Batch:**	**349188**
Matrix:	**Water**	**Method:**	**EPA 8260B**	**Prep Method:**	**EPA 5030B**

QC1183006 Analyte	Result	Qual	Units	RL	Prepared	Analyzed
3-Chloropropene	ND		ug/L	5.0	09/03/24	09/03/24
Freon 12	ND		ug/L	5.0	09/03/24	09/03/24
Chloromethane	ND		ug/L	5.0	09/03/24	09/03/24
Vinyl Chloride	ND		ug/L	5.0	09/03/24	09/03/24
Bromomethane	ND		ug/L	5.0	09/03/24	09/03/24
Chloroethane	ND		ug/L	5.0	09/03/24	09/03/24
Trichlorofluoromethane	ND		ug/L	5.0	09/03/24	09/03/24
Acetone	ND		ug/L	100	09/03/24	09/03/24
Freon 113	ND		ug/L	5.0	09/03/24	09/03/24
1,1-Dichloroethene	ND		ug/L	5.0	09/03/24	09/03/24
Methylene Chloride	ND		ug/L	5.0	09/03/24	09/03/24
MTBE	ND		ug/L	5.0	09/03/24	09/03/24
trans-1,2-Dichloroethene	ND		ug/L	5.0	09/03/24	09/03/24
1,1-Dichloroethane	ND		ug/L	5.0	09/03/24	09/03/24
2-Butanone	ND		ug/L	100	09/03/24	09/03/24
cis-1,2-Dichloroethene	ND		ug/L	5.0	09/03/24	09/03/24
2,2-Dichloropropane	ND		ug/L	5.0	09/03/24	09/03/24
Chloroform	ND		ug/L	5.0	09/03/24	09/03/24
Bromochloromethane	ND		ug/L	5.0	09/03/24	09/03/24
1,1,1-Trichloroethane	ND		ug/L	5.0	09/03/24	09/03/24
1,1-Dichloropropene	ND		ug/L	5.0	09/03/24	09/03/24
Carbon Tetrachloride	ND		ug/L	5.0	09/03/24	09/03/24
1,2-Dichloroethane	ND		ug/L	5.0	09/03/24	09/03/24
Benzene	ND		ug/L	5.0	09/03/24	09/03/24
Trichloroethene	ND		ug/L	5.0	09/03/24	09/03/24
1,2-Dichloropropane	ND		ug/L	5.0	09/03/24	09/03/24
Bromodichloromethane	ND		ug/L	5.0	09/03/24	09/03/24
Dibromomethane	ND		ug/L	5.0	09/03/24	09/03/24
4-Methyl-2-Pentanone	ND		ug/L	5.0	09/03/24	09/03/24
cis-1,3-Dichloropropene	ND		ug/L	5.0	09/03/24	09/03/24
Toluene	ND		ug/L	5.0	09/03/24	09/03/24
trans-1,3-Dichloropropene	ND		ug/L	5.0	09/03/24	09/03/24
1,1,2-Trichloroethane	ND		ug/L	5.0	09/03/24	09/03/24
1,3-Dichloropropane	ND		ug/L	5.0	09/03/24	09/03/24
Tetrachloroethene	ND		ug/L	5.0	09/03/24	09/03/24
Dibromochloromethane	ND		ug/L	5.0	09/03/24	09/03/24
1,2-Dibromoethane	ND		ug/L	5.0	09/03/24	09/03/24
Chlorobenzene	ND		ug/L	5.0	09/03/24	09/03/24
1,1,1,2-Tetrachloroethane	ND		ug/L	5.0	09/03/24	09/03/24
Ethylbenzene	ND		ug/L	5.0	09/03/24	09/03/24
m,p-Xylenes	ND		ug/L	10	09/03/24	09/03/24
o-Xylene	ND		ug/L	5.0	09/03/24	09/03/24
Styrene	ND		ug/L	5.0	09/03/24	09/03/24
Bromoform	ND		ug/L	5.0	09/03/24	09/03/24
Isopropylbenzene	ND		ug/L	5.0	09/03/24	09/03/24
1,1,2,2-Tetrachloroethane	ND		ug/L	5.0	09/03/24	09/03/24
1,2,3-Trichloropropane	ND		ug/L	5.0	09/03/24	09/03/24

ENTHALPY ANALYTICAL

Batch QC

QC1183006 Analyte	Result	Qual	Units	RL	Prepared	Analyzed
Propylbenzene	ND		ug/L	5.0	09/03/24	09/03/24
Bromobenzene	ND		ug/L	5.0	09/03/24	09/03/24
1,3,5-Trimethylbenzene	ND		ug/L	5.0	09/03/24	09/03/24
2-Chlorotoluene	ND		ug/L	5.0	09/03/24	09/03/24
4-Chlorotoluene	ND		ug/L	5.0	09/03/24	09/03/24
tert-Butylbenzene	ND		ug/L	5.0	09/03/24	09/03/24
1,2,4-Trimethylbenzene	ND		ug/L	5.0	09/03/24	09/03/24
sec-Butylbenzene	ND		ug/L	5.0	09/03/24	09/03/24
para-Isopropyl Toluene	ND		ug/L	5.0	09/03/24	09/03/24
1,3-Dichlorobenzene	ND		ug/L	5.0	09/03/24	09/03/24
1,4-Dichlorobenzene	ND		ug/L	5.0	09/03/24	09/03/24
n-Butylbenzene	ND		ug/L	5.0	09/03/24	09/03/24
1,2-Dichlorobenzene	ND		ug/L	5.0	09/03/24	09/03/24
1,2-Dibromo-3-Chloropropane	ND		ug/L	5.0	09/03/24	09/03/24
1,2,4-Trichlorobenzene	ND		ug/L	5.0	09/03/24	09/03/24
Hexachlorobutadiene	ND		ug/L	5.0	09/03/24	09/03/24
Naphthalene	ND		ug/L	5.0	09/03/24	09/03/24
1,2,3-Trichlorobenzene	ND		ug/L	5.0	09/03/24	09/03/24
cis-1,4-Dichloro-2-butene	ND		ug/L	5.0	09/03/24	09/03/24
trans-1,4-Dichloro-2-butene	ND		ug/L	5.0	09/03/24	09/03/24
Xylene (total)	ND		ug/L	5.0	09/03/24	09/03/24
Surrogates				**Limits**		
Dibromofluoromethane	104%		%REC	70-130	09/03/24	09/03/24
1,2-Dichloroethane-d4	91%		%REC	70-130	09/03/24	09/03/24
Toluene-d8	95%		%REC	70-130	09/03/24	09/03/24
Bromofluorobenzene	95%		%REC	70-130	09/03/24	09/03/24

Type:	**Matrix Spike**	**Lab ID:**	**QC1183069**	**Batch:**	**349188**
Matrix (Source ID):	**Water (515194-001)**	**Method:**	**EPA 8260B**	**Prep Method:**	**EPA 5030B**

QC1183069 Analyte	Result	Source Sample Result	Spiked	Units	Recovery	Qual	Limits	DF
1,1-Dichloroethene	1,936	ND	2500	ug/L	77%		70-130	50
MTBE	2,053	ND	2500	ug/L	82%		75-130	50
Benzene	2,007	ND	2500	ug/L	80%		70-130	50
Trichloroethene	2,049	ND	2500	ug/L	82%		63-130	50
Toluene	1,841	ND	2500	ug/L	74%		70-130	50
Chlorobenzene	2,084	ND	2500	ug/L	83%		70-130	50
Surrogates								
Dibromofluoromethane	2,572		2500	ug/L	103%		70-130	50
1,2-Dichloroethane-d4	2,225		2500	ug/L	89%		70-130	50
Toluene-d8	2,360		2500	ug/L	94%		70-130	50
Bromofluorobenzene	2,422		2500	ug/L	97%		70-130	50

ENTHALPY ANALYTICAL

Batch QC

Type:	**Matrix Spike Duplicate**	**Lab ID:**	**QC1183070**	**Batch:**	**349188**
Matrix (Source ID):	**Water (515194-001)**	**Method:**	**EPA 8260B**	**Prep Method:**	**EPA 5030B**

QC1183070 Analyte	Result	Source Sample Result	Spiked	Units	Recovery	Qual	Limits	RPD	RPD Lim	DF
1,1-Dichloroethene	1,907	ND	2500	ug/L	76%		70-130	1	30	50
MTBE	2,048	ND	2500	ug/L	82%		75-130	0	30	50
Benzene	1,991	ND	2500	ug/L	80%		70-130	1	30	50
Trichloroethene	2,022	ND	2500	ug/L	81%		63-130	1	30	50
Toluene	1,850	ND	2500	ug/L	74%		70-130	0	30	50
Chlorobenzene	2,052	ND	2500	ug/L	82%		70-130	2	30	50
Surrogates										
Dibromofluoromethane	2,548		2500	ug/L	102%		70-130			50
1,2-Dichloroethane-d4	2,210		2500	ug/L	88%		70-130			50
Toluene-d8	2,385		2500	ug/L	95%		70-130			50
Bromofluorobenzene	2,386		2500	ug/L	95%		70-130			50

ND Not Detected

Appendix D

Temporary Construction Dewatering Specifications

APPENDIX D - DEWATERING SPECIFICATIONS

PART 1.0 GENERAL

1.1 Description

A. Design, furnish, install, maintain, operate and remove complete temporary dewatering system(s) as required to lower and control water levels and hydrostatic pressures during construction and dispose of pumped water.

B. Obtain necessary permits from governing agencies for the discharge or disposal of the dewatering water.

1. Prior to construction, the Contractor shall obtain a permit from the Regional Water Quality Control Board for dewatering activities. The permit may be conditioned to protect the water quality in the project vicinity. These conditions may include treatment, discharge sampling, monitoring and reporting.

1.2 Definitions

Dewatering includes lowering the water table and intercepting seepage which would otherwise emerge from the faces or bottom of the excavation.

1.3 Quality Assurance

Before dewatering is commenced, the Contractor shall obtain the acceptance of the Engineer for the method, installation and details of the dewatering system that is proposed to be used. To that end, the Contractor shall submit to the Engineer plans setting forth the details of the proposed dewatering systems. The dewatering system plans shall be in sufficient detail to indicate sizes of pumps, piping, appurtenances, the ultimate disposal point for water and to permit the Engineer to judge the overall completeness and effectiveness of the proposed system.

The control of groundwater shall be such that softening of the bottom of excavations or formation of "quick" conditions or "boils", do not occur. Dewatering systems shall be designed and operated so as to minimize removal of the natural soils.

The Contractor shall select the particular method of dewatering to be employed.

1.4 Dewatering Submittals

A. At least thirty (30) days prior to installation of the dewatering system, submit six (6) copies of working informational and scheduling drawings and the following design data:

1. The proposed type of dewatering system, including relief of hydrostatic head and maintenance of the excavations in a dewatered and in a hydrostatically relieved condition.

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

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

4. Standby equipment and emergency power supply.

5. Location and size of sumps and discharge lines, including their relation to water disposal sites.

6. Types and sizes of filters.

7. Location, types and depths of wells and/or well points and observation wells.

8. Proposed locations of observation wells.

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

10. Coordination with earth support system design and excavation operations.

B. Review of dewatering and recharge system by the Engineer shall not relieve the Contractor from the responsibility for the adequacy of these systems to achieve the specified results.

PART 2.0 PRODUCTS

2.1 General

The Contractor shall furnish, install, operate and maintain all machinery, appliances, and equipment to maintain all excavations free from water during construction, and shall dewater and dispose of the water so as not to cause injury to public or private property, or to cause a nuisance or menace to the public.

The dewatering system shall be installed and operated so that the groundwater level outside the excavation is not reduced to the extent which would cause damage or endanger adjacent structures.

The static water level shall be drawn down a minimum of five feet (5') below the bottom of the excavation in order to maintain the undisturbed state of the foundation soils and to facilitate the placement of fill or backfill compacted to the required density.

2.2 Sump Pumping

Sumps shall be no deeper than four feet (4') and shall be at the low point of excavation. Excavation shall be graded to drain to the sumps.

2.3 Well Points

The annular space between the pipe and the borehole of the well point shall be sealed near the top of the well point to prevent vacuum leaks. Installation shall be carried out in such a way so as not to excessively disturb in situ material.

PART 3.0 EXECUTION

3.1 General

One hundred percent (100%) standby pumping capacity shall be available on site at all times and shall be connected to the dewatering system piping to permit immediate use. In addition, standby ancillary equipment and appliances for all ordinary emergencies, and competent workmen for operation and maintenance of all dewatering equipment shall be on site at all times. Standby equipment shall include emergency power generation and automatic switchover to the emergency generator when normal power fails.

Dewatering systems shall not be shut down between shifts, on holidays, on weekends, or during work stoppages.

The Contractor shall control surface water to prevent entry into excavations.

3.2 Drainage of Excavated Areas

A. Collect surface water and seepage which may enter the excavation, and divert the water into a sump so that it can be drained or pumped.

B. Install settling basins or other approved apparatus as required to reduce the amount of fine particles which may be carried by water diverted into the discharge line.

C. Backfill sumps and settling basins when no longer required with granular material, concrete or other material as approved by the Engineer.

3.3 Disposal

A. Dispose of all water in accordance with applicable provisions of all Federal, State, and local regulatory boards having jurisdiction over water discharges. Water containing soil, silt or chemical contaminants shall not be discharged into natural watercourses, municipal drains or sewers.

B. The Contractor shall obtain the necessary discharge permits from the Regional Water Quality Control Board for proposed groundwater dewatering discharges.

C. The Contractor shall submit to the Engineer copies of all permits obtained for the discharge or disposal of dewatering water. Copies of the permits shall be maintained on the Site at all times.

D. The Contractor shall be familiar with and shall conform to the requirements of the General Waste Discharge Requirements as they relate to the quantity, quality, testing, reporting, and all other aspects of construction dewatering discharges. The Contractor shall perform all construction dewatering disposal in accordance with the provisions of the General Waste Discharge Requirements.

Appendix E

Noise Data, Modeling, and Specifications

Number	Start Date	Start Time	End Time	Duration	LZeq	LCeq	LAeq	LZSmax	LCSmax	LASmax	LZSmin	LCSmin	LASmin	LZE	LCE
ST 1	11/7/2024	8:20:42 AM	8:36:02 AM	0:15:20	60.8	58.8	46.6	72.7	70.4	56.6	55.6	53.3	39.6	87.6	85.6
ST 2	11/7/2024	8:55:17 AM	9:10:17 AM	0:15:00	65	63.2	57	82.2	78	70	53.5	51.2	36.3	94.5	92.7
ST 3	11/7/2024	8:38:00 AM	8:53:00 AM	0:15:00	65.3	64.4	60.7	77.1	76.4	73.7	53.2	50.5	39.2	94.8	93.9

Number	LAE	LZpk	LCpk	LApk	LAS1%	LAS2%	LAS5%	LAS8%	LAS10%	LAS25%	LAS50%	LAS90%	LAS95%	LAS99%	
ST 1	73.6	83.9	82.2	78.3	54.1	53.4	51.5	50.1	49.4	47.0	45.0	41.4	40.9	40.2	
ST 2	86.5	97	92.7	87.1	66.5	65.4	63.8	62.5	61.8	57.3	50.6	39.6	38.5	36.9	
ST 3	90.2	91.4	90.6	90.6	70	68.8	67.3	66.2	65.6	61.3	53.7	43.7	42.2	40	

Roadway Construction Noise Model (RCNM),Version 1.1

Report date: 10/29/2024
Case Description: ETWD Aliso Creek Lift Station Rehabilitation Project

**** Receptor #1 ****

Description	Land Use	Baselines (dBA) Daytime	Evening	Night
Demolition	Industrial	60.0	55.0	50.0

Equipment

Description	Impact Device	Usage (%)	Spec Lmax (dBA)	Actual Lmax (dBA)	Receptor Distance (feet)	Estimated Shielding (dBA)
Concrete Saw	No	20	90.0		50.0	0.0
Excavator	No	40	85.0		50.0	0.0

Results

Noise Limits (dBA)

Noise Limit Exceedance (dBA)

Equipment	Calculated (dBA) Day Lmax	Day Leq	Evening Lmax	Evening Leq	Night Lmax	Night Leq	Day Lmax	Day Leq	Evening Lmax	Evening Leq	Night Lmax	Night Leq
Concrete Saw	90.0	83.0	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Excavator	85.0	81.0	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Total	90.0	85.1	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

Roadway Construction Noise Model (RCNM),Version 1.1

Report date: 10/29/2024
Case Description: ETWD Aliso Creek Lift Station Rehabilitation Project

**** Receptor #1 ****

Description	Land Use	Baselines (dBA) Daytime	Evening	Night
Site Preparation	Industrial	60.0	55.0	50.0

Description	Impact Device	Usage (%)	Equipment Spec Lmax (dBA)	Actual Lmax (dBA)	Receptor Distance (feet)	Estimated Shielding (dBA)
Auger Drill Rig	No	20	85.0		50.0	0.0
Excavator	No	40	85.0		50.0	0.0

Results

Noise Limits (dBA)

Noise Limit Exceedance (dBA)

Equipment	Calculated (dBA) Day Lmax	Day Leq	Evening Lmax	Evening Leq	Night Lmax	Night Leq	Day Lmax	Day Leq	Evening Lmax	Evening Leq	Night Lmax	Night Leq
Auger Drill Rig	85.0	78.0	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Excavator	85.0	81.0	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Total	85.0	82.8	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

Roadway Construction Noise Model (RCNM),Version 1.1

Report date: 10/29/2024
Case Description: ETWD Aliso Creek Lift Station Rehabilitation Project

**** Receptor #1 ****

Description	Land Use	Baselines (dBA) Daytime	Evening	Night
Grading/Excavation	Industrial	60.0	55.0	50.0

Equipment

Description	Impact Device	Usage (%)	Spec Lmax (dBA)	Actual Lmax (dBA)	Receptor Distance (feet)	Estimated Shielding (dBA)
Crane	No	16	85.0		50.0	0.0
Excavator	No	40	85.0		50.0	0.0

Results

Noise Limits (dBA)

Noise Limit Exceedance (dBA)

Equipment	Calculated (dBA) Day Lmax	Day Leq	Evening Lmax	Evening Leq	Night Lmax	Night Leq	Day Lmax	Day Leq	Evening Lmax	Evening Leq	Night Lmax	Night Leq
Crane	85.0	77.0	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Excavator	85.0	81.0	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Total	85.0	82.5	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

Roadway Construction Noise Model (RCNM),Version 1.1

Report date: 10/29/2024
Case Description: ETWD Aliso Creek Lift Station Rehabilitation Project

**** Receptor #1 ****

Description	Land Use	Baselines (dBA) Daytime	Evening	Night
Infrastructure Installation	Industrial	60.0	55.0	50.0

Equipment

Description	Impact Device	Usage (%)	Spec Lmax (dBA)	Actual Lmax (dBA)	Receptor Distance (feet)	Estimated Shielding (dBA)
Concrete Mixer Truck	No	40	85.0		50.0	0.0
Crane	No	16	85.0		50.0	0.0

Results

Noise Limits (dBA)

Noise Limit Exceedance (dBA)

Night	Day	Calculated (dBA) Evening	Night	Day Lmax	Day Leq	Evening Lmax	Evening Leq	Night Lmax	Night Leq	Lmax
Equipment		Lmax Leq	Lmax Leq	Lmax	Leq					
Concrete Mixer Truck		85.0 81.0		N/A	N/A	N/A	N/A	N/A	N/A	N/A
N/A	N/A	N/A	N/A N/A	N/A	N/A					
Crane		85.0 77.0		N/A	N/A	N/A	N/A	N/A	N/A	N/A
N/A	N/A	N/A	N/A N/A	N/A	N/A					
	Total	85.0 82.5		N/A	N/A	N/A	N/A	N/A	N/A	N/A
N/A	N/A	N/A	N/A N/A	N/A	N/A					

Roadway Construction Noise Model (RCNM),Version 1.1

Report date: 10/29/2024
Case Description: ETWD Aliso Creek Lift Station Rehabilitation Project

**** Receptor #1 ****

Description	Land Use	Baselines (dBA) Daytime	Evening	Night
Paving/Site Restoration	Industrial	60.0	55.0	50.0

Equipment

Description	Impact Device	Usage (%)	Spec Lmax (dBA)	Actual Lmax (dBA)	Receptor Distance (feet)	Estimated Shielding (dBA)
Concrete Saw	No	20	90.0		50.0	0.0
Concrete Mixer Truck	No	40	85.0		50.0	0.0

Results

Noise Limits (dBA)

Noise Limit Exceedance (dBA)

Calculated (dBA)				Day		Evening		Night	
Equipment	Lmax	Leq	Lmax	Leq	Lmax	Leq	Lmax	Leq	Lmax	Leq	Lmax	Leq
Concrete Saw	90.0	83.0	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Concrete Mixer Truck	85.0	81.0	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Total	90.0	85.1	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

Roadway Construction Noise Model (RCNM),Version 1.1

Report date: 10/29/2024
Case Description: ETWD Aliso Creek Lift Station Rehabilitation Project

**** Receptor #1 ****

Description	Land Use	Baselines (dBA) Daytime	Evening	Night
Architectural Coating	Industrial	60.0	55.0	50.0

Equipment

Description	Impact Device	Usage (%)	Spec Lmax (dBA)	Actual Lmax (dBA)	Receptor Distance (feet)	Estimated Shielding (dBA)
Generator	No	50	82.0		50.0	0.0

Results

Noise Limits (dBA)

Noise Limit Exceedance (dBA)

Night	Day	Calculated (dBA) Evening	Night	Day Evening	Night
Equipment	Lmax Leq	Lmax Leq	Lmax Leq	Lmax Leq	Lmax Leq	Lmax Leq
Generator	82.0 N/A	79.0 N/A	N/A N/A	N/A N/A	N/A N/A	N/A N/A
Total	82.0 N/A	79.0 N/A	N/A N/A	N/A N/A	N/A N/A	N/A N/A

Roadway Construction Noise Model (RCNM),Version 1.1

Report date: 10/29/2024
Case Description: ETWD Aliso Creek Lift Station Rehabilitation Project

**** Receptor #1 ****

Description	Land Use	Baselines (dBA) Daytime	Evening	Night
Bypass Pump	Industrial	60.0	55.0	50.0

Description	Impact Device	Usage (%)	Equipment Spec Lmax (dBA)	Actual Lmax (dBA)	Receptor Distance (feet)	Estimated Shielding (dBA)
Pumps	No	50		80.9	50.0	0.0

Results

Noise Limits (dBA)

Noise Limit Exceedance (dBA)

Night	Day	Calculated (dBA) Evening	Night	Day Evening	Night

Equipment	Lmax	Leq	Lmax	Leq	Lmax	Leq	Lmax	Leq	Lmax	Leq	Lmax	Leq
Pumps	80.9	77.9	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Total	80.9	77.9	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

Cat® GC ENCLOSURES

Image shown may not reflect actual configuration.

D250 GC – D600 GC Sound Attenuated Enclosures

60 Hz

Features

Robust/Highly Corrosion Resistant Construction

- Factory installed on skid base or tanks base
- Environmentally friendly, polyester powder baked paint
- Enclosure constructed with 18-gauge steel
- Interior zinc plated fasteners
- Internally mounted exhaust silencing system
- Comply with ASCE /SEI 7 for Wind loads up to 100 mph
- Designed and tested to comply with UL 2200 Listed generator set package

Excellent Access

- Large cable entry area for installation ease.
- Accommodates side mounted single or multiple breakers.
- Two doors on both sides.
- Vertically hinged allow 180° opening rotation
- Radiator fill cover.

Security and Safety

- Lockable access doors which give full access to control panel and breaker.
- Cooling fan and battery charging alternator fully guarded.
- Fuel fill, oil fill and battery can only be reached via lockable access.
- Externally mounted emergency stop button (Optional).
- Designed for spreader bar lifting to ensure safety.
- Stub-up area is rodent proof.

Sound Attenuated Level 2

- Caterpillar white paint
- UL Listed integral fuel tank with 24 hours running time capacity (Optional).
- DC lighting package (Optional)

Enclosure Package Operating Characteristics

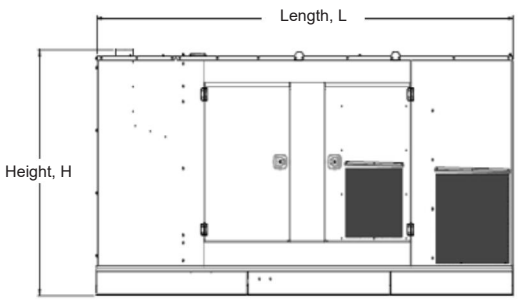
Enclosure Type	Standby	Cooling Air Flow Rate		Ambient Capability*		Sound Pressure Levels (dBA) at 7m (23 ft)
	ekW	m^3/s	cfm	°C	°F	100% Load
Level 2 Sound Attenuated Enclosure (Steel)	250	6.4	13561	57	135	74
	300	6.4	13561	51	125	74
	350	7.4	15680	57	134	71
	400	7.4	15680	53	127	71
	450	8.4	17692	54	130	73
	500	8.4	17692	50	122	73
	550	11.2	23731	56	133	73
	600	11.2	23731	53	127	73

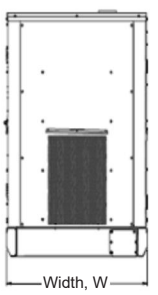
*Cooling system performance at sea level. Consult your Cat® dealer for site specific ambient and altitude capabilities.
Note: Sound level measurements are subject to instrumentation, installation and manufacturing variability, as well as ambient site conditions

Cat® GC ENCLOSURES

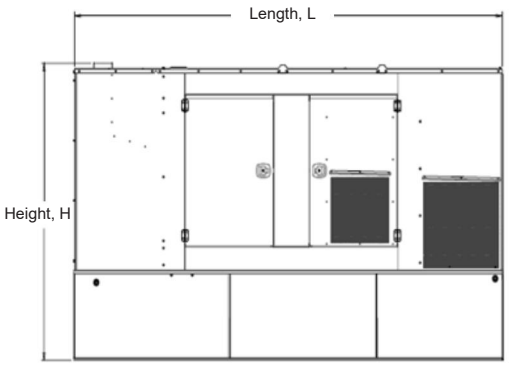
Weights and Dimensions

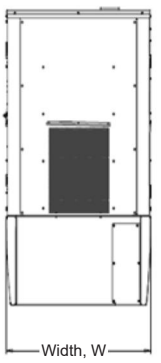
Enclosure Type	Standby Ratings	Length, L		Width, W		Height, H		Package Weights	
	ekW	mm	in	mm	in	mm	in	kg	lb
Sound Attenuated Enclosure on Skid Base	250	3958	155.8	1440	56.7	1991	78.4	2857	6298.6
	300							2945	6492.6
	350	4633	182.4	1630	64.2	2227	87.7	3983	8781.0
	400							4017	8856.0
	450	4823	189.8	1630	64.2	2227	87.7	4408	9718.0
	500							4457	9826.0
	550	4980	196.1	1865	73.4	2172	85.5	4754	10480.8
	600							4837	10663.8
Sound Attenuated Enclosure on UL Listed Integral Fuel Tank Base	250	3958	155.8	1440	56.7	2487	97.9	3497	7709.6
	300							3585	7903.6
	350	4633	182.4	1630	64.2	2644	104.1	4765	10505.0
	400							4799	10580.0
	450	4823	189.8	1630	64.2	2777	109.3	5345	11783.7
	500							5394	11891.7
	550	4980	196.1	1865	73.4	2723	107.2	5973	13168.2
	600							6056	13351.2
Sound Attenuated Enclosure on UL Listed Extended Integral Fuel Tank Base	250	4608	181.4	1430	56.3	2379	93.7	3590	7914.6
	300							3678	8108.6
	350	5251	203.7	1620	63.8	2561	100.8	4876	10749.7
	400							4910	10824.7
	450	5909	232.6	1620	63.8	2612	102.8	5497	12118.8
	500							5546	12226.8
	550	6759	266.1	1865	73.4	2487	97.9	6237	13750.2
	600							6320	13933.2





Sound Attenuated Enclosure on Skid Base





Sound Attenuated Enclosure on a UL Listed Integral Fuel Tank Base

Image shown may not reflect actual configuration

LET'S DO THE WORK.™

LEHE2014-05 (06/22)

Cat® C13
DIESEL GENERATOR SETS

Image shown may not reflect actual configuration.

350 ekW – 400 ekW
60 Hz

Standby	Prime
350 kVA	320 kVA
400 kVA	365 kVA

BENEFITS & FEATURES

CAT® GENERATOR SET PACKAGE

Cat generator set packages have been fully prototype tested and certified torsional vibration analysis reports are available. The packages are designed to meet the NFPA 110 requirement for loading, conform to the ISO 8528-5 steady state and fill transient response requirements.

CAT DIESEL ENGINES

The four-cycle Cat diesel engine combines consistent performance with excellent fuel economy and transient response that meets or exceeds ISO 8528-5. The engines feature a reliable, rugged, and durable design that has been field proven in thousands of applications worldwide in emergency standby installations.

COOLING SYSTEM

The cooling system has been designed and tested to ensure proper generator set cooling, and includes the radiator, fan, belts, and all guarding installed as standard. Contact your Cat dealer for specific ambient and altitude capabilities.

GENERATORS

The generators used on Cat packages have been designed and tested to work with the Cat engine. The generators are built with robust Class H insulation and provide industry-leading motor starting capability and altitude capabilities.

GCCP CONTROL PANELS

The GCCP controller features the reliability and durability you have to come to expect from your Cat equipment. Monitoring an extensive number of engine parameters, the controller will display warnings, shutdown and engine status information on the back-lit LCD screen, illuminated LEDs and remote PC. The controllers offer extensive number of flexible inputs, outputs and extensive engine protections so the system can be easily adapted to meet the most demanding industry requirements.

SPECIFICATIONS

ENGINE SPECIFICATIONS

Engine Model	Cat® C13 In-line 6, 4-cycle diesel
Bore x Stroke	130 mm x 157 mm (5.1 in x 6.2 in)
Displacement	12.5 L (763 in^3)
Compression Ratio	16.3:1
Aspiration	Turbocharged Air-to-Air Aftercooled
Fuel Injection System	MEUI
Governor	Electronic ADEM™ A4
Emission Certifications	EPA TIER III

GENERATOR SET SPECIFICATIONS

Alternator Design	Brushless Single Bearing, 4 Pole
Stator	2/3 Pitch
No. of Leads	12
Available Voltage Options	600V/480V/440V/240V/220V
Frequency	60 Hz
Alternator Voltage	24V
Alternator Insulation & IP	Class H; IP23
Standard Temperature Rise	125/130 Deg C
Available Excitation Options	Self-Excited, PMG
Voltage Regulation, Steady State+/-	≤1%

Cat® C13
DIESEL GENERATOR SETS

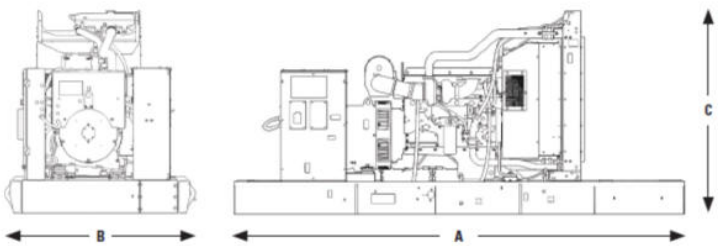
STANDARD EQUIPMENT

Air inlet system	Aftercooler core Turbocharger
Control panels	GCCP1.3 control panel
Cooling system	Coolant drain line with valve; terminated on edge of base Fan and belt guards Coolant level sensor Thermostats and housing, full open temperature 92 deg C (198 deg F) Coolant level sight gauge Jacket water pump, gear driven, centrifugal Caterpillar Extended Life Coolant
Telematics	PL444 4G LTE
Exhaust system	Exhaust manifold; dry
Fuel system	Primary fuel filter w/integral water separator & secondary filter Fuel cooler Fuel priming pump Flexible fuel lines Engine fuel transfer pump
Generators and generator attachments	Brushless, self-excited 2/3 pitch, random wound IP23 protection Insulation Class H and temperature rise Power centre, IP22 bottom cable entry Segregated low voltage wiring panel
Governing system	Cat electronic governor (ADEM A4)
Protection system	Safety shutoff – High water temperature Safety shutoff – Low oil Pressure Safety shutoff – Overspeed Coolant level sensor
Base/Fuel tank	Narrow skid Wide/Standard Sub tank base – UL & ULC listed Integral tank base – UL & ULC Listed spill containment Overfill prevention valve
Starting/charging system	24-Volt Electric Starting Motor Charging Alternator
Certifications	EPA Stationary Emergency Use

OPTIONAL EQUIPMENT

Air inlet system	Single/Dual element air cleaner Heavy duty air cleaner
Control panels	GCCP1.5 Local annunciator Remote annunciators Discrete I/O module Device server Volt free contact Earth (ground) fault relay
Circuit breakers	3-Pole 100% rated – Single (manual & motorized) 3-Pole 100% rated – Dual & third (manual) External paralleling Auxiliary contacts Neutral bar
Enclosures	Sound attenuated (SA) Weather protective
Cooling system	Stone guards
Telematics	PLG601, PLG641
Mufflers	Industrial grade (10 dBA) Residential and critical grade (25 dBA)
Base/Fuel Tank	Stone guards
Radiator	Audio & visual fuel alarm
Fuel system	Integral 670 gal tank base Sub tank bases: 660, 1000, 1900, 2200 gal
Generators and generator attachments	Excitation – Self Excitation – Internal/AREP/PMG Oversize Coastal protection (CIP) Space heater control
Starting/ charging system	Standard battery set Oversize battery set
Certifications	UL2200 Listed CSA 22.2 Certification of Compliance – IBC Seismic Certification of Compliance – IBC Seismic and HCAI
General	Tool set

WEIGHTS & DIMENSIONS



Standby Ratings	Length "A" mm (in)	Width "B" mm (in)	Height "C" mm (in)	Generator Set Weight kg (lb)
350 ekW	3505 (138)	1652 (65)	2069 (82)	3696 (8147)
400 ekW	3505 (138)	1652 (65)	2069 (82)	3823 (8427)

Note: General configuration not to be used for installation.
See general dimension drawings for detail.

Image shown may not reflect actual configuration.

Integral & Sub Base Fuel Tanks

FEATURES

- UL Listed for United States (UL 142) and Canada (CAN/ULC S601)
- Facilitates compliance with NFPA 30 code, NFPA 37 and 110 standards and CSA C282 code
- Dual wall
- Lockable fuel fill cap, 4" (101.6 mm) NPT
- Low fuel level warning standard, customer configurable warning or shutdown
- Primary tank leak detection switch in containment basin
- Tank design provides capacity for thermal expansion of fuel
- Fuel supply dip tube is positioned so as not to pick up fuel sediment
- Fuel return and supply dip tube is separated by an internal baffle to prevent immediate re-supply of heated return fuel
- Pressure washed with an iron phosphate solution
- Interior tank surfaces coated with a solvent-based thin-film rust preventative
- Heavy gauge steel gussets with internal lifting rings
- Primary and secondary tanks are leak tested at 20.7 kPa (3 psi) minimum
- Compatible with open packages and enclosures
- Gloss black polyester alkyd enamel exterior paint
- Welded steel containment basin (minimum of 110% of primary tank capacity)
- Direct reading fuel gauge with variable electrical output
- Emergency vents on primary and secondary tanks are sized in accordance with NFPA 30
- Rear stub-up access.

DUAL WALL TANKS

- The sub-base fuel tank mounts below the generator set wide base.

INTEGRAL

- Integral diesel fuel tank is incorporated into the generator set base frame
- Robust base design includes linear vibration isolators between tank base and engine generator.

OPTIONS

- Audio/visual fuel level alarm panel
- 5 gal (18.9 L) spill containment
- 5 gal (18.9 L) spill containment with fuel fill drop tube with in 6" (152 mm) from bottom of tank
- 5 gal (18.9 L) spill containment with overfill prevention valve and fuel fill drop tube with in 6" (152 mm) from bottom of tank
- ULC Listed 7.5 gal (28.4 L) spill containment with vent extensions, vent whistle, and drop tube facilitating compliance with CSA B139-09
- ULC Listed 7.5 gal (28.4 L) spill containment with overfill prevention valve, vent extensions, vent whistle and drop tube facilitating compliance with CSA B139-09.

Cat® C13
INTEGRAL & SUB BASE FUEL TANKS

INTEGRAL & SUB-BASE FUEL TANK BASE USABLE CAPACITIES WITH FUEL TANK DIMENSIONS & WEIGHTS

Integral – Width (W) 2014 mm (79.3 in)
Sub-base – Width (W) 2056 mm (81.0 in) Configuration

A. Open Set & Weather Protective Enclosure

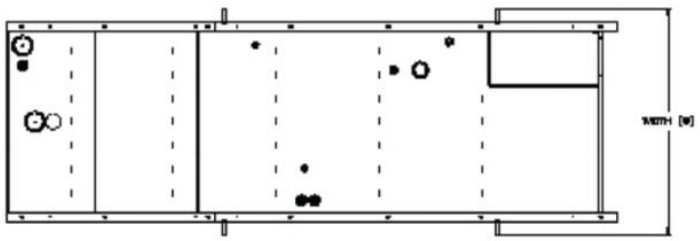
C13 Tank Design	Feature Code	Total Capacity		Usable Capacity		Tank Only						Overall Package height with Tank			
						Dry Weight#		Height 'H'		Length 'L'		Open		Enclosure	
		L	gal	L	gal	kg	lb	mm	in	mm	in	mm	in	mm	in
Integral	FTDW013	2646	699	2540	671	1569	3450	762	30	5461	215	2552	100.5	2743	108
Sub-Base	FTDW005	3941	1041	3876	1024	1659	3657	635	25	5550	218.5	2763	108.8	2955	116.3
Sub-Base	FTDW006	6980	1844	6818	1801	2228	4483	889	35.0	6184	243.5	3017	118.8	3209	126.3
Sub-Base	FTDW007	8339	2203	8244	2178	2150	4134	889	35	7074	278.5	2291	117.8	3789	149.2
Sub-Base	FTDW011	2476	654	2435	643	1468	3236	635	25	3810	150	2763	108.8	2955	116.3

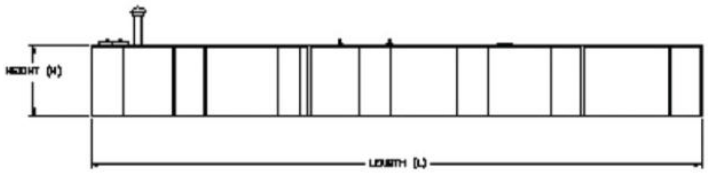
B. Sound Attenuated Enclosure

C13 Tank Design	Feature Code	Total Capacity		Usable Capacity		Tank Only						Overall Package height with Tank			
						Dry Weight#		Height 'H'		Length 'L'		Open		Enclosure	
		L	gal	L	gal	kg	lb	mm	in	mm	in	mm	in	mm	in
Integral	FTDW013	2646	699	2540	671	1569	3450	762	30.0	5461	215.0	NA	NA	2743	108.0
Sub-Base	FTDW005	3941	1041	3876	1024	1659	3657	635	25.0	5550	218.5	NA	NA	2955	116.3
Sub-Base	FTDW006	6980	1844	6818	1801	2228	4483	889	35.0	6184	243.5	3017	118.8	3209	126.3
Sub-Base	FTDW007	8339	2203	8244	2178	2292	5052	889	35.0	7074	278.5	NA	NA	3209	126.3
Sub-Base	FTDW011	2476	654	2435	643	1468	3236	635	25.0	3810	150.0	NA	NA	2955	116.3

C. Estimated Run Time (Hours) at 100% Load

C13 Tank Design	Feature Code	Standby Ratings (ekW)		Prime Ratings (ekW)	
		400	350	350	320
Integral	FTDW013	24	27	25	29
Sub-Base	FTDW005	36	41	38	43
Sub-Base	FTDW006	65	72	72	77
Sub-Base	FTDW007	77	87	81	93
Sub-Base	FTDW011	23	25	24	27





Cat® C13
INTEGRAL & SUB BASE FUEL TANKS

Tanks with full electrical stub-up area include removable end channel. Tanks with RH stub-up include stubup area directly below the circuit breaker or power terminal strips. Dimensions include weather-protective enclosure exhaust system.

Dual wall sub-base tanks are UL Listed and constructed in accordance with UL Standard for Safety UL 142, Steel Abo- veground Tanks for Flammable and Combustible Liquids and Canada CAN/ULC S601, Standard for Shop Fabricated Steel Aboveground Horizontal Tanks for Flammable and Combustible Liquids.

Fuel tanks and applicable options facilitate compliance with the following United States NFPA Code and Standards:

NFPA 30: Flammable and Combustible Liquids Code

NFPA 37: Standard for the Installation and Use of Stationary Combustion Engines and Gas Turbines

NFPA 110: Standard for Emergency and Standby Power Systems

Fuel tanks and applicable options facilitate compliance with the following Canadian Standard and Code:

CSA C282 – Emergency Electrical Power Supply for Buildings

CSA B139-09 – Installation Code for Oil-Burning Equipment

The following sub-base fuel tanks meet Chicago code for containment and labelling:

FTDW005

FTDW008
FTDW011

Image shown may not reflect actual configuration.

SOUND ATTENUATED & WEATHER PROTECTIVE ENCLOSURES

60 Hz

FEATURES

Robust/Highly Corrosion Resistant Construction

- Factory installed on skid base
- Environmentally friendly, polyester powder baked paint
- 14 gauge steel
- Interior zinc plated fasteners
- Exterior stainless steel fasteners
- Internally mounted exhaust silencing system
- Designed and tested to comply with UL 2200 Listed generator set package
- Compression door latches providing solid door seal

Excellent Access

- Large cable entry area for installation ease
- Accommodates side mounted single or multiple breakers
- Three doors on both sides
- Vertically hinged allow 180° opening rotation and retention with door stays
- Lube oil and coolant drains piped to the exterior of the enclosure base
- Radiator fill cover

Security and Safety

- Lockable access doors which give full access to control panel and breaker
- Cooling fan and battery charging alternator fully guarded
- Fuel fill, oil fill and battery can only be reached via lockable access
- Externally mounted emergency stop button
- Designed for spreader bar lifting to ensure safety
- Stub-up area is rodent proof.

Transportability

- These enclosures are of extremely rugged construction to withstand outdoor exposure and rough handling common on many construction sites.

FEATURES

Options (Sound Attenuated)

- Enclosure constructed with 14 gauge steel
- Enclosure constructed with 12 gauge aluminum (5052 grade)
- Caterpillar yellow or white paint
- Control panel viewing window
- UL Listed integral fuel tank with 670, 400, and 300 gallon capacities
- UL Listed sub base fuel tank with 660, 1000, 1900, and 2200 gallon capacities.
- Seismic certification per applicable building codes: IBC 2000, IBC 2003, IBC 2006, IBC 2009, IBC 2012, CBC 2007, CBC 2010
- IBC Certification for 150 mph wind loading
- AC/DC lighting package
- 5 kW Canopy space heater to facilitate compliance with NFPA 110
- Motorized louvers and gravity discharge damper
- 125A Load Center
- GFCI outlets

Options (Weather Protective)

- Caterpillar Yellow or white paint
- UL Listed integral fuel tank with 680, 400, and 300 gallon capacities
- UL Listed sub-base fuel tank with 660, 1000, 1900, and 2200 gallon capacities.
- Seismic certification per applicable building codes: IBC 2000, IBC 2003, IBC 2006, IBC 2009, IBC 2012, CBC 2007, CBC 2010.
- IBC Certification for 150 mph wind loading
- Anchoring details are site specific and are dependent on many factors such as generator set size, weight, and concrete strength. IBC Certification requires that the anchoring system used is reviewed and approved by a professional engineer.
- AC/DC lighting package

ENCLOSURE PACKAGE OPERATING CHARACTERISTICS

Enclosure Type	Standby ekW	Cooling Air Flow Rate		Ambient Capability*		Sound Pressure Levels (dBA) at 7m (23 ft)
		m^3/s	cfm	°C	°C	100% Load
Level 1 Sound Attenuated Enclosure (Steel)	350	8.5	18010	57	135	74
	400	8.5	18010	56	133	75
Level 2 Sound Attenuated Enclosure (Steel)	350	7.2	15256	50	122	70
	400	7.2	15256	50	122	70
Sound Attenuated Enclosure (Aluminum)	350	8.5	–	57	135	75
	400	8.5	–	56	133	75
Weather Protective Enclosure	350	8.5	–	54	129	87
	400	8.5	–	53	127	88

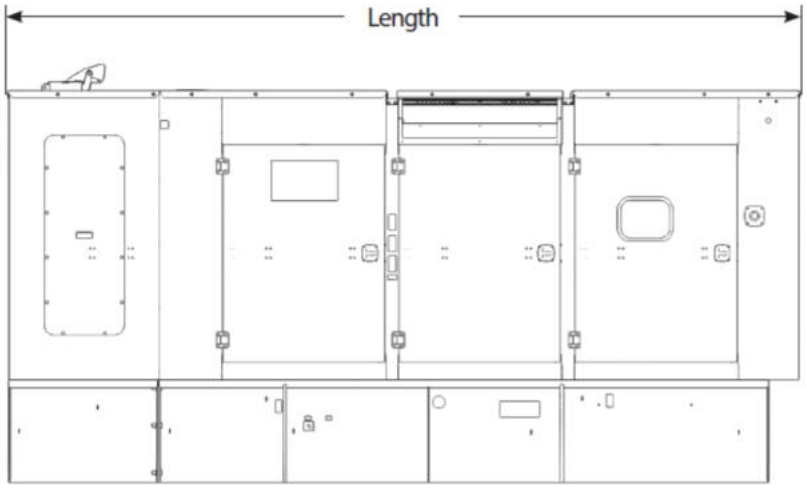
Note: Sound level measurements are subject to instrumentation, installation and manufacturing variability, as well as ambient site conditions.

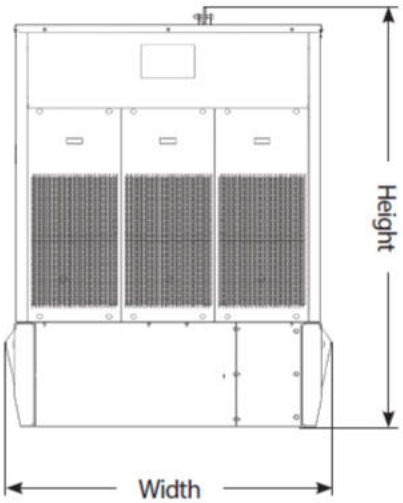
DIMENSIONS

Enclosure Type	Standby ekW	Length "L"		Width "W"		Height "H"	
		mm	in	mm	in	mm	in
Sound Attenuated Enclosure on Skid Base	350	4948	194.8	2014	79.3	2320	91.3
	400						
Sound Attenuated Enclosure on a UL Listed Integral Fuel Tank Base	350	5461	215.0	2014	79.3	2743	108.0
	400						
Sound Attenuated Enclosure on a UL Listed 660 Gallon Sub-Base Fuel Tank Base	350	4948	194.8	2056	80.9	2955	116.3
	400						
Sound Attenuated Enclosure on a UL Listed 1000 Gallon Sub-Base Fuel Tank Base	350	5751	226.4	2056	80.9	2955	116.3
	400						
Sound Attenuated Enclosure on a UL Listed 1900 Gallon Sub-Base Fuel Tank Base	350	6382	251.2	2056	80.9	3209	126.3
	400						
Sound Attenuated Enclosure on a UL Listed 2200 Gallon Sub-Base Fuel Tank Base	350	7074	278.5	2056	80.9	3209	126.3
	400						
Weather Protective Enclosure on Skid Base	350	4948	194.8	2014	79.3	2320	91.3
	400						
Weather Protective Enclosure on a UL Listed Integral Fuel Tank Base	350	5461	215.0	2014	79.3	2743	108.0
	400						

COMPONENT WEIGHTS TO CALCULATE PACKAGE WEIGHT

Standby ekW	Narrow Skid Base		Wide Skid Base		Sound Attenuated Enclosure (Steel)		Sound Attenuated Enclosure (Aluminum)		Weather Protective Enclosure	
	kg	lb	kg	lb	kg	lb	kg	lb	kg	lb
350	253	578	579	1276	1245	2745	765	1687	1166	2570
400										





Cat® C13
CONTROL PANEL

Image shown may not reflect actual configuration.

GCCP 1.3 – Control Panel

GCCP 1.3 Control Module is suitable for a wide variety of generator set applications. It controls operation of the generator, monitors an extensive number of engine parameters, and displays warnings, shutdown, and engine status information on the back-lit LCD screen, illuminated LEDs and remote PC, if desired

KEY FEATURES

- 4-line back-lit LCD text display
- Multiple display languages
- Five-key menu navigation
- LCD alarm indication
- Customisable power-up text and images
- Data logging facility
- Internal PLC editor
- Protections disable feature
- Fully configurable via PC using USB & RS485 communication
- Front panel configuration with PIN protection
- Power save mode
- 3-phase generator sensing and protection
- 3-phase mains (utility) sensing and protection (Optional)
- Automatic load transfer control (optional)
- Auto Mains (Utility) Failure capable (optional)
- Mains (utility) current and power monitoring (kW, kvar, kVA, pf) (Optional)
- Generator current and power monitoring (kW, kvar, kVA, pf)
- kW and kvar overload and reverse power alarms
- Over current protection
- Unbalanced load protection
- Breaker control via fascia buttons
- Fuel and start outputs configurable when using CAN
- Support for 0 V to 10 V & 4 mA to 20 mA sensors
- 8 configurable digital inputs (3 available for Customer use)
- 8 configurable digital outputs (5 available for Customer use)
- 4 configurable analogue outputs (3 available for Customer Use)
- CAN, MPU and alternator frequency speed sensing in one variant
- Real time clock
- Engine pre-heat and post-heat functions
- Engine run-time scheduler
- Engine idle control for starting & stopping
- Fuel usage monitor and low fuel level alarms
- 3 configurable maintenance alarms

BENEFITS

- Hours counter provides accurate information for monitoring and maintenance periods
- User-friendly set-up and button layout for ease of use
- Multiple parameters are monitored & displayed simultaneously for full visibility
- The module can be configured to suit a wide range of applications for user flexibility
- PLC editor allows user configurable functions to meet user specific application requirements.
- RS485 Communication port can be used for the Remote Monitoring Communication (Compatible with Cat PLG)

SPECIFICATION

DC SUPPLY
CONTINUOUS VOLTAGE RATING
8V to 35V Continuous
5V for upto 1 minute

CRANKING CROPOUTS
Able to survive 0V for 100mS, providing supply was at least 10V before dropout and supply recovers to 5V. This is achieved without the need for internal batteries.
LEDs and backlight will not be maintained during cranking.

MAXIMUM OPERATING CURRENT
260 mA at 12V, 150 mA at 24V

MAXIMUM STANDBY CURRENT
145 mA at 12V, 85 mA at 24V

CHARGE FAIL/EXCITATION RANGE
0V to 35V

GENERATOR & MAINS (UTILITY) VOLTAGE RANGE
15V to 415V AC (Ph to N)
26V to 719V AC (Ph to Ph)

FREQUENCY RANGE
3.5 Hz to 75 Hz

MAGNETIC PICKUP VOLTAGE RANGE
+/-0.5V TO 70V

FREQUENCY RANGE
10,000 Hz (max)

INPUTS

DIGITAL INPUTS A TO H
Negative switching

ANALOGUE INPUTS A & D
Configurable as:
Negative switching digital input 0V to 10V sensor
4 mA 20 mA sensor resistive sensor

ANALOGUE INPUTS B & C
Configurable as:
Negative switching digital input resistive sensor

OUTPUTS

OUTPUT A 7B (FUEL & START)
15A DC at supply voltage

AUXILIARY OUTPUTS C, D, E, F, G & H
2A DC at supply voltage

DIMENSIONS OVERALL
216 mm x 158 mm x 43 mm
8.5" x 6.2" x 1.5"

PANEL CUT-OUT
184 mm x 137 mm
7.2" x 5.3"

MAXIMUM PANEL THICKNESS
8 mm
0.3"

STORAGE TEMPERATURE RANGE
-40°C TO +85°C
-40°F TO 185°F

OPERATING TEMPERATURE RANGE
-30°C to +70°C
-22°F to +158°F

LET'S DO THE WORK.™

www.cat.com/electricpower

LEHE1571-06 (11/22)

Appendix F

Technical Specifications Report

Part IV

TECHNICAL SPECIFICATIONS

Technical Specifications Prepared Under the Supervision of:

TETRA TECH, INC.
17885 Von Karman Avenue, Suite 500
Irvine, CA 92614
(949) 809-5000

_____ _____

Thomas L. Epperson RCE No. 36399 (Expires 6/30/26) Date

EL TORO WATER DISTRICT
ALISO CREEK LIFT STATION IMPROVEMENTS PROJECT

TECHNICAL SPECIFICATIONS

TABLE OF CONTENTS

SECTION 01010

SUMMARY OF WORK

PART 1 - GENERAL

A. Scope of Work

The Contractor shall provide all labor, equipment, materials, transportation, etc. as necessary for the construction of the new Aliso Creek Lift Station including but not limited to construction of a concrete wet well, valve and meter vault, installation of three submersible pumps, motors, electrical building, emergency backup generator, piping, valves, electrical and control equipment, site work, modification of the existing lift station and all other appurtenant work as required in the Drawings and Specifications.

B. Location of Project Site

The Aliso Creek Lift Station Improvement Project is located within the existing Aliso Creek Lift Station site located at 24091 Avenida Sevilla in the City Laguna Woods, California.

C. Work Area Limits and Site Access

Work shall be limited to the Aliso Creek Lift Station property and the adjacent areas noted on the Drawings. Within Avenida Sevilla, the Contractor shall limit his work area to maintain at least the minimum travel lanes specified in Section L (Traffic Control Concepts) of this Technical Specification. The Contractor will be required to close the adjacent sidewalk but all sidewalk closures shall be limited to the time and duration specified in Section L (Traffic Control Concepts). Work shall be carried out in such a manner as to cause the minimum amount of interference to traffic, cyclists or pedestrians. Contractor/employee vehicle parking will not be allowed on Avenida Sevilla. Trucks, backhoes and equipment being used in the construction activities can be located in work areas within the Contractor's approved traffic control plans.

ETWD will be responsible for the operation of the Aliso Creek Lift Station throughout the execution of this contract. Equipment presently installed at the station must be available to District personnel at all times for use, maintenance and repair. If it is necessary in the course of operating the lift station, for the Contractor to move his equipment, materials, or any material included in the work, they shall do so promptly and place that equipment or material in an area which does not interfere with the operation of the lift station at no cost to the District. The Contractor shall not adjust or operate serviceable or functioning equipment or systems except as specifically required by this contract.

D. Storage/Staging Area

At the end of each working day and at times when construction operations are suspended for any reason, the Contractor shall remove all equipment, vehicles, material, portable restrooms, traffic control devices, stockpile or any other form of obstruction from Avenida Sevilla right-of-way.

The Contractor shall be solely responsible for the condition, maintenance and removal of materials and equipment from the public right-of-way at the end of each work day. It shall be the Contractor's responsibility to provide at their expense all materials, equipment, labor, and transportation necessary to facilitate delivery of the material and equipment from the work area to the Contractor's staging/storage area.

The Contractor shall acquire at their own expense any storage/staging area of adequate size and access to facilitate Contractor's own operations including storing and staging of materials, and Contractor/employee vehicle parking. The Contractor shall meet all conditions and requirements of the Property Owner. Expenses related to storage yards and staging areas shall be included in the mobilization bid item. The Contractor shall be responsible for securing the site to protect his property from vandalism and loss and to protect the public from possible injury.

The Contractor shall inform the District of their activities for obtaining any staging area they deem necessary. The Contractor is advised that the staging area must be obtained directly in writing from the Property Owner by the Contractor for use during the construction period. In obtaining such staging area, the Contractor shall obtain all necessary permits and comply with local ordinances and regulations. The Contractor is responsible for any rents, fines, damages, and restoration costs associated with the staging area. The District shall be furnished a copy of the written agreement with the affected Property Owner prior to using the staging area. The agreement shall contain a written release statement approved by the District and shall be executed by the Property Owner that all work including restoration is to be the Property Owner's satisfaction and is complete. The District shall be provided with a copy of a written release from the Property Owner releasing the Contractor from any future claims prior to filing the Notice of Completion.

E. Work Hours

The typical work hours are specified within Section 1-57 of the Special Provisions. The authorized work hours shall be 8:00 am to 4:30 pm within the lift station site. The Contractor shall schedule deliveries of materials between the hours of 9:00 am to 3:00 pm Monday through Friday to minimize traffic impacts during morning and evening rush hours.

F. Phasing of the Work

Construction schedule shall be determined by the Contractor and approved by the District. The Contractor shall submit a Construction Schedule and Sequence Plan to the District at least two (2) weeks prior to the beginning of construction, which shall include an overview and general sequence of work and the time and date for each item of work.

The existing lift station shall remain in service until the new lift station is tested and accepted. The Contractor shall perform the work in sequence and in general as shown on Sheet C-105 Conceptual Phasing Plan. Completion dates of the various stages shall be in accordance with the approved construction schedule submitted by the Contractor. The following is the anticipated general construction sequencing. The Contractor is responsible

to determine the final schedule of specific activities and sequencing based on the guidelines of the following general plan.

1. Submit shop drawings of long lead items (pump and motor, soft starters, diesel generator, pre-cast concrete vault and wet well, etc.).
2. Prepare and submit Traffic Control Plans. Obtain approval of traffic control plans.
3. Perform Phase I work for modifying the site for interim operation, including the following: relocation of the existing generator, bypass pump, electrical conduits; removal of interfering portions of the existing block wall, the existing electrical building, and force main bypass piping; removal of trees, landscaping, and irrigation lines; installation of a switchboard, ATS, and temporary electrical conduits and conductors.
4. Perform Phase II work for construction of the new lift station, including the following: construction of the electrical building, wet well, pumps and motors, valve and meter vault, and portions of yard piping, with the exception of connection to the existing gravity sewer and force main.
5. Perform the Phase III connections and new station startup, including the following: use a temporary to test and operate the new lift station for functionality testing of pumps, motors, and instrumentation. Contractor shall provide temporary discharge connection and above ground piping to connect to bypass connection as shown in the plans. Existing lift station will remain in service and will operate as needed during the testing of the new lift station.
6. Once the new station is tested, bypass pumping will be installed. Under bypass, construct new manhole and 18-inch gravity sewer to new wet well and construct force main connection piping. Connect the new lift station to the MSB/ATS.
7. Once these two activities are completed, the new lift station will be in service at all times and the existing lift station will be taken out of service.
8. Perform Phase IV for modification of the existing lift station including the following: removal of existing lift station piping, valves, pumps, motors, and electrical equipment (items to be salvaged and returned to the District as noted on the Plans); demolition of electrical building; and modification of the existing wet well to transfer flow, retrofit of the dry pit for overflow use, connection to the modified dry pit.
9. Perform Phase IV site improvements, including the following: installation of the stand-by generator pad and installation of the generator and electrical conduits; site improvements including replacement of the perimeter wall, construction of driveway, curb, gutter, AC paving; grind and cap of the Upper Aliso Creek Trail access path.
10. Perform generator testing and commissioning.
11. Site clean-up and demobilization.

G. Progress Meetings

The Contractor shall attend weekly construction progress meetings with the District's Representative and the District. These weekly meetings shall be attended by the Contractor's superintendent and representatives of all subcontractors, utilities, and others, who are active in the execution of the work.

The purpose of the weekly meetings is to review the progress of the project, discuss near term activities, clarifications and problems which need resolution, coordination with other contractors and the City, address potential delays, status of changes orders, safety issues, etc. At each progress meeting the Contractor shall submit their Plan of Activities for the following two weeks. The Plan of Activities shall describe all activities anticipated during that two-week period, including any traffic impacts.

H. Work by Others

The Contractor's attention is directed to the fact that work may be conducted at or adjacent to the project site by other contractors during the performance of the Work under this Contract. Coordination with other contractors shall be the responsibility of the Contractor as is specified in Section 1-60 of the Special Provisions. The following is a list of known work to be performed concurrently with this project:

- None

I. Permits

All Work performed shall be in accordance with the permit requirement of the agencies having jurisdiction including, but not limited to, work hours, traffic control and street renovation as is specified in Section 1-34 of the Special Provisions.

The following plan approval/permits are required. Contractor shall adhere to all requirements and special provisions thereof, including but not limited to providing business documentation to procure final permit.

1. City of Laguna Woods

    a. **Encroachment Permit:** The plans and specifications have been submitted to the City of Laguna Woods for an encroachment permit. The encroachment permit is required prior to any work within public right-of-way. The District will pay all encroachment permit fees. The Contractor will be responsible to procure the permit from the City of Laguna Woods prior to beginning any work within the City of Laguna Woods public right-of-way.

3. El Toro Water District

    The Contractor shall obtain and pay a deposit for a **Temporary Water (Flooding) Meter** from El Toro Water District as is specified in Section 1-21 of the Special Provisions. Construction water will be provided to the Contractor at no cost.

4. Regional Water Quality Control Board

   NPDES Permit: For this Contract, the Contractor will not be authorized to discharge groundwater, pipeline dewatering or water for pressure testing or flushing to the storm drain. All groundwater, pipeline dewatering and water for pressure testing or flushing shall be discharged to the nearest ETWD sewer facility. All discharges to the sewer shall be coordinated with the District.

5. Cal OSHA

   OSHA Permits and Excavation Permit: Including an inquiry I.D. number from "Underground Service Alert."

6. Best Management Practices (BMPs): The Contractor shall implement and maintain the appropriate BMPs to prevent storm water pollution within the project site at all times during the project duration.

J. City of Laguna Woods Requirements

An encroachment permit is required prior to any work within public right-of-way. The District will pay all encroachment permit fees. The Contractor will be responsible to procure the permit from the City of Laguna Woods prior to beginning any work within the City of Laguna Woods public right-of-way. The Standard Encroachment Permit Conditions are included in Appendix X. The following is a brief summary of some of the key requirements for the work within the City of Laguna Woods.

1. The Contractor shall schedule a pre-construction meeting with the City Engineer at the job site a minimum of two work days prior to the commencement of work. The City Engineer and City Inspection may be reached at (xxx)xxx-xxxx.

2. No work shall be performed within the City right-of-way without the full knowledge of the assigned City Public Works Inspector who shall be given not less than ***two (2) working days advance*** notice of the initiation of permitted use at (xxx)xxx-xxxx .

3. Any landscaping, irrigation or other hardscape facilities within the area of work damaged during construction activities shall be restored, repaired or replaced to the satisfaction of the City Engineer prior to the completion of work proposed by this permit.

4. Any striping damaged during the work proposed by this permit shall be restored in-kind to the satisfaction of the City Engineer prior to the completion of work proposed by this permit.

5. All traffic control measures shall be removed from the road way and sidewalks, if applicable, prior to 3:00 PM at the end of each work day.

6. A copy of the approved Encroachment Permit and approved plans shall be kept on the job site at all times. A copy of the approved Traffic Control Plans shall be kept on the job site at all times.

7. Excavated material cannot be stockpiled on any City streets.

8. All Underground Service Alert (USA) / utility markings shall be removed at the time of completion of the work. The Contractor will be responsible to meet this requirement, including the corresponding costs.

9. All improvements above ground shall provide: 18" clearance from curb face, 48" clearance on sidewalk for vertical obstructions. The City inspector, prior to installation, shall inspect each location.

10. All trenching or boring in streets shall be properly backfilled or properly protected (i.e. non-skid metal plates) at the end of each working day. The Contractor shall remove all equipment, vehicles, material, traffic control devices, stockpile, portable restrooms, or any other form of obstruction from the street right-of-way at the end of each working day.

11. Pedestrian access on sidewalks shall be maintained as much as practicably possible. If pedestrian access is blocked, the Contractor shall place "Closed Sidewalk" signs at the beginning and end of the sidewalk or at the nearest intersections.

12. Where Portland Cement Concrete pavement is removed or damaged, replacement Type V Portland Cement Concrete pavement conforming to Standard Specifications for Public Works Construction, latest edition, Section 201, and approved by the City Inspector MUST be provided to the next score joint. No partial slabs will be allowed. In no case shall any sidewalk removal / re-placement be less than 20 square feet and the smallest dimension not less than 48 inches. All final repairs shall be complete within five (5) working days of initial sidewalk removal.
13. orking days of initial sidewalk removal.
14. rking days of initial sidewalk removal.

15. Where Portland Cement Concrete pavement, as part of a handicap ramp, has been removed or damaged, replace Type V Portland Cement Concrete pavement conforming to Standard Specifications for Public Works Construction, latest edition, Section 201, approved by the City Inspector, and conforming to the latest Americans with Disabilities Act (A.D.A.) Standard as determined by the City Public Services Department.

16. All existing lane striping to be removed shall be sandblasted. Painting of existing lane striping black will not be allowed. Contractor shall replace all existing reflector markers located along the painted medians per the City's requirements.

17. In the event that existing traffic striping or stenciling is obliterated by construction, it will be the responsibility of the Contractor to replace the said striping or stenciling to the satisfaction of the City. All restriping shall require two coats (two phases).

K. Traffic Control Plans

The Contractor shall maintain at all times vehicle traffic flow and pedestrian traffic. If it is necessary to impact any vehicle traffic within either public roads, the Contractor shall submit traffic plans per the latest Work Area Traffic Control Handbook (WATCH) manual or the latest Manual on Uniform Traffic Control Devices (MUTCD). The Contractor shall have the traffic control plans, including detour plans, prepared, stamped, and signed by a Licensed Civil or Traffic Engineer.

Traffic control plans shall be prepared, stamped, and signed by a licensed Civil or Traffic Engineer, and submitted to the City of Laguna Woods for approval no later than six (6) weeks prior to the beginning of any desired lane closures. Assume for scheduling, the first submittal will require four (4) weeks for the City to review and that a second submittal will be required. Assume the second submittal will require two (2) weeks for the City to review and approve. It shall be the Contractor's responsibility to immediately revise said plan traffic control plans based on the review comments and the Contractor hereby agrees that such changes shall be considered as changes necessary to meet the requirements of the Contract Documents and shall not be taken as a basis of claims for extra work. The approved traffic control plans shall be strictly adhered to.

The Contractor will be solely responsible to prepare, process and obtain approval of the traffic control plans from the City of Laguna Woods. Preparation of any additional traffic control plans or details that may be required by the City having jurisdiction during the course of the construction shall be the Contractor's responsibility. Contractor shall also submit traffic control plans for pavement construction operations, prepared, stamped, and signed by a Licensed Civil or Traffic Engineer, for approval not less than six (6) weeks prior to the start of the paving operations.

No work shall begin involving or requiring traffic control until a traffic control plan is approved by the City having jurisdiction, and the plans are acceptable to the District. No time extension will be provided for delays related to failure of obtaining approval from a City of the traffic control plans.

L. Traffic Control Concepts

Traffic control plans, including detours, will need to be prepared for all work that will impact travel lanes, bike lanes, and pedestrian traffic within the project area. The following are the general traffic control requirements that are desired and shall be implemented if at all feasible:

1. For work within the project site, close and detour the adjacent sidewalk to pedestrian traffic. The sidewalk closure (detour sidewalk) will remain 24 hours per day from

Monday to Friday but will be opened for pedestrian traffic on Saturday, Sunday, holidays and all days that construction activities are not happening at the project site.

2. For work within the project site, close the street parking located immediately adjacent to the project site. Parking will be prohibited in front of the site Monday to Friday, except for holidays. Contractor to post No Parking signs for Monday thru Friday. The no parking signs will be covered/removed on Saturday, Sunday and holidays.

3. For work within the project site, the Contractor shall maintain a minimum of one (1) travel lanes in each direction. The traffic control can be left in place (24 hours per day) Monday thru Friday, except for holidays. The traffic control shall be removed by 3:00 pm on Friday and shall not be set up until 9:00 am on Monday. No travel lane closures will be allowed within Avenida Sevilla on Saturday, Sunday or holidays.

M. Additional General Traffic Requirements

The Contractor shall be responsible to furnish and maintain signage and barricades for any road closures or parking closures.

The Contractor shall develop the detour plan and location of sign placements to direct pedestrians around the Work for review and approval by the City and the District. The Contractor shall be responsible to maintain the signs and barriers at all times.

The Contractor shall be responsible for furnishing, posting, and removing temporary "No Parking" signs within Avenida Sevilla, adjacent to the project site. Signs shall be posted at least 48 hours in advance of work. Signs may be attached to existing poles, or whatever is existing. When necessary, the Contractor shall furnish posts. Format of temporary "No Parking" signs shall be reviewed and approved by the City and the District prior to posting.

The Contractor shall perform periodic patrols of the construction area during both working and non-working hours to replace and/or set up any signs, barricades, etc., which may have been knocked down. All flasher type barricades shall be maintained in operating conditions. When the project is complete, all traffic control signs, barricades and delineators shall be removed from the site and shall remain the property of the Contractor.

Any existing speed limit signs or other conflicting signs in the construction zone shall be covered during construction with heavy duty black plastic (non-transparent) sheets or bags, which are secured to the sign post below the sign with tape. In no case shall tape be applied to either front or back of any sign.

The following entities shall be notified at least 72 hours in advance of any lane closure or restriction to access by the Contractor.

1. City of Laguna Woods
2. El Toro Water District
3. Fire Department
4. Police Department
5. Refuse Collection Company

The Contractor shall provide two (2) solar powered changeable message signs (CMS) for Avenida Sevilla. The CMS shall be posted in advance of the work and shall be located at each end of the work on Avenida Sevilla. These CMS can be LED full matrix or letter matrix or equivalent, with three (3) rows of preferred 8" letters (minimum of 6"). The overall width of the sign including trailer shall not exceed 8 feet.

a. Prior to start of construction, display the following message: "ETWD Lift Station Construction Begins _____."

b. When construction starts, display the following message: "ETWD Lift Station Construction will impact traffic. Recommend alternative route."

The message may be changed at any time as determined by the City and/or the District.

N. Noise Abatement

As stated in Section 1-49 of the Special Provisions, the Work shall be carried on as quietly as possible to prevent possible annoyance to adjacent residential property owners. Unnecessary noise shall be avoided at all times. The Contractor shall comply with the requirements of Chapter 7.08 of the City of Laguna Woods Municipal Code.

O. Public Convenience and Access

Safe, adequate pedestrian access to all public streets, public parks, private streets, garages, places of business, and other establishments affected by the Work, shall be provided and maintained by the Contractor at all times.

The Contractor shall maintain and delineate a minimum of one four (4) foot wide pedestrian walkway along each public and private streets at all times during construction. The Contractor shall also place pedestrian detour signs as required if sidewalks will not be able to be maintained during the construction activities. The Contractor shall maintain existing pedestrian accesses at intersections at all times. When existing crosswalks are blocked by construction activity, the Contractor shall install signs directing pedestrian traffic to the nearest alternative cross walk.

Fencing or other means of securement shall be provided to preclude unauthorized entry to any excavation, not within travel way, during all non-working hours on a 24-hour basis

including weekends and holidays. Fencing shall be a minimum of seven (7) feet high around the entire excavation, and shall consist of a minimum 9-gage chain link type fence sturdy enough to prohibit toppling by children or adults. There shall be no openings under the wire large enough for any child to crawl through. Gates shall be locked if no adult is in attendance. Warning signs shall be placed at 50-foot centers on the outside of the fence with the statement "DEEP HOLE DANGER."

Reasonable access from public streets to all adjacent properties shall be maintained at all times during construction. Prior to restricting normal access from public streets to adjacent properties, each property owner or responsible person shall be informed of the nature of the access restriction, the approximate duration of the restriction, and the best alternate access route for that particular property.

P. Temporary Steel Plates

When the backfilling operations of an excavation in the traveled way, whether transverse or longitudinal cannot be properly completed within a work day, steel plate bridging with a non-skid surface and shoring may be required to preserve unobstructed traffic flow. In such cases, the following conditions shall apply:

1. Steel plates used for bridging shall extend a minimum of 12-inches beyond the edges of the trench.
2. Steel plate bridging shall be installed to operate with minimum noise.
3. The trench shall be adequately shored to support the bridging and traffic loads.
4. Temporary paving with hot mix asphalt concrete shall be used to feather the edges of the plates, if plate installation method (1) described below, is used.
5. Bridging shall be secured against displacement by using adjustable cleats, shims or other devices.

Steel plating bridging and shoring shall be installed using the following Method (1):

Method (1) (For speeds 45 mph or more)

The pavement shall be cold planed to a depth equal to the thickness of the plate and to a width and length equal to the dimensions of the plate.

Method (2) (For speeds less than 45 mph)

Approach plate(s) and ending plate (if longitudinal placement) shall be attached to the roadway by a minimum of two (2) dowels pre-drilled into the corners of the plate and drilled 2-inches into the pavement. Subsequent plates are butted to each other. Fine grades hot mix asphalt concrete shall be compacted to form ramps, maximum slope of 8.5% with a minimum of 12-inch taper to cover all edges of the steel plates.

When steel plates are removed, the dowel holes in the pavement shall be backfilled with either graded fines or asphalt concrete hot mix, concrete slurry or an equivalent slurry that is satisfactory to the City. The Contractor shall be responsible for maintenance of the steel plates, shoring and asphalt concrete ramps. The following table shows the advisory minimal thickness of steel plate bridging required for a given width (A-36 grade steel, designed for HS 20-44 truck loading).

Trench Width	Minimum Plate Thickness
10”	½”
1’-11”	¾”
2’-7”	7/8”
3’-5”	1”
5’-3”	1-1/4”

For spans greater than 5’-3”, a structural design prepared by a California registered civil engineer is required.

All steel plates within the right-of-way whether used in or out of the travel way shall be without deformation. Steel plates shall be non-skid. Advanced warning signs shall be required for steel plates within traveled ways (Type P per the Watch Manual or a “Rough Road” sign (W33) per Caltrans requirements).

Q. Work Site Maintenance

The Contractor shall keep the work sites clean and free from rubbish and debris in accordance with Section 1-39 of the Special Provisions and Section 3-12 of the SSPWC.

The Contractor shall provide and operate a self-loading motor sweeper with spray nozzles, every day any public or private street work is performed or on days when multi-deliveries of materials have occurred, for the purpose of keeping the streets and surrounding streets clean as acceptable to the City of Laguna Woods and the Laguna Woods Village Community. The functional street sweeper shall be available at all times during the construction work hours when work is being performed in the public and private streets. The Contractor shall clean the public and private streets at the end of each work day, as a minimum, and at any time requested by the City of Laguna Woods, Laguna Woods Village Community and/or District. Payment for the clean-up and dust control shall be included in the price paid for other items of work. No additional payment will be made for work site maintenance.

The Contractor will be required to comply with the requirements of the Clean Water Act which is enforced by the Regional Water Quality Control Board through the City of Laguna Woods. This act prohibits certain discharges to the storm water drainage system. Any discharge, which is not comprised entirely of storm water or which contains any pollutant, shall not be discharged to the storm water drainage system or any upstream flow which is tributary to the storm water drainage system. Only clean potable water can be dumped onto the street or into the gutter. Any work that creates a slurry of asphalt or cement, such as saw cutting, shall be picked up by vacuum and disposed of other than in the street or gutter. The

Contractor will be required to collect the corresponding water and either convey it into local sewer facilities, pick it up by a vacuum, or place sand bags at the catch basins and desilt/filter the runoff until it meets the Clean Water Act requirements.

R. Water Pollution Control

Since the project disturbs less than (1) acre of land, the Contractor is not required to file a Notice of Intent with the State Water Resources Control Board (SWRCB). The Contractor shall employ methods and approved devices for the control of erosion and storm water runoff within the work area. All work must meet the current requirements for permitting, reporting, and implementing best management practices of the SWRCB.

S. Water Discharges

All water drained or flushed from pipelines, or used to disinfect or test portions of a pipeline shall be piped or conveyed for disposal into local sewage facilities. The Contractor will not be allowed to discharge this water to an existing storm drain facility or to a natural drainage channel.

The Contractor will need to coordinate this disposal with the District in order to schedule the flushing as well as confirm that the sewer system has adequate capacity to handle the flushing rate. All costs for draining existing lines and disposing of or reutilizing the water shall be paid for by the Contractor at his sole expense.

T. Dewatering

The Contractor shall submit their method of dewatering, if needed, to the District for approval as soon as groundwater is encountered. The use of gravel filled trenches or sumps alone may or may not be sufficient to adequately dewater the site for construction. The dewatering plan shall include drawings and data showing the planned method of dewatering, excavation plan, location and capacity of such facilities as dewatering wells, well points, pumps, sumps, collection and discharge lines, standby units proposed, and protective fills and ditches required for control of groundwater and surface water.

Review by the District will not relieve the Contractor of the responsibility for the adequacy of the dewatering and excavation plan or for furnishing all equipment, labor, and materials necessary for performing the various parts of the work.

If, during the progress of the work, it is determined by the District's Representative that the dewatering system and excavation plan are inadequate or the Contractor's plan of construction is inoperative, the Contractor shall, at his expense, furnish, install, and operate such additional dewatering equipment and make such changes in other features of the plan or operation as may be necessary to perform the work in a manner satisfactory to the District.

Dewatering of non-contaminated or contaminated groundwater via surface erosion is prohibited. All dewatering of groundwater shall be discharged to the nearest sewer facility.

The Contractor will need to coordinate this disposal with the District in order to schedule the disposal as well as confirm that the sewer system has adequate capacity to handle the dewatering rate.

Based on exploratory borings during design, groundwater was encountered at a stabilized level of approximately 19ft bgs; groundwater contour maps of the area indicate the historic high groundwater table in the area is approximately 10 feet below the existing grade. The geotechnical report prepared by Verdantas Inc., dated September 25, 2024, and revised October 17, 2024, and entitled "Geotechnical Exploration Report, El Toro Water District, Aliso Creek Lift Station Improvements" has been included in Appendix X.

U. Restoration of Improvements

The Contractor shall be responsible for the protection of all the trees, shrubs, irrigation systems, fences, hardscape, walkways, street and other landscape items adjacent to or within the work area, unless they are directed to do otherwise on the Drawings.

In the event of damage to City improvements, the Contractor shall replace the damaged items in a manner satisfactory to the City. In the event of damage to private improvements, the Contractor shall replace the damaged items in a manner satisfactory to the District and the site representative.

All curbs, gutters, medians, driveways, sidewalks, cross gutters, buildings, equipment, roadways, utilities, traffic loops, detectors and wiring, grounds, landscaping, irrigation and similar improvements that are broken or damaged by the Contractor's operations shall be reconstructed by the Contractor. Reconstruction shall be of the same kind of materials with the same finish and in no less than the same dimensions as the original work. Repairs shall be made by removing and replacing the entire portion between joints or scores and not merely refinishing any damaged part. All work shall match the appearance of the existing improvements as nearly as possible.

Parking lots and roads in which the surface is removed, broken, or damaged, or in which the ground has caved or settled during the work under this Contract, shall be resurfaced and brought to the original grade and section. Parking lots and roadways used by the Contractor shall be cleaned and repaired. Before resurfacing material is placed, edges of pavements shall be trimmed back far enough to provide clean, solid, vertical faces, and shall be free of loose material.

Planted areas (including grass) and hardscape areas which are damaged by actions of the Contractor shall be restored as nearly as possible to their original condition. All trees, bushes or shrubbery that are removed or cut must be replaced with similar kind and quality. All irrigation lines and wires that are cut or damaged during the construction activities shall be repaired by approved methods to good working order at the end of each day. The Contractor shall be responsible for maintaining and cleaning up of all areas within each site of all paper, debris, etc., occurring from his construction activity. The Contractor shall resod all grass areas damaged during the construction activities. This restoration shall include

placement of five (5) inches of good topsoil, along with resoding and/or replacement of the landscape items.

Not all landscaped areas are shown on the Plans. The Contractor shall exercise extreme care and take every precaution necessary to protect existing landscaping. Contractor shall remove only those portions of the existing landscaping necessary for construction of this project. All landscaped areas shall be restored or replaced with similar kind and quality.

All costs for any of this work shall be included in the contract unit or lump sum prices for such work appurtenant thereto, and no additional allowance will be made therefore.

V. Permanent Traffic Control Devices

1. Existing permanent traffic control signs, barricades, and devices shall remain in effective operation unless a substitute operation is arranged for and approved as a portion of vehicular traffic control per all City/District Requirements. Replaced work shall be in accordance with the ordinances/regulations of the City of Laguna Woods.

2. Restriping of Streets: Any permanent restriping that is required shall be done by the Contractor. The Contractor is cautioned to check with the City of Laguna Woods to ascertain the extent and specifications for restriping.

   Temporary striping required for traffic control during construction shall also be done by the Contractor. Temporary striping includes any striping required on any pavement replaced prior to the final surface course. The Contractor shall remove any permanent striping that conflicts with the detour plan and all detour striping completely, prior to replacement of any final striping, by sandblasting only. Painting out existing striping shall not be permitted. Any damaged or obliterated raised pavement markers shall also be replaced in accordance with the City of Laguna Woods regulations.

3. Traffic Control Wire Loops: Traffic control wire loops which are cut, removed, or otherwise disturbed for construction of the pipeline shall be replaced to the exact original position. Replaced work shall be in accordance with section 86-5.01A of the State of California, Department of Transportation, Standard Specifications, and in accordance with all the requirements of the City of Laguna Woods. The number of turns in the loop shall be in accordance with the manufacturer's specifications for the vehicle detector. The proposed pipeline does not cross any traffic control wire loops.

   Detector lead-in conductors, cable, inductive loop conductor, and epoxy, shall conform to the provisions of Section 86 of the State of California, Department of Transportation, Standard Specifications and in accordance with all the requirements of the City of Laguna Woods. The cable shall not be spliced. Splices to lead-in conductors shall be made in pull boxes and soldered, wrapped, and water-proofed after sensitivity check at tuning turn on. Inductive loop wires shall be labeled in the pull box, identifying the loop and the direction of current flow. Saw cuts for

inductive loop wire shall be of a width such that the loop wires will fit within the cut snugly but without need for forcing of the wire.

4. Traffic Signals: Damaged traffic signal conduits shall be replaced to the nearest pull box, including new wire, back to the terminal, and/or back to the signal controller to the satisfaction of the City of Laguna Woods. Damaged traffic loops or signal conduit shall be repaired before proceeding to the next construction phase.

   Two traffic signal vehicle heads shall be visible at all times to vehicular at signalized intersections during construction.

W. Potholing

The Contractor shall pothole and locate the existing underground utilities as specified in Section 1-36 of the Special Provisions. The Contractor shall pothole and locate existing crossing and parallel underground utilities and points of connection prior to commencing construction. The Contractor shall be liable for any additional cost required in the event that he has not correctly located the existing utilities.

If the utilities differ from those shown on the Drawings, the Contractor shall notify the District's Representative immediately in writing. Within one week, the District may make changes with alignment and/or grade of the work to obviate the necessity to remove, relocate, protect or temporarily maintain such utilities or to reduce the costs of the Work involved in removing, relocating, protecting or temporarily maintaining such utilities.

X. Existing Pavement Structural Sections

The Contractor shall assume the following existing minimum pavement structural sections:

Within District Property:	2-inch thick AC over 4-inch AB
Within Avenida Sevilla:	2-inch AC (rubberized) over 10-inch AB with SC-2 Prime coat

The type and depth of the existing pavement structural sections were obtained from improvement plans and the District does not guarantee the accuracy of this determination.

The original saw cutting of the trench for removal of existing pavement structural section can be either accomplished by saw cutting with a power-driven saw or grinding with an asphalt zipper or cold planner. The final saw cutting, in conjunction with the trench pavement replacement, shall be accomplished by the use of a power-driven saw.

The depth of the cut shall be deep enough to produce a clean, straight break without loosening, cracking, or damaging adjoining asphalt so that there will be a good join between the existing pavement structural section and the trench pavement replacement structural section. The use of a grinder (cold planer) shall not be allowed in lieu of power-driven saw.

Y. Construction Staking

The Contractor shall be responsible for providing all construction staking required to prosecute the Work of the Contract. The District will not perform any construction survey staking. The construction staking shall be done under the direction and supervision of a Registered Licensed Surveyor. The Contractor shall provide the Engineer with copies of all cut sheets. The accuracy of all the Contractor's stakes, alignments and grades is the responsibility of the Contractor. However, the District has the discretionary right to check the Contractor's stakes, alignments, and grades at any time. Where such discretion is to be exercised by the District, the District's Representative will notify the Contractor of their intention, stating the time at which the checking will commence. Any part of the work in progress, the results of which are predicated directly upon the Contractor's stakes, alignments, or grades to be checked, shall be held in abeyance until the District has notified the Contractor that the checking has been completed.

All survey points destroyed as a result of the Contractor's negligence or failure to provide proper protection shall be replaced at the Contractor's expense.

The construction staking will include, but not be limited to: establishing the bench mark and basis of bearing; staking the pipeline for the USA marking; staking the pipeline at 50 foot intervals; staking all horizontal angle points, vertical angle points, tees, valves, and appurtenances.

Prior to commencement of work, all survey monuments in the project area shall be located and tied out by the Contractor. All centerline monuments or ties lost or destroyed by the construction activities shall be replaced and the Contractor shall file a corner record for all reset monuments at the expense of the Contractor per all applicable local and state laws, regulations and acts. The method of establishment shall be stated on the tie sheet. Tie sheets shall be prepared and stamped by a licensed Engineer or Surveyor and shall be delivered to the City of Laguna Woods or the County Surveyor.

Z. Compaction Testing

All compaction testing shall be performed by the District as specified in Section 1-63 of the Special Provisions.

AA. Project Signs

The Contractor shall furnish and install one project information sign. The District shall approve sign location in the field. The Contractor shall install all one sign a minimum of two weeks prior to beginning any construction activities. The Contractor shall provide adequate supports for the signs as site conditions may require and the signs shall be kept above ground and situated in a location visible by the public and acceptable to the City and the District. The Contractor shall include the cost of maintaining the signs and the removal of the sign once construction has been completed.

Dimensions of signs shall be 8-feet wide by 4-feet high mounted on 4-inch by 4-inch

wooden posts. Signs shall be white with black letters. The lettering and layout shall be provided by the District. The sign shall be made of metal by a firm regularly engaged in the business of sign making. Signs shall identify the District provided phone number for people to call for information and to call in case of emergency. If the face of the sign is defaced in any manner, the Contractor shall correct immediately.

BB. Pre-construction Video

The Contractor shall video the project area (the street pavement, striping, curb, gutter, sidewalk, etc.) and all adjacent properties to the street (block walls, fencing, structures, etc.) prior to any equipment being moved to the site.

The color video is intended for use as indisputable evidence in ascertaining the extent of any damage which may occur as a result of the Contractor's operations and are for the protection of the property owners, the Contractor and the District, and will be the means of determining whether and to what extent damage, resulting from the Contractor's operations, occurred during the Contract work. The video shall be provided on DVD and shall indicate on the case the date, name of the contract, and the location where the video was recorded. The video shall contain an audio track, which narrates the progression of the video through the site. Two copies of each DVD shall be delivered to the District within ten working days after the video is completed. The videographer shall be experienced in this type of work and equipped to video either interior or exterior scenes, with lenses having diagonal fields of coverage that range at least from 15 degrees to 65 degrees. The video on the DVD shall be write protected.

CC. Field Office Facilities

No Field Office Facilities are required. The Contractor shall provide his own field office facility for his own use.

DD. Supplemental Information

1. Whenever the term Engineer / Architect occurs in these Specifications, its meaning is as follows: Tetra Tech
   17885 Von Karman Avenue, Suite 500
   Irvine, CA 92614
   Telephone: (949) 809-5000; Fax: (949) 809-5010
   Contact: Mr. Tom Epperson, P.E.

2. Investigations and Reports: The following reports which have been prepared for the District and are provided in the appendix

   a. "Geotechnical Exploration Report, El Toro Water District, Aliso Creek Lift Station Improvements, 24091 Avenida Sevilla, Laguna Woods, California," prepared by Verdantas Inc., dated September 25, 2024 and revised October 17, 2024. A copy is included within Appendix X.

EE. Maintaining Sewer Flows

Contractor is cautioned that sewage will be flowing into the Aliso Creek Lift Station at all times. **Sewage Flow must be pumped from the lift station site at all times. Therefore, either the existing Aliso Creek Lift Station or the new Lift Station or bypass pumping will be required to be operational 24 hours per day, every day of the year.**

The current inflow to the Aliso Creek Lift Station varies from a minimum of about 300 gpm to a maximum of 3,400 gpm. This flow must be maintained at all times.

At a minimum, the existing Aliso Creek Lift Station and the new Aliso Creek Lift Station will both not be able to operate during the following construction: the piping connection to the existing force main; piping installation through the existing wet well; and the disconnect and connection of the SCE service from the existing and new electrical meter and switchboard.

For these activities, as a minimum, the District will either notify the Contractor, they will be required to bypass pump the sewage during the duration of the construction activities. For bidding purposes, the Contractor shall assume that bypass pumping will be required.

To minimize the risk of lift station failure, the District is requesting that the testing and start-up of the new lift station occur using a roll-up generator (connecting to the roll-up generator connection) while the existing lift station is still connected to SCE and is operational. The Contractor shall provide the generator and fuel as necessary. The Contractor shall coordinate the testing and start-up with the District so that the District can immediately turn on the existing lift station if issues arise with the new lift station. Contractor is responsible for all costs for the testing, functional testing and start-up of the new lift station prior to connecting to SCE for power.

END OF SECTION

SECTION 01045

EXISTING FACILITIES

PART 1 – GENERAL

A. Description

This section includes requirements for connection to and abandonment of existing water and sewer facilities.

B. Related Work Specified Elsewhere

1. Trenching, Backfilling, and Compacting: 02223.

2. Manual Valves: 15100.

C. Location

1. The Contractor shall be responsible for determining in advance the location of all existing pipelines to which connections are to be made.

2. The Contractor shall notify Underground Service Alert of Southern California (Dig Alert) at least two working days prior to construction at 1-800-422-4133.

D. Condition of Existing Facilities

The District does not warranty the condition, size, material, and location of existing facilities. The Contractor shall be responsible for verifying the properties of the existing pipe that will be connected to the proposed piping.

E. Protection of Existing Utilities and Facilities

1. The Contractor shall be responsible for the care and protection of all existing sewer pipe, water pipe, gas mains, culverts, power or communications lines, sidewalks, curbs, pavement, or other facilities and structures that may be encountered in or near the area of the work.

2. The Contractor shall submit a plan as to the method the Contractor will use to protect and support any utilities which will become exposed during excavation or that which are vulnerable to failure due to unsupported trenches or other construction activity.

3. In the event of damage to any existing facilities during the progress of the work and of the failure of the Contractor to exercise the proper precautions, the Contractor will pay for the cost of all repairs and protection to said facilities. The Contractor's work may be stopped until repair operations are complete.

F. Protection of Landscaping

1. The Contractor shall be responsible for the protection of all the trees, shrubs, irrigation systems, fences, and other landscape items adjacent to or within the work area, unless they are directed to do otherwise on the plans.

2. In the event of damage to landscape items, the Contractor shall replace the damaged items in a manner satisfactory to the District representative and the owner, or pay damages to the owner as directed by the District.

3. When the proposed pipeline and/or vault is to be within planted or other improved areas in public or private easements, the Contractor shall restore such areas to the original condition after completion of the work. This restoration shall include grading, a placement of 5 inches of good topsoil, resoding, and replacement of all landscape items indicated.

4. If the Contractor does not proceed with the restoration after completion of the work or does not complete the restoration in a satisfactory manner, the District reserves the right to have the work done and to charge the Contractor for the actual cost of the restoration including all labor, material, and overhead required for restoration.

PART 2 – MATERIALS

All materials used in making the connection or removing the facility from service shall conform to the applicable sections of these specifications.

A. Grout

Grout shall consist of Portland cement and water or of Portland cement, sand, and water; and all grout mixtures shall contain 2% of bentonite by weight of the cement. Grout shall be a pump mix with a minimum of six sacks cement (564 lbs) per cubic yard.

Portland cement, water and sand shall conform to the applicable requirements of the concrete section (Section 03300), except that sand to be used shall be of such fineness that 100% will pass a standard 8-mesh sieve and at least 45%, by weight, will pass a standard 40-mesh sieve.

B. Concrete

Concrete used for the replacement of damaged or removed facilities shall be in accordance with Section 03300 and shall match the mix design of the existing facility and per the requirement of the jurisdictional agency.

PART 3 – EXECUTION

A. Connection to Existing Water Lines, Recycled Water Lines, and Sewer Lines

1. Notification: The Contractor shall give the District a minimum of four (4) working days notice before the time of any proposed shutdown of existing mains or services.

2. Notice to Proceed: Connections shall be made only in the presence of the District Representative and no connection work shall proceed until the District Representative has given notice to proceed.

3. Material: The Contractor shall furnish all pipe and materials including as may be required: labor and equipment necessary to make the connections, all required excavation, backfill, pavement replacement, lights and barricades, water truck, highline hose, and fittings for making the connections. In addition, the Contractor shall assist the District in alleviating any hardship incurred during the shutdown for connections.

4. Temporary Work: Where connections are made to existing valves, the Contractor shall furnish and install all temporary blocking, steel clamps, shackles, and anchors as required by the District Representative. Valve boxes and covers shall be replaced and adjusted to the proper grade in accordance with Section 15100.

5. Dewatering: The Contractor shall dewater existing mains, as required, in the presence of the District Representative. The dewatering shall be discharged to a sewer system. The Contractor shall notify the District of the dewatering activities two working days prior to commencing the activity.

6. Inadequate Progress: If progress is inadequate during the connection operations to complete the connection in the time specified, the District Representative shall order necessary corrective measures. All costs for corrective measures shall be paid by the Contractor.

7. Tapping Sleeves and Valves: Tapping sleeves and valves shall be installed in accordance with Section 15100.

8. Connections: Connections shall be made with as little change as possible in the grade of new main.

   If the grade of the existing pipe is below that of the new pipeline, a sufficient length of the new line shall be deepened so as to prevent the creation of any high spot or abrupt changes in grade of the new line.

   Where the grade of the existing pipe is above that of the new pipeline, the new line shall be laid at specified depth, except for the first joint adjacent to the connection, which shall be deflected as necessary to meet the grade of the existing pipe.

If sufficient change in direction cannot be obtained by the limited deflection of the first joint, a fitting of the proper angle shall be installed.

Where the connection creates a high or low spot in the line, a standard air release or blow-off assembly shall be installed as directed by the District Representative.

9. Testing: The new pipeline shall NOT be connected to an existing facility until the new pipeline has successfully passed all pressure and disinfection tests in accordance with Sections 15042 and 15044.

B. Removal from Service of Existing Mains and Appurtenances

1. General: Existing mains and appurtenances shall be removed from service at the locations shown on the plans or as directed by the District Representative.

2. Method of Abandonment: Existing pipe and appurtenances shall be abandoned by the following methods. In all cases, backfill and repair of surface shall be in accordance with Section 02223, Trenching, Backfilling, and Compacting.

Item	Allowable Demolition and Abandonment Methods			
	Sealing Ends	Grout Fill	Removal	Crushed-in-Place
A. Pressure Mains:				
1. Piping not under roadway:				
a) 12-inch and smaller	X	X	X	X
b) Larger than 12-inch		X	X	X
2. Piping under roadway:				
a) 6-inch and smaller	X	X	X	X
b) Larger than 6-inch		X	X	X
B. Gravity Sewer Mains:				
a) 8-inch and smaller	X	X	X	X
b) Larger than 8-inch		X	X	X

a. Abandonment by Sealing: Pipe section shall be cut and sealed solid with concrete to a depth of not less than one pipe diameter, forming a solid waterproof plug completely bonded to the pipe.

b. Abandonment by Grout Filling: The abandoned pipe section shall be grout filled by pumping a one-sack sand cement slurry mixture into the pipe. The pipe shall be completely filled, leaving no voids or air space. The grout shall be pumped into the pipe from the inlet end to the receiving end (exit end). Samples of the outgoing water (at exit end) shall be made until the exiting grout mix is observed as similar to the grout being injected at the inlet end. The cost of the testing, including

labor and testing equipment shall be provided by the contractor. The grouting plan, including the grout mix design shall be reviewed and approved by the District Representative prior to initiating the work.

c. Abandonment by Removal: Removal of existing pipelines shall mean complete removal of the existing pipeline and disposal of the pipe and appurtenances designated as unsalvageable.

Where connections or stub-outs are abandoned, all valves shall be removed and the remaining flanged fitting shall be closed/plugged using a blind-flange fitting and thrust block.

3. Storage of Removed Material: Removed pipe and appurtenances may be temporarily stockpiled on the job in a location that will not disrupt traffic or be a safety hazard, or it may be delivered to the District yard as directed by the District Representative. In all cases the Contractor shall be responsible for the final disposal of all removed materials, including asbestos cement pipe.

4. Asbestos Cement Pipe (ACP): Asbestos cement pipe shall be removed at the joint or fitting, and disposed of in a proper manner. No field cutting of ACP shall be allowed. The Contractor shall be responsible for the proper manifesting of the ACP at an authorized disposal site.

5. Maintenance of Service: Prior to performing any work to replace existing pipes and/or services, the Contractor shall make proper provisions for the maintenance and continuation of service as directed by the District Representative.

6. Abandoned Water Services: As directed by the District Representative, the abandoned water service shall:

a. have its corporation stop closed and the service line cut and crimped,

b. have its corporation stop removed and a brass plug installed in the service saddle, or

c. have its service saddle and corporation stop removed and the tap plugged with a repair clamp.

If the water service is a direct tap, the corporation stop shall be removed and a repair clamp shall be installed.

If there is no corporation stop, the District Representative shall determine the method of water service abandonment.

If the water service is abandoned and the service line and meter box are to remain, the angle meter stop shall be closed and locked, and the meter shall be removed and returned to the District.

7. Contractor shall record all abandonment, tie-ins and revision to existing facilities and submit this information to the Engineer and/or District to be incorporated into the Record Drawings.

END OF SECTION

SECTION 01300

CONTRACTOR SUBMITTALS

PART 1 – GENERAL

A. General

1. Wherever submittals are required hereunder, all such submittals by the Contractor shall be submitted to the District's Representative.

2. Within 14 days after the date of commencement as stated in the Notice to Proceed, the Contractor shall submit the following items to the District's Representative for review.

   a. A preliminary schedule of Shop Drawing, Sample, and proposed Substitutes or "Or Equal" submittals.

   b. A list of all 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.

B. Shop Drawings

1. Wherever called for in the Contract, or where required by the District, the Contractor shall furnish to the District's Representative for review, by uploading to a web based construction document management system and providing one (1) hard copy of the final approved shop drawing submittal. The term "Shop Drawings" as used herein shall be understood to include detail design calculations, shop drawings, fabrication, and installation drawings, erection drawings, list, graphs, catalog sheets, data sheets, and similar items. 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 wherein the project is to be built, unless otherwise directed.

2. Except as may otherwise be indicated herein, the District will return two (2) prints of each submittal to the Contractor with its comments noted thereon, within 21 calendar days following their receipt by the District.

3. If the submittal is returned to the Contractor marked "NO EXCEPTIONS TAKEN," formal revision and resubmission of said submittal will not be required.

4. If the submittal is returned to the Contractor marked "MAKE CORRECTIONS NOTED," formal revision and resubmission of said submittal will not be required.

5. If the submittal is returned to the Contractor marked "AMEND-RESUBMIT," the Contractor shall revise said submittal and shall resubmit the required number of copies of said revised submittal to the District's Representative.

6. If the submittal is returned to the Contractor marked "REJECTED-RESUBMIT," the Contractor shall revise said submittal and shall resubmit the required number of copies of said revised submittal to the District's Representative.

7. Fabrication of an item shall be commenced only after the District has reviewed the pertinent submittals and returned copies to the Contractor marked either "NO EXCEPTIONS TAKEN" or "MAKE CORRECTIONS NOTED." Corrections indicated on submittals shall be considered as changes necessary to meet the requirements of the Contract Documents and shall not be taken as the basis for changes to the contract requirements.

8. All Contractor shop drawings submittals shall be carefully reviewed by an authorized representative of the Contractor, prior to submission to the District. Each submittal shall be dated, signed, and certified by the Contractor, as being correct and in strict conformance with the Contract Documents. In the case of shop drawings, each sheet shall be so dated, signed, and certified. No consideration for review by the District of any Contractor submittals will be made for any items which have not been so certified by the Contractor. All non-certified submittals will be returned to the Contractor without action taken by the District, and any delays caused thereby shall be the total responsibility of the Contractor.

9. The District's review of Contractor shop drawings submittals shall not relieve the Contractor of the entire responsibility for the correctness of details and dimensions. The Contractor shall assume all responsibility and risk for any misfits due to any errors in Contractor submittals. The Contractor shall be responsible for the dimensions and the design of adequate connections and details.

C. Proposed Substitutes Or "Equal" Item Submittal

1. Whenever materials or equipment are specified or described in the Contract Documents by using the name of a proprietary item or the name of a particular Supplier, the naming of the item is intended to establish the type, function, and quality required. If the name is followed by the words "or equal" indicating that a substitution is permitted, materials or equipment of other Suppliers may be accepted by the Engineer if sufficient information is submitted by the Contractor to allow the Engineer to determine that the material or equipment proposed is equivalent or equal to that named, subject to the following requirements.

    a. The burden of proof as to the type, function, and quality of any such substitute material or equipment shall be upon the Contractor.

b. The Engineer will be the sole judge as to the type, function, and quality of any such substitute material or equipment and Engineer's decision shall be final.

c. The Engineer may require the Contractor to furnish at the Contractor's expense additional data about the proposed substitute.

d. The District may require the Contractor to furnish at the Contractor's expense a special performance guarantee or other surety with respect to any substitute.

e. Acceptance by the Engineer of a substitute item proposed by the Contractor shall not relieve the Contractor of any responsibility for full compliance with the Contract Documents and for adequacy of the substitute item.

f. The Contractor shall be responsible for resultant changes and all additional costs which the accepted substitution requires in the Contractor's work, the work of its subcontractors and of other contractors, and shall effect such changes without cost to the District.

2. The procedure for review by the Engineer will include the following:

a. If the Contractor wishes to furnish or use a substitute item of material or equipment, the Contractor shall make written application to the Engineer on the "Substitutions Request Form" for acceptance thereof.

b. Unless otherwise provided by law or authorized in writing by the Engineer the "Substitution Request Form(s)" shall be submitted within the 35 day period after award of the Contract.

c. Wherever a proposed substitute material or equivalent has not been submitted within said 35 day period, or wherever the submission of a proposed substitute material or equipment has been judged to be unacceptable by the Engineer, the Contractor shall provide the material or equipment named in the Contract Documents.

d. The Contractor shall certify that the proposed substitute will perform adequately the functions and achieve the results called for by the general design, be similar and of equal substance to that specified, and be suited to the same use as that specified.

e. The Engineer will be allowed a reasonable time within which to evaluate each proposed substitute.

f. As applicable, no shop drawing submittals will be made for a substitute item nor will any substitute item be ordered, installed, or utilized without the Engineer's prior written acceptance of the Contractor's "Substitution Request Form" which will be evidenced by a Change Order.

g. The Engineer will record the time required by the Engineer in evaluating substitutions proposed by the Contractor and in making changes in the Contract Documents occasioned thereby. Whether or not the Engineer accepts a proposed substitute, the Contractor shall reimburse the District for the charges of the Engineer for evaluating each proposed substitute.

3. The Contractor's application using the "Substitution Request Forms" shall contain the following statements and/or information which shall be considered by the Engineer in evaluating the proposed substitution:

   a. The evaluation and acceptance of the proposed substitute will not prejudice the Contractor's achievement of substantial completion on time.

   b. Whether or not acceptance of the substitute for use in the Work will require a change in any of the Contract Documents to adopt the design to the proposed substitute.

   c. Whether or not incorporation or use of the substitute in connection with the Work is subject to payment of any license fee or royalty.

   d. All variations of the proposed substitute for that specified will be identified.

   e. Available maintenance, repair, and replacement service will be indicated.

   f. Itemized estimate of all costs that will result directly or indirectly from acceptance of such substitute, including cost of redesign and claims or other contractors affected by the resulting change.

D. Samples Submittal

1. Whenever in the Specifications samples are required, the Contractor shall submit not less than 3 samples of each item or material to the Engineer.

2. Samples, as required herein, shall be submitted for acceptance a minimum of 21 days prior to ordering such material for delivery to the jobsite, and shall be submitted in any orderly sequence so that dependent materials or equipment can be assembled and reviewed without causing delays in the Work.

3. All samples shall be individually and indelibly labeled or tagged, indicating thereon all specified physical characteristics and Manufacturer's name of identification and submitted to the Engineer for acceptance. Upon receiving acceptance of the Engineer, one set of the samples will be stamped and dated by the Engineer and returned to the Contractor, and one set of samples will be retained by the Engineer, and one set of samples shall remain at the job site until completion of the Work.

4. Unless indicated otherwise, all colors and textures of specified items presented in sample submittals shall be from the manufacturer's standard colors and standard materials, products, or equipment lines.

E. Critical Equipment Submittals

The Contractor shall make submittals to the District's Representative in a timely manner for the Work to be completed within the specified Contract Time. For the following items, inquiry reveals that potentially long lead times for delivery are required, making these items critical for the completion of the Work within the Contract Time.

- Switchboard and ATS
- Submersible Pump and Submersible Motor
- Precast Concrete Vault and Wet Well
- Stand-By Diesel Generator
- Motor Control Center
- PLC

The preceding list does not necessarily include all critical equipment items. The Contractor shall be responsible for identification and timely submittal of all equipment items. The Engineer will endeavor to expedite submittal review of the critical equipment items to aid in reducing submittal-processing time.

F. Shop Drawings

The Contractor shall furnish to the District's Representative such working drawings, data on materials, calculations, and equipment and samples as are required for the proper control of the work, including, but not limited to the following:

1. Pipe and fittings
2. Submersible pump and submersible motor.
3. Check Valves
4. Valves and valve boxes.
5. Bolts, nuts and gaskets
6. Stainless steel pipe and fittings
7. Copper pipe and fittings
8. Magnetic Flow Meter
9. Ductile Iron Pipe and Fittings

10. Pre-cast concrete vaults, wet well, and manhole.
11. Aluminum access hatches
12. Stand-by diesel generator
13. Concrete masonry units
14. Motor control center
15. Automatic transfer switch
16. PLC
17. Instrumentation
18. Bypassing Plan
19. Dewatering Plan
20. Trench shoring design and details per General Provisions
21. Pavement and Concrete Mix Design

All working drawings, data, and samples, shall be subject to review by the Engineer for conformity with the drawings and specifications.

G. Record Drawings Submittals

1. The Contractor shall keep and maintain, at the job site, one record set of Drawings. On these, it shall mark all project conditions, locations, configurations, and any other changes or deviations which may vary from the details represented on the original Contract Drawings, including buried or concealed construction and utility features which are revealed during the course of construction. Special attention shall be given to recording the horizontal and vertical location of all buried utilities that differ from the locations indicated, or which were not indicated on the Contract Drawings. Said record drawings shall be supplemented by any detailed sketches as necessary or directed to indicate, fully, the Work as actually constructed. These master record drawings of the Contractor's representation of as-built conditions, including all revisions made necessary by addenda and change orders shall be maintained up to date during the progress of the Work.

2. In the case of those drawings which depict the detail requirement for equipment to be assembled and wired in the factory, such as motor control centers and the like, the record drawings shall be updated by indicating those portions which are superseded by change order drawings or final shop drawings, and by including appropriate reference information describing the change orders by number and the shop drawings by manufacturer, drawing, and revision numbers.

3. Record drawings shall be accessible to the Engineer at all times during the construction period and shall be delivered to the Engineer upon completion of the Work.

4. Upon substantial completion of the Work and prior to final acceptance, the Contractor shall complete and deliver a complete set of record drawings to the Engineer for transmittal to the District, conforming to the construction records of the Contractor. This set of drawings shall consist of corrected drawings showing the reported location of the Work.

   The information submitted by the Contractor and incorporated by the Engineer into the Record Drawings will be assumed to be reliable, and the Engineer will not be responsible for the accuracy of such information, nor for any errors or omissions which may appear on the Record Drawings as a result.

PART 2 – PRODUCTS

Not Used.

PART 3 – EXECUTION

Not Used.

END OF SECTION

SECTION 01310

CONSTRUCTION SCHEDULE

PART 1 -- GENERAL

1.1 General

A. The Contractor shall schedule the Work in accordance with this Section.

B. Development of the schedule, monthly payment requisitions and project status reporting requirements of the Contract shall employ computerized Critical Path Method (CPM) scheduling.

C. The CPM schedule and related reports should be prepared with the current version of Primavera Project Planner (P3) or Microsoft Project software.

1.2 Definitions

A. **CPM Scheduling**: The term shall be interpreted to be generally as outlined in the Association of General Contractors (AGC) publication, "The Use of CPM in Construction." except that either "i-j" arrow diagrams or precedence diagramming format may be utilized. In the case of conflicts between this Section and the AGC document, this Section shall govern.

B. **Float**: Unless otherwise indicated herein, float and total float are synonymous. Total float is the period of time measured by the number of Days each non-critical path activity may be delayed before it and its succeeding activities become part of the critical path. If a non-critical path activity is delayed beyond its float period, then that activity becomes part of the critical path and controls the end date of the Work. Thus, delay of a non-critical path activity beyond its float period will cause delay to the project itself.

1.3 Scheduling Qualification Submittals

A. Contractor shall submit a statement of computerized CPM capability within 10 Days after Notice to Proceed to verify that either: (1) the Contractor has in-house capability qualified to use CPM techniques and the Primavera P3 or Microsoft Project software or (2) that the Comtractor will arrange for the services of a CPM consultant so qualified. In either event the statement shall identify the individual who will perform the CPM scheduling and shall describe the construction projects required below. The statement shall also identify the contact persons for the referenced projects with current telephone and address information.

B. **Criteria**: The individual performing scheduling shall have successfully applied computerized CPM technique to at least 2 projects of similar nature, scope, and value not less than one half the Total Bid Price of this project.

1.4 Initial Schedule Submittals

A. Where submittals are required hereunder, the Contractor shall submit 4 copies of each submittal item.

B. The Contractor shall submit 2 schedule documents at the Preconstruction Conference which serve as the Contractor 's plan of operation for the initial 60 Day period of the Contract Times and identify the manner in which the Contractor intends to complete the Work within the Contract Times.

1. 60 Day Plan of Operation: During the initial 60 Days of the Contract Times, the Contractor shall conduct operations in accordance with a 60 Day bar chart type schedule. The chart so prepared shall show accomplishment of the Contractor 's early activities (mobilization, permit acquisition, submittals necessary for early material and equipment procurement, submittals necessary for long lead equipment procurement, CPM submittals, initial sitework and other submittals and activities required in the first 60 Days).

2. Project Overview Bar Chart: The overview bar chart shall indicate the major components of the Work and the sequence relations between major components and subdivisions of major components. The overview bar chart shall indicate the relationships and time frames in which the various components of the Work will be made substantially complete and placed into service in order to meet the required milestones. Sufficient detail shall be included to subdivide major components in such activities as (1) excavation, (2) foundation subgrade preparation, (3) foundation concrete, (4) completion of structural concrete, (5) major mechanical Work, (6) major electrical Work, (7) instrumentation and control Work, and (8) other important Work for each major facility within the overall project scope. Planned durations and start dates shall be indicated for each Work item subdivision. Each major component and subdivision component shall be accurately plotted on time scale sheets not to exceed 36-inches by 60-inches in size. No more than 4 sheets shall be employed to present this overview information.

C. The District’s Representative and the Contractor shall meet to review and discuss the 60 Day plan of operation and project overview bar chart within 5 Days after submittal to the District’s Representative. The Disrict’s Representative's review and comment on the schedules will be limited to conformance with the sequencing and milestone requirements in the Contract Documents. The Contractor shall make corrections to the schedules necessary to comply with the requirements and shall adjust the schedules to incorporate any missing information requested by the District’s Representative.

1.5 CPM Schedule Submittals

A. **Original CPM Schedule Submittal**: Within 30 Days after the commencement date stated in the Notice to Proceed, the Contractor shall submit for review by the District’s Representative a hard copy of the CPM schedule and the computerized schedule report tabulations. The Contractor shall also submit a CD that contains the schedule submittal information. The data shall be compatible with Primavera P3 or Microsoft Project to

generate network diagrams and schedule reports identical to the hard copies submitted. This submittal shall have already been reviewed and approved by the Contractor 's Project Manager, superintendent, and estimator prior to submission. The CPM schedule shall be a time-scaled network diagram of the "i-j" activity-on-arrow or precedence type. The network diagram shall describe the activities to be accomplished and their logical relationships and shall show the critical path.

B. **The computerized schedule report tabulations shall include the following**:

1. Report of activities sorted by activity number.

2. Report of activities sorted by early start date.

3. Report of activities sorted by total float.

4. Report of activities sorted by responsibility code. Responsibility codes shall be established for the Contractor, the District's Representative, District, Subcontractors, Suppliers, etc.

5. A successor-predecessor report which shall identify the successor and predecessor activities for each activity and ties between schedule activities.

C. **Analysis**

1. Early Completion

   a. The Contractor may show early completion on the original CPM submittal if that is its plan.

   b. An original CPM submittal showing early completion shall either be accompanied by:

      1) Request for change of Contract Times at zero change of Contract Price, accompanied by documentation demonstrating that the Bid was based on early completion, or

      2) Demonstration in the submittal that the time difference between early completion and the original Contract Time is total float.

   c. An early completion schedule unaccompanied by one of these will not be accepted.

   d. The District's Representative will analyze a request for Change Order in accordance with the Special Provisions.

2. **Float Ownership**: Neither the District nor the Contractor owns the float time. The project owns the float time. Liability for delay to the project completion date rests with the party causing the delay. For example, if Party A is responsible for consuming a portion of the float time and Party B later consumes the remainder of

the float time plus additional time beyond the float time, Party B is responsible for the time that is a delay past the completion date. Party A would not be responsible for any delay since it did not consume all the float time, additional float time remained after its delay, and the completion date was unaffected by its tardiness.

D. **Original CPM Schedule Review Meeting**: The Contractor shall, within 40 Days from the commencement date stated in the Notice to Proceed, meet with the District's Representative to review the original CPM schedule submittal. The Contractor shall have the Project Manager, superintendent, and the scheduler in attendance. The District's Representative's review will be limited to conformance with the Contract Documents. However, the review may also include:

1. Clarifications of the design intent.

2. Directions to include activities and information missing from the submittal.

3. Requests to the Contractor to clarify and revise the schedule.

E. **Revisions to the Original CPM Schedule**: Within 50 Days after the commencement date stated in the Notice to Proceed, the Contractor shall revise the original CPM schedule submittal to address review comments from the original CPM schedule review meeting and resubmit the network diagrams and reports for the District's Representative 's review. The District's Representative, within 7 Days from the date that the Contractor submitted the revised schedule will either (1) accept the schedule activities as submitted, or (2) advise the Contractor in writing to review any part or parts of the schedule which either do not meet the requirements or are unsatisfactory for the District's Representative to monitor the progress and status of Work or evaluate monthly payment requests by the Contractor. The District's Representative may accept the schedule conditional upon the first monthly CPM schedule update correcting deficiencies identified. When the schedule is accepted, it shall be considered as the "Original CPM Construction Schedule" until an updated schedule has been submitted. The District's Representative reserves the right to require that the Contractor adjust, add to, or clarify any portion of the schedule which may later be discovered to be insufficient for the monitoring of Work or approval of partial payment requests. No additional compensation will be provided for such adjustments, additions, or clarifications.

F. **Acceptance**

1. Acceptance of the Contractor 's schedule by the District's Representative and District will be based solely upon compliance with the requirements. By way of the Contractor assigning activity durations and proposing the sequence of the Work, the Contractor agrees to utilize sufficient and necessary management and other resources to perform Work in accordance with the schedule. Upon submittal of a schedule update, the updated schedule shall be considered the "current" project schedule.

2. Submission of the Contractor 's progress schedule to the District's Representative shall not relieve the Contractor of total responsibility for scheduling, sequencing, and pursuing the Work to comply with the requirements of the Contract Documents, including adverse effects such as delays resulting from ill-timed Work.

G. **Monthly Updates and Periodic CPM Schedule Submittals**

1. Following acceptance of the Contractor's original CPM schedule, the Contractor shall monitor the progress of the Work and adjust the schedule each month to reflect actual progress and any changes in planned future activities. Each schedule update submittal shall be complete including information requested in the original schedule submittal and be in the schedule report format indicated below. Each update shall continue to show Work activities including those already completed. Completed activities shall accurately depict "as built" information by indicating when the Work was actually started and completed.

2. Neither the submission nor the updating of the Contractor's original schedule submittal nor the submission, updating, change, or revision of any other report, curve, schedule, or narrative submitted by the Contractor, nor the District's Representative 's review or acceptance of any such report, curve, schedule, or narrative shall have the effect of amending or modifying in any way the Contract Times or milestone dates or of modifying or limiting in any way the Contractor's obligations under the Contract. Only a signed, fully executed Change Order can modify contractual obligations.

3. The monthly schedule update submittal will be reviewed with the Contractor during a monthly construction progress meeting. The goal of these meetings is to enable the Contractor and the District's Representative to initiate appropriate remedial action to minimize any known or foreseen delay in completion of the Work and to determine the amount of Work completed since the last schedule update. The status of the Work will be determined by the percent complete of each activity in the updated CPM schedule. These meetings are considered a critical component of the overall monthly schedule update submittal, and the Contractor shall have appropriate personnel attend. As a minimum, the Contractor's Project Manager and superintendent shall attend these meetings. Within 7 Days after the monthly progress meeting, the Contractor shall submit the revised CPM schedule, the revised CPM computerized tabulations, the revised successor/predecessor report, the project status reports as defined below and the Contractor's Application for Payment. Within 5 Days of receipt of the revised submittals, the District's Representative will either accept or reject the monthly schedule update submittal. If accepted, the percent complete in the monthly update shall be the basis for the Application for Payment to be submitted by the Contractor. If rejected, the update shall be corrected and resubmitted by the Contractor before the Application for Payment for the update period will be processed.

H. **Schedule Revisions**: The Contractor shall highlight or otherwise identify changes to the schedule logic or activity durations made from the previous schedule. The Contractor shall modify any portions of the CPM schedule which become infeasible because activities are behind schedule or for any other valid reason.

1.6 Change Orders

A. Upon approval of a Change Order or upon receipt by the Contractor of authorization to proceed with additional Work, the change shall be reflected in the next submittal of the CPM Schedule. The Contractor shall utilize a sub-network in the schedule depicting the changed Work and its effect on other activities. This sub-network shall be tied to the main network with appropriate logic so that a true analysis of the critical path can be made. Whenever the Contractor believes that a Change Order will extend the Contract Times, the sub-network analysis herein shall be submitted with the price proposal for the change. If the Contractor does not submit the sub-network demonstrating that the change affects the Contract Times, then no subsequent claim for additional time due to the change will be accepted.

1.7 CPM Standards

A. **Construction Schedules**: Construction schedules shall include a graphic network diagram and computerized schedule reports as required below for status reporting.

B. **Networks**: The CPM network shall be in a form of a time scaled "i-j" activity-on-arrow or precedence type diagram and may be divided into a number of separate sheets with suitable match lines relating the interface points among the sheets. Individual sheets shall not exceed 36-inches by 60-inches.

C. Construction and procurement activities shall be presented in a time-scaled format with a calendar time line along the entire sheet length. Each activity arrow or node shall be plotted so that the beginning and completion dates of each activity are accurately represented along the calendar time line. Every activity shall use symbols that clearly distinguish between critical path activities, non-critical activities, and free float for each non-critical activity. Activity items shall be identified by their activity number, responsibility code, duration, and dollar value. Non-critical path activities shall show total float time in scale form by utilizing a dotted line or some other graphical means.

D. **Duration Estimates**: The duration estimate for each activity shall be computed in Days and shall represent the single best estimate considering the scope of the Work and resources planned for the activity. Except for certain non-labor activities such as curing of concrete or delivery of materials, activity duration shall not exceed 10 Days nor be less than one Day, unless otherwise accepted by the District's Representative.

1.8 Schedule Report Format

A. **Schedule Reports**: Schedule reports shall be prepared based on the CPM schedule, shall be submitted on paper and floppy disk or CD, depending on file size, and shall include the following minimum data for each activity:

1. Activity numbers and responsibility codes.
2. Work Order No.
3. CIP No.
4. Estimated activity duration.
5. Activity description.
6. Activity percent completion.
7. Early start date (calendar dated).
8. Early finish date (calendar dated).
9. Late start date (calendar dated).
10. Late finish date (calendar dated).
11. Status (whether critical).
12. Total float for each activity.
13. Free float for each activity.

B. **Project Information**: Each Schedule Report shall be prefaced with the following summary data:

1. Project name.
2. Contractor name.
3. Type of tabulation.
4. Project duration.
5. Contract Times (as revised by Change Orders).
6. The commencement date stated in the Notice to Proceed.
7. The data date and plot date of the CPM Schedule.
8. If an update, cite the new schedule completion date.

1.9 Project Status Reporting

A. The Contractor shall furnish monthly project status reports (overview bar chart and a written narrative report) in conjunction with the revised CPM schedules as indicated above. Status reporting shall be in the form below.

B. The Contractor shall prepare and submit monthly an overview bar chart schedule of the major project components. The overview bar chart schedule shall be a summary of the current CPM schedule (original and as updated and adjusted throughout the entire construction period). The major project components shall be represented as time bars which shall be subdivided into various types of Work including demolition, excavation and earthwork, yard piping, concrete construction, and mechanical, electrical and instrumentation installations. Major components shall include each new structure by area designation, sitework, modifications to existing structures, tie-ins to existing facilities, and plant startups.

C. Each major component and subdivision shall be accurately plotted consistent with the project overview bar chart above. It shall represent the same status indicated by early start and finish activity information contained in the latest update of the CPM schedule. In addition, a percent completion shall be indicated for each major component and subdivision. The initial submittal of the overview bar chart schedule shall be made at the time that the revised original CPM schedule is submitted to the District's Representative. The Contractor shall amend the overview schedule to include any additional detail required by the District's Representative. The Contractor shall include any additional information requested by the District's Representative at any time during the construction of the Work.

D. The Contractor shall prepare monthly written narrative reports of the status of the project for submission to the District's Representative. Status reports shall include:

1. The status of major project components (percent complete, amount of time ahead or behind schedule) and an explanation of how the project will be brought back on schedule if delays have occurred.

2. The progress made on critical activities indicated on the CPM schedule.

3. Explanations for any lack of Work on critical path activities planned for the last month.

4. Explanations for any schedule changes, including changes to the logic and to activity durations.

5. A list of the critical activities scheduled to be performed in the next 2 months.

6. The status of major material and equipment procurement.

7. The value of materials and equipment properly stored at the Site but not yet incorporated into the Work.

8. Any delays encountered during the reporting period.

9. An assessment of inclement weather delays and impacts to the progress of the Work.

E. The Contractor may include any other information pertinent to the status of the Work. The Contractor shall include additional status information requested by the District's Representative.

PART 2 -- PRODUCTS (NOT USED)

PART 3 -- EXECUTION (NOT USED)

END OF SECTION

SECTION 01322

WEB BASED CONSTRUCTION DOCUMENT MANAGEMENT

PART 1 GENERAL

A. Summary

1. Section includes:
   a. Requirements for web-based construction document management.

2. Related sections:
   a. The Contract Documents are complementary; what is called for by one is as binding as if called for by all.
   b. It is the Contractor's responsibility for scheduling and coordinating the Work of subcontractors, suppliers, and other individuals or entities performing or furnishing any of Contractor's Work.
   c. The following Sections are related to the Work described in this Section. This list of Related Sections is provided for convenience only and is not intended to excuse or otherwise diminish the duty of the Contractor to see that the completed Work complies accurately with the Contract Documents.
      a. Section 01300 - Contractor Submittals.

B. Requirements

1. The District and Contractor shall utilize a web based construction management system (WBCMS). For submission of all data and documents (unless specified otherwise in this Section) throughout the duration of the Contract.
   a. WBCMS shall be hosted by the WBCMS.
   b. WBCMS is paid for by the District.
   c. WBCMS will be made available to all Contractor's personnel, subcontractor personnel, suppliers, consultants, DESIGN ENGINEER, and the District's Representative.
   d. The joint use of this system is to facilitate electronic exchange of information, automation of key processes, and overall management of Contract Documentation.
   e. WBCMS shall be the primary means of project information submission and management.

2. User access limitations:
   a. The District's Representative will control the Contractor's access to WBCMS by allowing access and assigning user profiles to accepted Contractor personnel. User profiles will define levels of access into the system; determine assigned function based authorizations and user privileges. Subcontractors and suppliers will be given access to WBCMS by and through the Contractor. Entry of information exchanged and transferred between the Contractor and its

subcontractors and suppliers on WBCMS shall be the responsibility of the Contractor.

3. Joint ownership of data:
   a. Data entered in a collaborative mode (entered with the intent to share as determined by permissions and workflows within the WBCMS system) by the District's Representative and the Contractor will be jointly owned.

4. Automated system notification and audit log tracking:
   a. Review comments made (or lack thereof) by the District on Contractor submitted documentation shall not relieve the Contractor from compliance with requirements of the Contract Documents. The Contractor is responsible for managing, tracking, and documenting the Work to comply with the requirements of the Contract Documents. District's acceptance via automated system notifications or audit logs extends only to the face value of the submitted documentation and does not constitute validation of the Contractor's submitted information.

5. Computer Requirements:
   a. The Contractor shall use computer hardware and software that meets the requirements of WBCMS as recommended by WBCMS to access and utilize WBCMS. As recommendations are modified by WBCMS, the Contractor will upgrade their system(s) to meet or exceed the recommendations. Upgrading of the Contractor's computer systems will not be justification for a cost or time modification to the Contract.
   b. The Contractor shall ensure that connectivity to the WBCMS system is accomplished through DSL, cable, T-1 or wireless communications systems. The minimum bandwidth requirements for using the system is 128kb/s. It is recommended a faster connection be used when uploading pictures and files into the system.

6. Contractor responsibility:
   a. The Contractor shall be responsible for the validity of their information placed in WBCMS and for the abilities of their personnel.
   b. Accepted users shall be knowledgeable in the use of computers, including Internet Browsers, email programs, cad drawing applications, and Adobe Portable Document Format (PDF) document distribution program.
   c. The Contractor shall utilize the existing forms in WBCMS to the maximum extent possible. If a form does not exist in WBCMS the Contractor must include a form of their own or provided by the District's Representative as an attachment to a submittal.
   d. Adobe PDF documents will be created through electronic conversion rather than optically scanned whenever possible. The Contractor is responsible for the training of their personnel in the use of WBCMS (outside what is provided by the District and the other programs indicated above as needed.

7. Connectivity problems:
    a. Provide a list of Contractor's key WBCMS personnel for the District's Representative's acceptance. Contractor is responsible for adding and removing users from the system. The District's Representative reserves the right to perform a security check on all potential users. The Contractor will be allowed to add additional personnel and subcontractors to WBCMS.

C. Submittals

1. Preconstruction Submittals List of Contractor's key WBCMS personnel. Include descriptions of key personnel's roles and responsibilities for this project. Contractor should also identify their organizations administrator on the list.

PART 2 PRODUCTS

A. Description

1. A WBCMS project management application will be provided by the District.

PART 3 EXECUTION

A. WBCMS Utilization

1. WBCMS shall be utilized in connection with all document and information management required by these Contract Documents.

B. Submittals

1. Shop drawings:
    a. Shop drawing and design data documents shall be submitted PDF attachments to the WBCMS submittal work flow process and form. Examples of shop drawings include, but are not limited to:
        a. Standard manufacturer installation drawings.
        b. Drawings prepared to illustrate portions of the work designed or developed by the Contractor.
        c. Steel fabrication, piece, and erection drawings.
    b. Hard copy submittals may be allowed, if approved by the District's Representative on a case-by-case basis.
        a. Hard copy submittals shall be handled following procedures for Samples defined below.

C. Product Data

1. Product catalog data and manufacturer's instructions shall be submitted as PDF attachments to the WBCMS submittal work flow process and form. Examples of product data include, but are not limited to:
    a. Manufacturer's printed literature.
    b. Preprinted product specification data and installation instructions.

D. Samples

1. Sample submittals shall be physically submitted as specified in Section 01330. Contractor shall enter submittal data information into WBCMS with a copy of the submittal form(s) attached to the sample. Examples of samples include, but are not limited to:
    a. Product finishes and color selection samples.
    b. Product finishes and color verification samples.
    c. Finish/color boards.
    d. Physical samples of materials.

E. Administrative Submittals

1. All correspondence and pre-construction submittals shall be submitted using WBCMS. Examples of administrative submittals include, but are not limited to:
    a. Permits.
    b. Requests for substitutions (RFS).
    c. List of contact personnel.
    d. Requests for Information (RFI).

2. Network Analysis Schedules and associated reports and updates. Each schedule submittal specified in these Contract Documents shall be submitted as a native backed-up file (.PRX or .STX) of the scheduling program being used. The schedule shall also be posted as a PDF file in the format specified in these Contract Documents.

3. Plans for safety, demolition, environmental protection, and similar activities.

4. Quality Control Plan(s), Testing Plan and Log, Quality Control Reports, Production Reports, Quality Control Specialist Reports, Preparatory Phase Checklist, Initial Phase Checklist, Field Test reports, Summary reports, Rework Items List, etc.

5. Meeting minutes for quality control meetings, progress meetings, pre-installation meetings, etc.

6. Any general correspondence submitted.

F. Compliance Submittals

1. Test reports, certificates, and manufacture field report submittals shall be submitted on WBCMS as PDF attachments. Examples of compliance submittals include, but are not limited to:
    a. Inspection requests:
        a. When a portion of Work is ready for inspection and prior to covering up the Work (for example, a concrete pour that has waterstop, rebar and embeds placed prior to pouring the concrete), inspection requests shall be submitted via WBCMS and approved via WBCMS.
        b. Reports associated with this element of the Work will be submitted via WBCMS and associated with the inspection request.

b. Field test reports.
c. Quality Control certifications.
d. Manufacturer's documentation and certifications for quality of products and materials provided.

G. Record And Closeout Submittals

1. Operation and maintenance data and closeout submittals shall be submitted on WBCMS as PDF documents during the approval and review stage as specified, with actual set of documents submitted for final. Examples of record submittals include, but are not limited to:
   a. Operation and Maintenance Manuals: final documents shall be submitted as specified.
   b. Extra materials, spare stock, etc.: submittal forms shall indicate when actual materials are submitted.

H. Closeout Activities

1. Training:
   a. The District has arranged and paid for training to be provided to the Contractor.
   b. Training consists of web-based seminars in conjunction with a conference call.

2. Contractor shall arrange and pay for the facilities and hardware/software required to facilitate his own training.

I. Financial Submittals

1. Schedule of Value, Pay Estimates, and Change Request Proposals shall be submitted on WBCMS. Supporting material for Pay Estimates and Change Requests shall be submitted on WBCMS as PDF attachments. Examples of compliance submittals include, but are not limited to:
   a. Contractor's Schedule of Values.
   b. Contractor's Monthly Progress Payment Requests.
   c. Contract Change proposals requested by the District.

END OF SECTION

SECTION 01510

TESTING, TRAINING AND FACILITY START-UP

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Section Includes: Equipment and system testing and start-up, services of manufacturer's representatives, training of District's personnel, and final testing requirements for the complete facility.

1.02 CONTRACT REQUIREMENTS

A. Testing, training, and start-up are requisite to the satisfactory completion of the Contract.

B. Complete testing, training, and start-up within the Contract Time.

C. Allow realistic durations in the Progress Schedule for testing, training, and start-up activities.

D. Furnish labor, power, chemicals, tools, equipment, instruments, and services required for and incidental to completing functional testing, performance testing, and operational testing.

E. Provide competent, experienced technical representatives of equipment manufacturers for assembly, installation and testing guidance, and operator training.

1.03 START-UP/TESTING PROCESS OVERVIEW

A. This specification describes a process. The following definitions are provided for terms that are used in this specification and which describe the steps of the process.

B. Start-up Plan: A complete outline and schedule of the work that will be performed to meet the requirements of this specification.

C. Factory/Source Performance Testing: Testing which takes place at the supplier's facility to test equipment performance prior to shipment of the equipment to the job site. Factory pump test, or a control panel test, for example.

D. General Start-up and Testing: Initial adjustments, alignments, inspections, testing, etc., which are performed to confirm equipment is installed correctly and ready to be operated. Line flush, lubrication check, electrical integrity tests, instrument calibrations, for example.

E. Individual Equipment Functional Testing: Individual equipment operating tests which verify proper operation of the equipment. An individual pump functional test would include testing flow, pressure, amps, vibration, motor controls, associated instrument loops, and remote controls, for example.

F. Certification of Proper Installation: A written report from the equipment supplier and the equipment installer which certifies that the equipment tests are complete and the equipment performs satisfactorily.

G. Equipment/System Operational Testing: A test of the entire facility which demonstrates the individual equipment operates as a system and meets the operational requirements of the facility design. Operational requirements to test shall include system control features, station performance requirements such as flow and pressure for example.

1.04 START-UP PLAN

A. Submit start-up plan for each piece of equipment and each system not less than 3 weeks prior to planned initial equipment or system start-up.

B. Provide a schedule with the following activities identified: Manufacturer's services; Installation certifications; Operator training; Submission of Operations and Maintenance Manual; Performance testing; Functional testing; and Operational testing.

C. Provide testing plan with test logs for each item of equipment and each system when specified. Include testing of alarms, control circuits, capacities, speeds, flows, pressures, vibrations, sound levels, and other parameters.

D. Provide summary of shutdown requirements for existing systems, which are necessary to complete start-up of new equipment, and systems.

E. Revise and update start-up plan based upon review comments, actual progress, or to accommodate changes in the sequence of activities.

1.05 FACTORY/SOURCE PERFORMANCE TESTING

A. Test equipment for proper performance at point of manufacturer or assembly when specified.

B. Equipment that is to be tested includes, but is not limited to: pumps, motors, generator, air conditioning, meters, control panels, and motor controllers. Provide certified copies of test results.

C. Testing shall demonstrate that equipment meets specified performance requirements.

D. Factory Witnessed Pump Tests: Pumps shall undergo factory witnessed pump testing. Each pumping unit, complete with the actual job motor drive, shall be tested at the factory. Tests shall be performed in accordance with the applicable standards of the Hydraulic Institute. To successfully pass a laboratory performance test, a pumping unit shall meet all performance requirements specified.

1.06 GENERAL START-UP AND TESTING

A. Mechanical Systems:

1. Remove rust preventatives and oils applied to protect equipment during construction.
2. Flush lubrication systems and dispose of flushing oils. Recharge lubrication system with lubricant recommended by manufacturer.
3. Install and adjust packing, mechanical seals, O-rings, and other seals. Replace defective seals.

4. Remove temporary supports, bracing, or other foreign objects installed to prevent damage during shipment, storage, installation and construction.
5. Check rotating machinery for correct direction of rotation and for freedom of moving parts before connecting driver.
6. Perform cold alignment and hot alignment to manufacturer's tolerances.
7. Adjust V-belt tension and variable pitch sheaves.
8. Inspect hand and motorized valves for proper adjustment. Tighten packing glands to insure no leakage but permit valve stems to rotate without galling. Verify valve seats are positioned for proper flow direction.
9. Tighten leaking flanges or replace flange gasket. Inspect screwed joints for leakage.
10. Install gratings, safety chains, handrails, shaft guards, and sidewalks prior to operational testing.

B. Electrical Systems:

1. Perform insulation resistance tests on wiring except 120-volt lighting, wiring, and control wiring inside electrical panels.
2. Perform continuity tests on grounding systems.
3. Test and set switchgear and circuit breaker relays for proper operation.
4. Check motors for actual full load amperage draw. Compare to nameplate value.

C. Instrumentation Systems:

1. Bench or field calibrate instruments and make required adjustments and control point settings. Provide data on District's calibration sheets.
2. Leak test pneumatic controls and instrument air piping.
3. Energize transmitting and control signal systems, verify proper operation, ranges and settings.

1.07 INDIVIDUAL EQUIPMENT FUNCTIONAL TESTING

A. Functional test mechanical and electrical equipment for proper operation after general start-up and testing tasks have been completed. Use potable water for the functional testing of the pumps and motors.

B. Demonstrate proper rotation, alignment, speed, flow, pressure, vibration, sound level, adjustments, and calibration. Perform initial checks in the presence of and with the assistance of the manufacturer's representative.

C. Demonstrate proper operation of each instrument loop function including alarms, local and remote controls, instrumentation and other equipment functions. Generate signals with test equipment to simulate operating conditions in each control mode.

D. Conduct continuous 8-hour test under full load conditions using water. Replace parts which operate improperly.

1.08 CERTIFICATE OF PROPER INSTALLATION

A. At completion of Functional Testing, furnish written report prepared by Manufacturer's Authorized Representative, certifying equipment: has been properly installed, adjusted, aligned and lubricated; is free of any stresses imposed by connecting piping or anchor bolts; is suitable for satisfactory full-time operation under full load conditions; and operates within the allowable limits for vibration; controls, protective devices, instrumentation, and control panels furnished as part of the equipment package are properly installed, calibrated and functioning; and control logic for start-up, shutdown, sequencing, interlocks, and emergency shutdown have been tested and are properly functioning.

B. Furnish written report prepared and signed by the Electrical and/or Instrumentation Subcontractor certifying: motor control logic that resides in motor control centers, control panels, and circuit boards furnished by the electrical and/or instrumentation subcontractor has been calibrated and tested and is properly operating; and control logic for equipment start-up, shutdown, sequencing, interlocks and emergency shutdown has been tested and is properly operating.

1.09 TRAINING OF DISTRICT'S PERSONNEL

A. Provide operations and maintenance training for the following equipment: submersible sewage pump and motor; VFD, generator, and air conditioning. Utilize manufacturer's representatives to conduct training sessions. Coordinate with District to develop content for training sessions. Assume four hours of training for the pump and motor, VFD, generator, and air conditioning. Assume that each of these training sessions will occur on separate days.

B. Coordinate training sessions to prevent overlapping sessions. Arrange sessions so that individual operators and maintenance technicians do not attend more that two sessions per week.

C. Provide Operation and Maintenance Manuals for specific pieces of equipment or systems one month prior to training session for that piece of equipment.

D. Satisfactorily complete functional testing before beginning operator training.

E. Provide training sessions during the District's standard working hours.

F. The Contractor shall coordinate the training periods with the District personnel and manufacturer's representatives and shall submit a training schedule for each piece of equipment or system for which training is to be provided. Such training schedule shall be submitted not less than 21 calendar days prior to the time that the associated training is to be provided and shall be based on the current plan of operation.

1.10 EQUIPMENT/SYSTEM OPERATIONAL TESTING

A. Contractor and the District shall jointly develop and coordinate equipment system operational testing. Operational testing shall be performed with sewer.

B. The Contractor shall provide the District with 21 days' notice to when the System Operational Test will be ready to be performed.

C. Only after all individual equipment functional testing has been completed by the Contractor and accepted by the District shall the project be deemed ready to commence System Operational Testing.

D. Conduct operational testing of the entire facility after completion of operator training. Demonstrate satisfactory operation of equipment and systems in actual operation.

E. Conduct operational test for continuous 7-day period.

F. Contractor shall furnish labor, power, fuel, and other consumables for duration of the operational test. The Contractor shall have a minimum of two personnel on site 24 hours for the first day of operation of the lift station.

G. Immediately correct defects in material, workmanship, or equipment which became evident during operational test.

H. Repeat operational test when malfunctions or deficiencies cause shutdown or partial operation of the facility or results in performance that is less than specified.

I. In the event an item of equipment cannot be tested continuously for seven (7) days, provide information for an alternative test, or modify the seven (7) day test period.

1.11 RECORD KEEPING

A. Maintain and submit records generated during start-up and testing phase of project. Provide daily logs of equipment testing identifying all tests conducted and outcome.

B. Log time spent by manufacturer's representatives performing services on the job site.

C. Provide equipment lubrication records.

D. Provide electrical phase, voltage and amperage measurements.

E. Insulation resistance measurements.

F. Data sheets of control loop testing including testing and calibration of instrumentation devices and set points.

G. Records documenting all startup, testing, and commissioning activity shall be organized by major process system into organized files/binders and turned over to the District prior to applying for final payment. Testing records shall be accessible to the District at all times to allow monitoring of the progress.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION

SECTION 02050

DEMOLITION

PART 1 – GENERAL

A. Description

1. The Contractor shall furnish materials, equipment and labor necessary to perform and complete the demolition work called for on the construction plans and these specifications.

2. The work includes demolition of the Aliso Creek Lift Station electrical room, block wall, emergency generator, wet well, dry pit equipment, as shown and specified in the Contract Documents (Plans and Specifications).

3. Building structures, foundations, slabs, roofs and supporting walls shall be demolished as required by the Contract Documents, in an orderly and careful manner.

4. Manufactured articles, materials, equipment, and accessories shall be demolished as shown and in accordance with the manufacturer's specifications and recommendations, and industry standards, unless otherwise shown or specified. Asbestos-containing materials shall be handled and disposed of in accordance with the Contract Documents and regulatory requirements.

5. Building utilities shall be disconnected, removed, capped and identified as necessary and as required.

B. Related Work Specified Elsewhere

1. Summary of Work: 01010

2. Contractor Submittals: 01300.

3. Existing Facilities: 01045.

4. Earthwork and Grading: 02201.

C. Submittals

1. Demolition Schedule: The Contractor shall submit a complete coordination schedule for demolition work. Demolition Schedule shall include the following:

    a. Detailed sequence of demolition and removal of work, with starting and ending dates of each activity. Ensure District's on-site operations are uninterrupted.

b. Interruption of utility services. Indicate how long utility services will be interrupted.

c. Coordination for shut off, capping, and continuation of utility services.

2. Submit shop drawing describing demolition, removal procedures, means of protection for items to remain, path of waste removal from building, locations of proposed dust and noise control, and means of egress.

3. The Contractor shall submit a haul route to the District for review and approval. Haul routes may be adjusted, if necessary, with concurrence of the City Traffic Engineer.

4. Pre-demolition Videos: Show existing conditions of adjoining construction and site improvements, including finish surfaces that might be misconstrued as damage caused by demolition operations. The Contractor shall document the condition of the existing walls and sidewalk. Two DVDs of the video shall be submitted to the District.

D. Quality Assurance

1. Demolition Firm Qualifications: An experienced firm that has specialized in demolition work similar in material and extent to that indicated in this Project.

2. Regulatory Requirements: Comply with governing EPA notification regulations before beginning demolition. Comply with hauling and disposal regulations of authorities having jurisdiction. The Contractor shall obtain all permits necessary to perform the work and pay all associated permitting fees.

3. Standards: Comply with ANSI A10.6 and NFPA 241.

4. Predemolition Conference: Conduct conference at Project site. Review methods and procedures related to demolition including, but not limited to, the following:

a. Inspect and discuss condition of construction to be demolished.

b. Review structural load limitations of existing structure.

c. Review and finalize demolition schedule and verify availability of materials, demolition personnel, equipment, and facilities needed to make progress and avoid delays.

d. Review requirements of work performed by other trades that rely on substrates exposed by demolition operations.

e. Review areas where existing construction is to remain and requires protection.

E. Project Conditions

1. The existing Aliso Creek Lift Station shall not be demolished until the new lift station is tested and accepted by the District. Refer to Section 01010 – Summary of Work for demolition sequence.

2. Conditions at time of inspection for bidding purposes will be maintained by the District as far as practical.

3. Notify the District's Representative of discrepancies between existing conditions and Drawings before proceeding with demolition.

4. Hazardous Materials: It is not expected that hazardous materials will be encountered in the work:

    a. Hazardous materials will be removed by the District before start of work.

    b. If materials suspected of containing hazardous materials are encountered, do not disturb; immediately notify the District and the District's Representative. District will remove hazardous materials under a separate contract.

5. Utility Service: Maintain existing utilities indicated to remain in service and protect them against damage during demolition operations.

F. Project Record Documents

The Contractor shall accurately record locations of capped or abandoned utilities, subsurface obstructions, and other item remaining after demolition.

PART 2 – MATERIALS

(Not Applicable)

PART 3 – EXECUTION

A. Preparation

1. Notify District's Representative of Work that may affect adjacent property owners, potential noise, and utility outage or disruption.

2. Mark locations of utilities, areas to be protected, and surveyor's marks.

3. Perform a structural survey per the National Association of Demolition Contractors Demolition Safety Manual prior to demolition of structures.

4. Establish emergency exits and procedures for the Work area, satisfactory to fire officials.

Provide evacuation directions inside of buildings during Work in English and Spanish. Mark arrows, as appropriate, with fluorescent paint on floors and walls indicating evacuation routes and exits. Post temporary evacuation route arrows in building not to be demolished. Do not damage surfaces in buildings to remain.

5. Temporary Facilities: Provide temporary barricades and other protection required to prevent injury to people and damage to adjacent building and facilities to remain.

   a. Provide protection to ensure safe passage of people around demolition area and to and from occupied buildings.

   b. Provide temporary weather protection, during interval between demolition of existing construction on exterior surfaces and new construction, to prevent water leakage and damage to structure and interior areas.

   c. Protect wall, ceiling, floors, and other existing finish work that are to remain of that are exposed during demolition operations.

6. Prevent movement or settlement of adjacent structures. Provide and maintain shoring, bracing, and structural supports as required to preserve stability and prevent movement, settlement, or collapse of construction and finishes to remain, and to prevent unexpected or uncontrolled movement or collapse of construction being demolished.

7. Water sprinkling, temporary enclosures, chutes, and other suitable methods shall be used to limit dust and dirt rising and scattering in the air. Comply with government regulations pertaining to environmental protection.

B. Protection

1. Safe passage of persons around area of demolition shall be ensured. Operations shall be conducted to prevent damage to adjacent buildings, structures, other facilities, and people s described in Part 3.A.5.

2. Existing structures, landscaping materials, structures, and appurtenances, which are not to be demolished shall be protected and maintained as necessary.

3. The Contractor shall protect and maintain conduits, drains, sewers, pipes, and wires that are to remain on the property.

C. Examination

1. Verify that utilities have been disconnected or capped.

2. Survey existing conditions and correlate with requirement indicated to determine extent of demolition required.

3. When unanticipated mechanical, electrical, or structural elements that conflict with intended function or design are encountered, investigate and measure the nature and extent of the conflict. Promptly submit a written report to the District's Representative.

4. Engage a professional engineer to survey the condition of building to determine whether removing any element might result in structural deficiency or unplanned collapse of any portion of structure or adjacent structure during demolition operations.

5. Survey of Existing Conditions: Record existing conditions by use of construction videotapes. Comply with requirements specified in this Section.

6. Perform surveys as the work progresses to detect hazards resulting from demolitions activities.

D. Traffic Control

1. The Contractor shall provide such flagmen, barricades, flares, lights, warning signs, and safety devices as may be required for the control of traffic adjacent to all areas of work.

2. Obtain all permits required for road or lane closures.

D. Utility Services and Mechanical/Electrical Systems

1. Existing Services/Systems: Maintain services/systems indicated to remain and protect them against damage during demolition operations.

2. Service/System Requirements: Locate, identify, disconnect, and seal or cap off indicated utility services and mechanical/electrical systems serving areas to be demolished. Coordinate to shut off indicated utilities with the perspective utility company.

3. Cut off pipe or conduit in walls or partitions to be removed. Cap, valve, or plug and seal remaining portion of pipe or conduit after bypassing. Where entire wall is to be removed, existing services/systems may be removed with removal of the wall.

4. Maintain service to active electrical systems in building to be demolished until ready for demolition of each system.

F. Structure Demolition

1. General: Demolish and remove existing construction only to the extent required by new construction as indicated. Use methods required to complete work within limitations of governing regulations and as follows.

a. Proceed with demolition systematically, from high to lower level. Complete demolition operations above each floor or tier before disturbing supporting members on the next lower level.

b. Neatly cut openings and holes plumb, square, and true to dimensions required. Use cutting methods least likely to damage construction to remain or adjoining construction. Use hand tools or small power tool designed for sawing or grinding, not hammering or chopping, to minimize disturbance of adjacent surfaces. Temporarily cover openings to remain.

c. Cut or drill from the exposed or finished side into concealed surfaces to avoid marring existing finished surfaces.

d. Do not use cutting torches until work area is cleared of flammable materials. At concealed spaces, such as duct and pipe interiors, verify condition and contents of hidden space before starting flame-cutting operations. Maintain fire watch and portable fire-suppression devices during flame-cutting operations.

e. Maintain adequate ventilation when using cutting torches.

f. Remove decayed, vermin-infested, or otherwise dangerous or unsuitable materials and promptly dispose off-site.

g. Remove structural framing members and lower to ground by method suitable to avoid free fall and to prevent ground impact or dust generation.

h. Locate selective demolition equipment and remove debris and materials so as not to impose excessive loads on supporting walls, floors, or framing.

i. Dispose of demolished items and materials promptly.

2. Building structures and appurtenances shall be demolished per Contract Documents and all work including hazardous material removal and disposal shall be completed in accordance with governing regulations.

3. Existing Items to Remain: Protect construction indicated to remain against damage during demolition.

4. Remove foundations, and footings, in their entirety. Remove other subsurface structures to a minimum of 2 feet below existing grade unless otherwise noted. Compaction of subsurface structures to satisfy the removal requirement is prohibited.

5. Backfill and compact areas excavated or disturbed during demolition and removal of subsurface structures and utilities.

6. Rough grade disturbed areas and demolition work areas.

7. Cease work immediately if adjacent structure appears to be in danger. Notify the District's Representative. Do not resume operations until directed by the District's Representative.

8. Spray Work with water to minimize dust. Provide hoses and water connections for this purpose.

9. Ensure that street drainage, drainage structures, and natural drainage or diversions are not obstructed. Provide protective measures to eliminate solids and debris from being discharged off site or entering drainage structures.

G. Demolition for Specific Materials

1. Concrete and masonry shall be demolished in small sections. Cut concrete or masonry full depth at junctures with construction to remain and at regular intervals, using power-driven saw, then remove concrete between saw cuts

2. Air-Conditioning Equipment shall be removed without releasing refrigerants.

H. Below-Grade Demolition

1. Footings, foundation walls, below-grade construction and concrete slabs on grade shall be demolished and removed in accordance with the contract documents and the approved demolition plan.

2. Below-grade areas and voids resulting from demolition of structures shall be completely filled. Voids beneath the existing slab-on-grade and footings which are to remain shall be filled completely with cement/sand slurry.

3. All fills and compaction shall be in accordance with Section 02201 – Earthwork and Grading.

4. After fill and compaction, surfaces shall be graded to meet adjacent contours and to provide flow to surface drainage structures, or as shown.

I. Disposal of Demolished Materials

1. Demolition and removal of debris shall be conducted to ensure minimum interference with roads, streets, walks, and other adjacent occupied or used facilities which shall not be closed or obstructed without permission from the District and/or City. Alternate routes shall be provided around closed or obstructed traffic ways.

2. Site debris, rubbish, and other materials resulting from demolition operations shall be removed off-site by the Contractor. Burning of removed materials from demolished structures shall not be permitted on site.

3. Except for items or materials indicated to be reused, salvaged, reinstalled, or otherwise indicated to remain the District's property, remove demolished materials from the site and legally dispose of then in an EPA-approved landfill.

4. Do not allow demolished materials to accumulate on-site. During and upon completion of work, the Contractor shall promptly remove unused tools and equipment, surplus materials, rubbish, debris, and dust and shall leave areas affected by work in a clean condition approved by the District's Representative.

5. Remove and transport debris in a manner that will prevent spillage on adjacent surfaces and areas.

6. Remove debris from elevated portions of build by chute, hoist, or other device that will convey debris to grade level in a controlled decent.

7. Contractor shall recycle demolition materials wherever possible.

J. Cleaning

Clean adjacent structures and facilities of dust, dirt, and debris caused by demolition, as directed by the District's Representative, and return adjacent areas to condition existing prior to start of work.

K. Demolition Scope

1. Existing construction to be removed is indicated in the Drawings by text and graphic representation. Elements generally include, but are not limited to, the following:

    a. Exterior on grade paving.

    b. Exterior door.

    c. Interior structural framing.

    d. Interior floor and ceiling finishes

    e. Interior ladder.

    f. Mechanical system components.

    g. Electrical system components.

    h. Exterior Masonry walls.

    i. Piping, valves, supports.

    j. Pumps, electrical motors, electrical equipment.

END OF SECTION

SECTION 02140

DEWATERING

PART 1 GENERAL

1.01 SECTION INCLUDES

A. This section includes labor, materials, installation, maintenance, operation and removal of temporary dewatering systems, as required to lower and control and dispose of surface and ground waters encountered during trench and surface excavations of the work. In addition, this section specifies the noise attenuation measures that will be required to be implemented for the dewatering systems. The temporary dewatering system shall continue its operation as required to complete the Work and to protect adjacent property or construction until danger of damage resulting from rise and fall of groundwater and/or inflow of surface water is precluded. Remove or relocate equipment when no longer required, or as approved well-points and like items may be abandoned in place in accordance with all Laws and Regulations.

B. Based on the geotechnical report prepared for the project, groundwater was encountered in the borings at a depth of approximate 23 feet below ground surface and measured to a stabilized depth of 19 feet below ground surface. The historically high groundwater table in the area is about 10 feet below the existing grade. Interpolating the available groundwater data, the report put the groundwater table at about Elevation 386 feet. Fluctuations of the groundwater, localized zones of perched water, and an increase in soil moisture should be anticipated during and following the rainy seasons or periods of locally intense rainfall or stormwater runoff. As such, the actual depth of groundwater may vary and should be verified during construction.

C. It is possible, the Contractor may be required to dewater prior to excavation of the new twelve-foot diameter manhole and its foundation. If encountered, the ground water level shall be lowered to at least five (5) feet beneath the bottom of the excavation. The Contractor shall dewater continuously until the manhole shaft has been backfilled.

D. Dewatering includes lowering the water table and intercepting seepage which would otherwise emerge from the faces or bottom of the excavation.

1.02 REFERENCES, CODES, AND STANDARDS

A. Prior to construction, the Contractor shall obtain necessary permits for the discharge or disposal of the dewatering water if it is discharged to storm drain facilities from the Regional Water Quality Control Board General Water Discharge Requirements for Groundwater Remediation and Dewatering Waste Discharges. The permit may be conditioned to protect the water quality in the project vicinity. These conditions may include treatment, discharge sampling, monitoring and reporting.

1.03 QUALITY ASSURANCE/WARRANTY

A. Qualifications

1. Furnish the services of an experienced, qualified, and equipped dewatering subcontractor to design and operate the dewatering system(s) required for the Work. In lieu of the above, implement the dewatering in accordance with a system approved by the District and designed by a Civil Engineer who is registered in the State of California and who has proven experience in this type of work.

B. Data Available for Examination

1. The geotechnical report prepared by Verdantas Inc., dated September 25, 2024 (Revised October 17, 202) and entitled "Geotechnical Exploration Report, El Toro Water District, Aliso Creek Lift Station Improvements, 24091 Avenida Sevilla, Laguna Woods, California" has been included in Appendix X.

C. Dewatering shall be performed by methods that will ensure a dry excavation and preservation of the final lines and grades of the bottoms of the excavations. The control of groundwater shall be such that softening of the bottom of excavations or formation of "quick" conditions or "boils" do not occur. Dewatering systems shall be designed and operated so as to minimize removal of the natural soils.

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

E. Dispose of the groundwater in a manner to prevent damage to adjacent property or structures. Where critical structures or facilities exist immediately adjacent to areas of proposed dewater, reference points shall be established and observed at frequent intervals to detect any settlement which may develop. The responsibility of conducting the dewatering operation in a manner which will protect adjacent structures and facilities rests solely with the Contractor. The cost of repairing any damage to adjacent structures and restoration of facilities shall be the responsibility of the Contractor.

1.04 SUBMITTAL

A. The Contractor shall submit his method of dewatering to the District for approval prior to excavation activities. The dewatering plans shall include drawings and data showing the planned method of dewatering, excavation plan, location and capacity of such facilities such as dewatering wells, well points, pumps, sumps, collection and discharge lines, standby units proposed, water disposal methods, discharge location, monitoring and settlement measuring equipment, and data collection and dissemination procedures, and protective fills and ditches for control of surface water. Submit not less than 45 days prior to start of dewatering.

B. The following design data shall be submitted: proposed type of dewatering system, including relief of hydrostatic head and maintenance of the excavations in a dewatered and in a hydrostatically relieved condition; arrangement, location and depths of the components of the system; a complete description of equipment to be used with installation, operation, and maintenance procedures; standby equipment and emergency power supply; location and size of sumps and discharge lines; types and sizes of filters; location, types and depths of wells and/or well points and observation wells; and design calculations demonstrating adequacy of the selected system and equipment.

C. Information on groundwater conditions may be found in the above Geotechnical Exploration Report. The Contractor is advised that the reports present conditions which existed at the time of the investigation.

D. Review by the District will not relieve the Contractor of the responsibility for the adequacy of the dewatering and excavation plan, compliance with dewatering permit requirements or for furnishing all equipment, labor and materials necessary for performing this work.

1.05 DISPOSAL OF GROUNDWATER DEWATERING

A. An NPDES permit is not needed if the groundwater is discharged to a sanitary sewer. The Contractor will be able to discharge groundwater dewatering to the existing District sewer system which goes to the existing Aliso Creek Lift Station.

B. The Contractor shall submit a report to the District containing the following items even if the groundwater dewatering is discharged to the District's sewer:

1. A description of facilities to control the concentration of pollutants in the waste including, but not limited to, suspended solids and total sulfides, or the reason that the necessity of such facilities is not anticipated.

2. Characterization of the groundwater dewatering discharge quality.

3. Weekly reports on the dewatering operations, including the estimated average and maximum daily flow rates.

PART 2 MATERIALS

A. Furnish, install, operate and maintain all materials, tools, machinery, equipment, facilities and services as required to maintain all excavations free from water during construction, and shall dewater and dispose of the water so as not cause injury to public or private property or adjacent structures. The dewatering system shall be installed and operated so that the groundwater level outside of excavation is not reduced to the extent which could cause damage or endanger adjacent structures. The static water level shall be drawn down a minimum of five (5) feet below the bottom of the excavation in order to maintain the undisturbed state of the foundation soils and to facilitate the placement of fill or backfill compacted to the required density.

B. The Contractor shall provide 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 dewater operation during power failure.

C. Dewatering system shall be equipped with meters that register in gallons in order to measure dewatering volumes.

D. Sumps shall be no deeper than four (4) feet and shall be at the low point of the excavation. Excavation shall be graded to drain to the sumps.

E. The annular space between the pipe and the borehole of the well point shall be sealed near the top of the well point to prevent vacuum leaks. Installation shall be carried out in such a way so as not to excessively disturb in situ material.

F. 100% standby pumping capacity shall be available on site at all times and shall be connected to the dewatering system piping to permit immediate use.

G. Dewatering system shall not be shut down between shifts, on holidays, on weekends, or during work stoppages.

PART 3 EXECUTION

3.01 PREPARATION

A. Lay out and install dewatering installations beyond the limits of the permanent works. Avoid interference with access or other necessary activities. Provide protections for vital parts from accidental damage, and erect signs and barricades to isolate hazardous areas.

3.02 PERFORMANCE

A. Dewatering

1. Perform dewatering operations as required so all underground and below-grade Work is performed or installed in dry excavations, in accordance with recommendations set forth in Section 02223, Trenching, Backfilling and Compacting. Maintain dewatering systems in continuous operation until the Work is completed, including the placing and compaction of backfill materials.

B. Protection of Existing Facilities

1. Provide standby equipment of sufficient size and capacity to insure continuous operation of the dewatering systems. Where any sloped excavation infringes on or potentially endangers any existing facilities or structures, provide shoring, sheeting, and bracing according to shop drawings and calculations signed and stamped by a Structural or Civil Engineer registered in the State of California. File a copy of such plans and calculations with the District for record purposes. At Contractor's sole expense and to the District's satisfaction, repair and make good all damage or settlement to the foundation or other portion of any new or any existing facilities or structures caused by permanent or temporary failure or operation of the dewatering or by failure to maintain the existing groundwater level outside the dewatering areas.

C. Drainage

1. Provide and maintain ample means to promptly and effectively remove water from all areas of work to prevent the entry of harmful quantities of water into the excavations and to dispose of the water removed. Avoid environmental damage and nuisance.

D. Removal

1. Remove equipment when no longer required for dewatering or water controlling operations. Maintain operation of monitoring and settlement measurements systems until their removal is approved. To the extent approved, well points and like items may be abandoned in place; otherwise, all temporary works, dewatering and recharging facilities shall be removed in a manner satisfactory to the District.

E. Dewatering for structures and pipelines shall commence prior to excavation and removal of material for the construction of structures and pipelines, when groundwater is first encountered, and shall be continuous until such times as water can be allowed to rise in accordance with these specifications.

F. Dewater to a minimum of five (5) feet below the bottom of excavation and/or work zone.

G. Dewatering shall at all times be conducted in such a manner as to preserve the undisturbed bearing capacity of the subgrade soils at the proposed bottom of excavation.

H. If foundation soils are disturbed or loosened by the upward seepage of water or an uncontrolled flow of water, the affected areas shall be excavated and replaced with 1 to 2-inch rock at no additional cost to the District.

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. The Contractor will be able to discharge dewatering flows to the existing Aliso Creek Lift Station. The Contractor shall notify the District 48 hours prior to discharging flows to the lift station.

K. Concrete shall not be poured in water, nor shall water be allowed to rise around the concrete or mortar until it has set at least four hours.

3.03 TESTING AND FIELD QUALITY CONTROL

A. Observe and record the elevation of the groundwater during the period that the dewatering system is in operation.

3.04 REPAIRS AND CLEANUP

A. The dewatering system can be removed when surface water or ground water is no longer encountered in the work or when the requirements of this Section are met.

B. Replace or repair any defective equipment or system components prior to commencing construction operations to ensure all dewatering requirements are adhered to.

3.05 NOISE ATTENUATION REQUIREMENTS

A. At the commencement of dewatering activities, the Contractor shall employ noise attenuation measures for the dewatering generator, including, but are not limited to, generator silencers, acoustical enclosures, mufflers, noise barriers, and/or acoustical panels/blankets as necessary to reduce the night time exterior noise levels at nearby sensitive receptors that are in compliance with the City of Laguna Wood's Noise Ordinance.

END OF SECTION

SECTION 02145

SEWER FLOW BYPASSING

PART 1 – GENERAL

A. DESCRIPTION

1. Scope: This Section specifies the requirements for temporary bypassing of sewers during construction of manholes, connections to existing manholes, connecting the new lift station to the existing force main and electrical service. The Contractor is responsible for the temporary handling of sewage, spill prevention and control, and odor control throughout any sewer flow bypass operation. Temporary handling of sewage includes bypass pumping, bypass piping, plugs, flow-through plugs and other means of handling the sewage flows. Contractor shall provide all materials, labor, supervision, and equipment required for temporary handling of flow, including preparation and implementation of a spill prevention, control and countermeasure plan (SPCCP) to facilitate the work. The Contractor shall comply with the Regional Water Quality Control Board, Health Department, Air Quality Management District permits and regulations.

2. Bypass Pumping: Contractor shall prepare a detailed bypass pumping plan, and bypass sequence plan for review and acceptance by the District. The Contractor shall design a sealed flow bypass system in order to eliminate nuisance odors. The bypass pumping system shall be completely installed and commissioned to the full satisfaction of the District and Contractor prior to performing any bypass pumping operation.

   Contractor shall be responsible for all aspects of the mobilization, set up, operation, management, monitoring, maintenance operation, pressure testing, spill containment, spill management including clean up, replacement of damaged property and fines that may occur for any reason including, but not limited to equipment failure, clogging, hose or pipe breakage.

   When bypassing flows the Contractor shall have at least two designated staff on site 24 hours per day to operate, monitor and maintain the bypass pumping system and implement the spill prevention and control procedures. Those staff shall be factory-trained to operate the bypass pumping, perform maintenance on all aspects of the bypass system, including activation of standby equipment, and periodic pump deragging. The person shall also be certified to monitor and maintain the bypass system and implement the emergency procedures in case of an emergency.

3. Spill Prevention, Control and Countermeasure Plan: The Contractor shall develop a Spill Prevention, Control and Countermeasure Plan (SPCCP) including the following items:

a. Identify all equipment, materials and labor necessary to prevent a sewage spill in the event there is a sewage leak during bypassing of sewers.
b. A description of the Contractor's plan to respond to a sewage spill should it occur.
c. The plan shall include a step by step procedure on how the equipment, materials and labor will be mobilized and implemented in the event there is a potential for a spill or in the event a spill occurs.
d. Describe handling of sewage flow during a bypass system failure.
e. A plan identifying existing storm drains and material used to block the openings in the event of a spill.

At a minimum, the Contractor shall provide the following emergency sewage overflow response equipment along with the labor and materials necessary to implement emergency use of the following items in response to a sewage overflow or spill:

a. A minimum of 10-feet of pipe of each size and type used on the bypass system together with matching repair couplings.
b. Storm drains shall be protected from entry of sewage spills using rubber matting and sand bags. Rubber matting shall overlap storm drain inlets by a minimum of 24-inches on all sides. For inlets located in traffic, the grating may be removed, wrapped with rubber sheeting and reinstalled to provide a barrier to the inlet.
c. The Contractor shall have a minimum of one 48-inch wide by 36-foot long roll of rubber matting and the equivalent of eight cubic yards of sandbags in a pre-loaded truck ready for use in addition to the materials required to cover storm drain inlets.
d. Temporary sewer and storm drain plugs to manage collection and disposal of any sewage overflows.

The Contractor shall provide at least two (2) people who can be contacted 24 hours per day by phone and are available to go to the project site at any time to address on-site emergencies.

4. Odor Mitigation:

The Contractor shall prepare an Odor Control Plan identifying and locating any potential construction activities that might produce odors. The plan shall describe the means of mitigating the odors and identifying all materials, equipment and systems the Contractor is planning to use. Potential nuisance odor areas shall include open manholes, and open sewers where sewer gases may be present or can be released. Potential nuisance odor areas do not include covered manholes or plugged sewer pipes. During bypass pumping, manholes upstream of the pump shall also be considered as potential odor sources due to the blocking off of the

airflow in the headspace of sewer.

5. Contractor Liability: The Contractor shall be responsible for the continuity of sewage during the execution of the work. The Contractor shall perform his work to ensure no spill of sewage. Contractor shall provide a no spill plan and shall be responsible for all cleanup costs, damages, and fines associated with sewage spills on site, directly or indirectly caused by the construction activities. Contractor shall notify the District of any sewage spills immediately upon discovering the spill.

6. Existing sewage flows: A flow monitoring study, dated March 4, 2024 for the sewers influent to the lift station, reflects data between January 15, 2024 through February 17, 2024. However, the District makes no guarantee that the estimated flow rates given will be sufficient to fully bypass the quantity of flow encountered in the performance of the Work. The Contractor shall provide various means (gravity diversion and/or pumping system) to bypass the amount of flow that is actually encountered. The anticipated flow rates into the station are as follows: minimum flow of 300 gpm and maximum inflow of 3,400 gpm.

B. SUBMITTALS

1. The Contractor shall submit drawings and complete design data showing methods and equipment he proposes to utilize in sewer bypassing for approval by the District. The submittal shall include the following information:

    a. Drawings indicating the location of temporary sewer plugs and bypass discharge lines.
    b. Capacities of pumps, prime movers, and standby equipment.
    c. Design calculations proving adequacy of the system and selected equipment.
    d. Standby power source.
    e. Staffing plan for maintaining equipment for 24-hour continuous, reliable operation on weekdays and/or weekend days.
    f. Noise and Odor Control Plan.
    g. Plan showing the existing sewer line and the proposed points of flow interruption and/or flow diversion.
    h. Construction time schedule showing anticipated times of flow interruption and/or flow diversion.
    i. A description of the equipment to be used including:
        1) Size of suction and discharge pipe diameter and pipe material.
        2) Size and model of pumps, including horsepower, speed, voltage, phase, fuel type, and fuel consumption.
        3) Bury depth, backfill material, pipe material, temporary surface restoration, and permanent surface restoration material for portions of bypass pipe to be buried.

4) Generator (if used) make, model, horsepower, speed, voltage, phase, fuel type, and fuel consumption.
5) Total Design Head calculations.
6) Noise rating for all equipment.
7) Security and protection of bypass system.
8) Standby equipment that will be provided on-site in case of emergency.

j. Spill Contingency plan detailing precautions to be implemented to prevent sewage spills including specific responses and control measures to follow during an overflow resulting from breakage or blockage and maintenance and inspection schedules to detect potential problems to mitigate the potential release resulting from overflows, bypass pipe ruptures, and blockages.

C. JOB CONDITIONS

1. PROTECTION: In areas where flows are bypassed, all bypass flow shall be discharged as approved by the District. No bypassing to the ground surface, receiving waters, storm drains, or bypassing which results in groundwater contamination or potential health hazards shall be permitted.

2. SCHEDULING: The bypassing system shall not be shut down between shifts, on holidays or weekends, or during work stoppages without written permission from the District. The bypassing system is prohibited from use during rain events, but in no case will the Contractor remove the bypass without informing the District.

PART 2 – PRODUCTS

A. Materials

1. The Contractor shall provide temporary pumps, conduits, and other equipment to bypass the sewer flow. Contractor shall furnish the necessary labor and supervision to set up and operate the pumping and bypass system. Engine-driven pumps shall be equipped with mufflers and/or shall be enclosed to keep the noise level less than 60db or 10db above ambient noise levels when measured at the property lines closest to the noise source. Pumps and bypass lines shall be of adequate capacity and size to handle the flows.

2. The Contractor shall maintain on-site sufficient equipment and materials to ensure continuous and successful operation of the bypass systems. Standby pumps shall be fueled and operational at all times. The Contractor shall maintain on site a sufficient number of valves, tees, elbows, connections, tools, sewer plugs, piping, and other parts or system hardware to ensure immediate repair or modification of

any part of the system as necessary.

3. All piping, joints and accessories shall be designed to withstand at least twice the maximum system pressure, or 150 psi, whichever is greater.

4. Bypass duty and standby pumps shall be designed for raw sewage applications, resistant to ragging, and capable of passing a 3-inch solid sphere. Pumps shall be self-priming with suction lift sufficient to avoid sewer surcharge. The self-priming system shall allow the pump to start dry and run dry without causing damage. Pumps may be equipped with a vacuum assisted self-priming device. Any orifice designed to discharge air during pump priming shall be connected to a portable activated carbon scrubber or shall be equipped with a designated activated carbon scrubber. All engines shall be critically silenced for sound control and regardless of the noise level, soundproofing shield not less than eight feet high shall be provided around each engine to absorb noise. Pumps shall have a minimum total dynamic head and flow capacities to meet the flow and lift requirements for the new submersible pumps. Pumps shall be capable of readily starting up after a non-operational period during low flow conditions and be capable of operating 24 hours per day, while handling the full range of flows. 100% standby pumping shall be provided. Standby pump shall be sized to match the duty pump. Standby pumping equipment shall be at the site continuously during bypassing to provide standby pumping capacity. Standby pumping equipment shall be fully connected to the suction and discharge piping of the duty pumps so the system is available at any time. Bypass and standby pumps shall be Godwin, Rain for Rent, or approved equal.

5. Above ground bypass piping shall be high density polyethylene (HDPE) pipe, steel or aluminum pipe with grooved couplings. HDPE shall be butt welded and have a minimum wall thickness of SDR 17. For protection against damage, the bypass piping shall be protected in place by barrier or crash cushions when adjacent to traffic. All temporary connections to existing and new manholes shall be properly covered and sealed to prevent nuisance odors from escaping into the atmosphere. Suction and discharge piping shall be sized per the Contractor's recommendation and shall not be smaller than the pump intake/discharge. Where the bypass piping discharges into a manhole, the discharge pipe shall extend into the manhole, ending at the elevation of the center of the trunk sewer. All valves used on the bypass system shall be open port gate, plug or ball valves.

6. Temporary plugging of sewer: Plugs shall be appropriate for the application. Plugs shall be a heavy-duty inflatable type with a steel rod through plug centerline, a retaining plate and an eye-lift on both ends. Plugs shall be new, made of natural rubber and shall show no cracks or signs of damage. The plugs shall have a flexible sealing design to compensate for any irregular interior surface of the pipe. The plugs shall be equipped with continuous pressure monitoring. The eye-lifts shall be secured to a 5/8-inch diameter stainless steel pulling cable accessible for removal without entry.

7. Flow-through plug: flow-through plugs shall be appropriate for the application and provided with the required configuration to perform the bypass. The flow-through plug shall consist of a flow-through plug and a flexible hose. The flexible hose shall be rubber coated, heavy duty, nylon hose with an enclosed steel helix coil. The flow-through plug shall attach to the flexible hose using high torque, stainless steel pipe clamps. The flow-through plugs shall be equipped with continuous pressure monitoring.

8. Manhole level sensors with alarm: The wet well shall be fitted with a level monitoring system connected to an audible alarm and light to monitor the sewage level during bypass pumping operations. The level monitoring system will be required whether bypass pumping is being performed or the interim piping configuration shown on the plans is used. The level shall be monitored by smart cover, float, ultrasonic level device, radar level device or other means suitable for monitoring sewage level and shall be either self-powered or powered from a standby generator. Sensors shall be suitable for a Class I, Division 1 environment. Alarm circuit shall be intrinsically safe and suitable for a Class I, Division 1 environment. Mounting height of the level sensor shall be acceptable to the District.

PART 3 – EXECUTION

A. General

1. The Contractor shall have pumping equipment and machinery in good working condition on hand for emergencies and shall have workmen available for its operation.

2. During bypass pumping, sewage shall not be leaked, dumped or spilled onto any area outside the sewer system. When bypass pumping operations are complete, all piping shall be drained into the sanitary sewer prior to disassembly. In the event that sewage spills, the Contractor shall immediately correct the bypass operation, notify the District and take the necessary action to clean up and disinfect the spillage to the satisfaction of the District.

3. The Contractor shall take all necessary precautions, including constant monitoring of bypass pumping to prevent sewage spills due to back-up and/or overflow resulting from breakage or blockage of the bypass system. The Contractor shall provide experienced personnel knowledgeable in the operation of the bypass equipment to monitor each bypass when the bypass is installed and operating. At no time shall the bypass system be left unattended during operation by the designated personnel. The Contractor shall be liable for all cleanup, damages, and resultant fines in the event of a spill.

4. The pumps and piping shall be protected from damage, vandalism, and/or theft to the maximum extent possible

5. The bypass system (all equipment) shall be fully tested prior to commencing bypass operation including the following as a minimum:

   a. Pressure test the piping to at least 150 psi with potable water prior to introducing sewage to the line.

   b. Inspect the piping for leaks and repair or replace leaking sections and joints.

   c. Test pumping system, including back-up pumps.

6. All material and equipment identified in the spill contingency plan, including control measures in the event of a spill shall be on-site prior to commencing bypass operation.

7. After the work is completed the temporary bypass system shall be removed and the surrounding area including all hardscape and landscape shall be returned to pre-construction condition.

8. All labor, materials, equipment, and incidentals associated with the temporary controls and diversions required to maintain uninterrupted flow in all existing sewer lines associated with this project shall be borne by the Contractor.

END OF SECTION

SECTION 02201

EARTHWORK AND GRADING

PART 1 - GENERAL

A. Description

This section presents general procedures and requirements for grading and earthwork, including preparation of areas to be filled, placement of fill and excavations. This section also presents the procedures and requirements for the preparation of the subgrade foundation for the lift station and valve vault.

B. Related Work Specified Elsewhere

1. Structure Earthwork: 02220

2. Trenching, Backfilling, and Compacting: 02223.

C. Geotechnical Report

A report of geotechnical exploration prepared by Verdantas Inc., dated September 25, 2024 (Revised October 17, 202) and entitled "Geotechnical Exploration Report, El Toro Water District, Aliso Creek Lift Station Improvements, 24091 Avenida Sevilla, Laguna Woods, California" has been included in Appendix X. Contractor shall be familiar with the recommendations contained within the report.

D. Submittals

1. Material samples and grain size analyses shall be submitted for any imported fill material used.

2. Submit a report from a testing laboratory verifying that gravel layer and aggregate base conform to the specified gradations or characteristics.

3. Submit manufacturer's catalog data and descriptive literature for the filter fabric and filter drain material.

PART 2 - MATERIALS

A. Fill Material

1. General: Material to be placed as fill shall be free of organic matter and other deleterious substances, and shall be approved by the District's Representative. Expansive soils, or soils of poor gradation or strength characteristics shall either be removed from the site, and disposed of in accordance with all local regulations, placed in areas designated by the District's Representative, or mixed with other soils to serve as satisfactory fill or soil material.

2. Oversize Material: Oversize material defined as rock or other irreducible material with a maximum dimension greater than 6 inches, shall not be buried or placed in fills, unless the location, materials, and disposal methods are specifically approved by the District's Representative. Oversize disposal operations shall be such that nesting of oversize material does not occur, and such that the oversize material is completely surrounded by compacted or densified fill. Oversize material shall not be placed within 10 feet vertically of finish grade or within the range of future utilities or underground construction, unless specifically approved by the District's Representative.

3. On-site Material: Excavated on-site soils may be reused as compacted fill provided they are free of deleterious substances, have an organic content less than 3 percent by weight, contains no rocks or lumps larger than 6-inches in greatest dimension, with no more than 15 percent larger than 2 1/2 inches and has suitable moisture content to obtain proper compaction. However, on-site material may be required to be dried prior to placement as fill due to their high degree of saturation.

4. Imported Fill Material: If importing of fill material is required, the import material shall meet the requirements above, as well as, be non-expansive and inorganic and have a Plasticity Index of 15 or less. Imported fill shall have sufficient binder to prevent caving of the foundation and utility trenches. Import soils shall not be more corrosive than the native materials.

B. Crushed Rock

Crushed rock shall conform to the Standard Specifications for Public Works Construction, Section 200-1.2 and shall be uniformly graded, 1 to 2-inch washed, crushed aggregate.

D. Aggregate Base

Aggregate base shall conform to the Standard Specifications for Public Works Construction, Section 200-2.2.

E. Filter Fabric Material

Filter fabric shall be manufactured from polyester, nylon, or polypropylene material; shall be of non-woven construction conforming to the following requirements:

Property	ASTM Method	Mirafi 140N	Mirafi 600X
Weight, oz. per sq. yd.	D 3776	4.5	6.0
Grab Elongation, %	D 4632	55	35 (max)
Grab Tensile Strength, lbs.	D 4632	120	300
Puncture Strength, lbs.	D 4833	70	130
Thickness, mils.	D 1777	60	30
Permittivity, Sec^{-1},	D 4491	0.35	0.40
Water flow rate, gal/min/sf	D 4491	170	35

Filter Fabric shall be manufactured by Mirafi or approved equal.

PART 3 - EXECUTION

A. Earthwork Observation Testing

1. Access: Adequate access shall be provided at all times to allow the District's Representative to make observations and conduct tests to verify that the work complies with the requirements of the specifications. The District's Representative shall be given assistance as necessary for performing test, and shall be kept apprised of work schedules.

2. Methods: Adequate equipment and methods shall be employed to accomplish the work in accordance with applicable grading codes or agency ordinances, these specifications and the approved grading plans. If, in the opinion of the District's Representative, unsatisfactory conditions, such as questionable soil, poor moisture condition, inadequate compaction, adverse weather, etc., have resulted in a quality of work less than required in these specifications, the District may reject the work and recommend that construction be stopped until the conditions are rectified.

3. Compaction Testing: Maximum dry density test used to determine the degree of compaction will be performed in accordance with the American Society for Testing and Materials ASTM Test Method D1557.

B. Preparation of Areas to be Filled

1. Processing: The existing ground which is determined to be satisfactory for support of fill shall be scarified to a minimum depth of 6 inches. Existing ground which is not satisfactory shall be overexcavated as specified in the following subsection. Scarification shall continue until the soils are broken down and free of large clay lumps or clods and until the working surface is reasonably uniform and free of uneven features which would inhibit uniform compaction.

2. Overexcavation: Soft, dry, spongy, highly fractured or otherwise unsuitable ground, extending to such a depth that surface processing cannot adequately improve the condition, shall be overexcavated down to firm ground, as directed by the District's Representative.

3. Moisture Conditioning: Overexcavated and processed soils conforming to "Fill Material" specified herein shall be watered, dried-back, blended, and/or mixed, as required to attain a uniform moisture content near the optimum moisture content prior to placement and compaction.

4. Recompaction: Overexcavated and processed soils which have been properly mixed and moisture-conditioned shall be recompacted to a minimum of 90 percent of maximum dry density, except for the following:

   - 95% minimum for the area below pavement areas.

5. Approval: All areas to receive fill, including processed areas, removal areas and toe-of-fill benches shall be approved by the District's Representative prior to fill placement.

C. Fill Placement and Compaction

1. Fill Lifts: Approved fill material shall be placed in areas prepared to receive fill in near-horizontal layers not exceeding 8 inches (loose) in thickness. The District may approve thicker lifts if testing indicates the grading procedures are such that adequate compaction is being achieved with lifts of greater thickness. Each layer shall be spread evenly and shall be thoroughly mixed during spreading to attain uniformity of material and moisture in each layer.

2. Fill Moisture: Fill layers having a moisture content less than optimum shall be watered and mixed. Fill layers having a moisture content greater than optimum shall be aerated by scarification or shall be blended with drier material. Moisture-conditioning and mixing of fill layers shall continue until the fill material is plus or minus two percent of the optimum moisture content.

3. Compaction of Fill: After each layer has been evenly spread, moisture-conditioned, and mixed it shall be uniformly compacted to not less than 90

percent of maximum dry density per ASTM DI557, latest version (see Part 3.C.4 of this Section for the areas requiring 95 percent of maximum dry density). Compaction equipment shall be adequately sized and shall be either specifically designed for soil compaction or of proven reliability, to efficiently achieve the specified degree of compaction.

4. Fill Slopes: Fill slopes shall be overfilled and compacted, then blade cut to a firm surface. Compacting of fill slopes shall be accomplished, in addition to normal compacting procedures, by back- rolling of slopes with sheepsfoot rollers at frequent increments of 2 to 3 feet in fill elevation gain, or by other methods producing satisfactory results. At the completion of grading, the relative compaction of the slope out to the slope face shall be at least 90 percent of maximum dry density.

5. Compaction Testing: Field test to check the fill moisture and degree of compaction shall be performed by the District's Representative. The location and frequency of tests shall be at the District's Representative's discretion. In general, the tests will be taken at an interval not exceeding 2 feet in vertical rise with a maximum of 200 feet distance, and/or 1,000 cubic yards of fill. In addition, on slope faces, at least one test shall be taken for each 5,000 square feet of slope face and/or each 10 feet of vertical height of slope.

D. Backfill Placement Adjacent to Lift Station

If fill is required beneath the proposed lift station, the Contractor shall place additional crushed rock (increase the thickness of the crushed rock layer). All fill beneath the proposed mat foundation shall be compacted to a minimum of 90% of maximum dry density per ASTM D1557 in 6-inch thick lifts.

Light weight compaction equipment within 10 feet of the structure wall shall be used so as not to damage the wall. The backfill shall be placed equally around the structure as it is compacted, it shall not be piled against one portion of the perimeter unevenly.

E. Excavation

Temporary excavations and shoring shall be performed in accordance with OSHA's "Guideline for Excavations and Temporary Sloping" for Type C soils.

Excavations that might extend below an imaginary plane inclined at 45 degrees below the edge of an existing foundation shall be properly shored to maintain foundation support of the existing structure. Contractor shall be familiar with the shoring design recommended within the geotechnical report.

Excavations and cut slopes will be examined during grading. If directed by the District's Representative, further excavation or overexcavation and refilling of cut areas shall be performed, and/or remedial grading of cut sloped shall be performed. Where fill-over-cut slopes are to be graded, unless otherwise approved, the cut portion of the slope shall be made and approved by the District's Representative prior to placement of materials for construction of the fill portion of the slope.

Contractor and the Contractor's Shoring Subcontractor shall be familiar with the shoring design recommended within the geotechnical report, prior to submitting their bid for the proposed contract and shall report any discrepancies and/or omissions in writing per the requirements of Section 3-1 of the "Greenbook", Standard Specifications for Public Works Construction.

Temporary cuts may require temporary shoring in order to be supported. Shoring systems shall be designed, signed and stamped by a California Registered Civil or Structural Engineer. Preliminary design guidelines are presented within the geotechnical report. Heavy construction loads, such as those resulting from stockpiles or heavy machinery, should be kept a minimum distance equivalent to the excavation height or 15 feet, whichever is greater, unless these surcharges are considered in the design of the shoring system.

F. Maintenance

1. Protection of Graded Areas: Newly graded areas shall be protected from traffic and erosion. Settled, eroded, and rutted graded areas shall be repaired and re-established to specified tolerances.

2. Reconditioning Compacted Areas: Where completed compacted areas are disturbed by subsequent construction operations or adverse weather, these areas shall be scarified, re-shaped, and compacted to required density prior to further construction.

3. Settling: Where settling is measurable or observable at excavated areas during the project or warranty period, the surface (pavement, lawn or other finish), shall be removed, backfill material added and compacted, and surface treatment replaced. The appearance, quality, and condition of surface or finish shall be restored to match adjacent work.

END OF SECTION

SECTION 02220

STRUCTURE EARTHWORK

PART 1 - GENERAL

A. Description

This section describes excavation, backfilling, materials, testing, and shoring for the surface structures (block walls).

B. Related Work Specified Elsewhere

1. Trenching, Backfilling, and Compacting: 02223.

2. Pavement Removal and Replacement: 02578.

3. Concrete Formwork: 03100.

C. Submittals

1. Shop drawings shall be submitted in accordance with Section 01300.

2. Shop drawing shall be submitted showing excavation and shoring, bracing or sloping for worker protection.

3. Submit a report from a testing laboratory verifying that gravel base and structural backfill conforms to the specified gradations or characteristics.

4. Test reports on borrow material.

5. Other tests and material reports as required.

D. Protection of Existing Utilities and Facilities

1. General: The Contractor shall be responsible for the care and protection of all existing sewer pipelines, water pipelines, gas mains, storm drains, culverts, or other facilities and structures that may be encountered in or near the area of work.

2. Notification: It shall be the duty of the Contractor to notify each agency of jurisdiction and make arrangements for locating each agency's facilities prior to beginning construction.

3. Damage: In the event of damage to any existing facilities during the progress of the work due to the failure of the Contractor to exercise the proper precautions, the Contractor shall be responsible for the cost of all repairs and protection to said facilities. The Contractor's work may be stopped until repair operations are complete.

E. Protection of Landscaping

The Contractor shall be responsible for the protection of all the trees, shrubs, fences, and other landscape items adjacent to or within the work area, unless directed otherwise on the plans. In the event of damage to landscape items, the Contractor shall replace the damaged items in a manner satisfactory to the District Representative.

PART 2 - MATERIALS

A. Definition of Zones

1. Pavement and Street Zones: Pavement and street zones shall be as defined in Section 02223: Trenching, Backfilling and Compacting.

2. Upper Backfill Zone: The upper backfill zone is defined as the backfill to the full width of the excavation from the top of the structure to the bottom of the street zone in paved areas or to the finished surface in unpaved areas.

3. Structural Backfill Zone: The structural backfill zone is defined as backfill from the top of the structure to the bottom of the excavation, extending the full width of the excavation.

B. Native Earth Backfill-Upper Backfill Zone

Native earth backfill shall be excavated fine grained non-organic materials free from peat, roots, debris, and rocks larger than 3 inches, and which can be compacted to the specified relative compaction.

C. Structural Backfill - Structural Backfill Zone

Structural backfill materials shall consist of hard, durable, and clean sand, gravel, or crushed stone which is free of organic material, clay balls, and other deleterious substances, and shall have the following gradation:

Sieve Size	Percent Passing by Weight
2 inches	100
1-1/2 inches	95 to 100
3/4 inch	50 to 100
3/8 inch	15 to 55
No. 4	0 to 25
No. 8	0 to 5
No. 200	0 to 3

D. Crushed Rock Base

Crushed or natural rock with the following gradation shall be provided as base under the structure.

Sieve Size	Percent Passing by Weight
2 inches	100
1-1/2 inches	70 to 100
3/4 inch	60 to 100
No. 4	25 to 55
No. 30	10 to 30
No. 200	0 to 5

E. Slurry Backfill

Slurry backfill shall consist of one sack (94 pounds) of portland cement per cubic yard of sand and sufficient moisture for workability.

F. Water for Compaction

Water used to assist in compaction shall conform to Section 02223, Trenching, Backfilling, and Compacting.

PART 3 - EXECUTION

A. Testing for Compaction

Testing for compaction shall conform to Section 02223, Trenching, Backfilling, and Compacting.

B. Compaction Requirements

1. Backfill in Street Zone: 95% relative compaction.

2. Upper Backfill Zone: 90% relative compaction.

3. Structural Backfill Zone: 90% relative compaction.

C. Dewatering

1. General: Dewatering operations shall continuously remove and dispose of all water entering the excavation during construction of the structure and all backfill operations. The ground water shall be maintained a minimum of two (2) feet below the excavation bottom. Water shall be disposed of in a manner to prevent damage to adjacent property and pipe trenches in conformance with all local regulations. Water shall not be allowed to rise in the excavation until backfilling around and above the structure is completed.

2. Notification: The District shall be notified 48 hours prior to commencement of dewatering. Water shall be discharged to sewer system.

D. Structure Excavation

1. Removal of Material: Structure excavation shall include the removal of all material necessary for the construction of underground structures and foundations for the block wall.

2. Clearance: Unless noted otherwise on the plans, the sides of excavations for structures shall be sufficient to leave at least a 2-foot clearance, as measured from the extreme outside of formwork or the structure. Excavation side slopes shall be as specified in Subsection E.

3. Structure Foundation: The proposed block wall footing shall be supported on three (3) feet of properly compacted fill and shall be compacted to 90% maximum dry density prior to installing the block wall footing. The ground water shall be maintained a minimum of two (2) feet below the excavation.

4. Overdepth Excavations: Overdepth excavations shall be corrected by backfilling with crushed rock or concrete, as directed by the District Representative. No native earth backfill will be permitted to correct overdepth excavation beneath structures.

6. Surplus Material: Surplus material shall be disposed of in accordance with Section 02223, Trenching, Backfilling, and Compacting.

E. Support for Excavations for Structures

1. Safety: A safe working area shall be provided for workers. The services of a Registered Civil Engineer shall be obtained to design sheeting, shoring and bracing, or side slopes. The requirements of CAL/OSHA and of these Specifications shall be used as minimum design criteria. The data contained within the geotechnical report shall be used to provide safe design.

2. Temporary Construction Excavation Side Slopes: Minimum side slope shall be per CAL/OSHA but not steeper than 1.5:1 for Type C soils.

3. Traffic Safety: Methods of support or side slopes shall be selected to provide sufficient clearance for public/construction traffic safety and convenience.

4. Design Loads: The characteristics of the soil exposed in the excavation, the groundwater conditions, traffic, and other surcharge loads shall be considered when selecting lateral pressures to be used for design of soil supporting systems.

5. Design Criteria: Contractor shall obtain the minimum design criteria for the required shoring from the geotechnical report prepared for the project which is included in the Appendix.

5. Verification of Soil Types: Prior to design and submittal of support system, verification of the type of soil below the bottom of the excavation shall be made.

F. Backfill Against Walls and Over Roof Slabs

1. Precautions:

   a. Backfill over structure shall be placed in a manner so as to not damage the roof membrane and protective cover.

   b. Backfill shall not be placed against walls or above buried roof slabs until the concrete has obtained a comprehensive strength equal to the specified 28-day compressive strength. Where backfill is to be placed on both sides of the wall, the backfill shall be placed uniformly on both sides. Where backfill is to be placed around a structure, the backfill shall be placed at a uniform rate around the structure.

   c. Backfill shall not be placed against the walls of structures that are laterally restrained or supported by suspended slabs or slabs on grade until the slab is poured and the concrete has reached the specified compressive strength.

2. Equipment: Equipment for placing and compacting backfill over structures shall not exceed 15 tons total weight and a maximum wheel load of 10,000 pounds. Equipment weighing more than 10,000 pounds shall not be used closer to walls and structures than a horizontal distance equal to the depth of fill at the time.

G. Compaction

1. Compaction for Zones: Compaction shall be controlled to the percentage of density specified for each zone.

2. Moisture Control: Moisture shall be controlled as follows:

   a. Where subgrade or soil material layers must be moisture conditioned before compaction, water shall be uniformly applied to the subgrade surface or soil layer material in order to prevent free water from appearing on the surface during or subsequent to compaction operations. The moisture content of the compacted soil shall be within 2 percentage points of the optimum.

   b. Soil material that is too wet to permit compaction to specified density shall be removed and replaced with fill with proper moisture content.

   c. Soil material that has been removed because it is too wet to permit compaction may be stockpiled or spread within an approved area and allowed to dry. Drying may be assisted by discing, harrowing or pulverizing, until moisture content is reduced to satisfactory value.

   d. Backfill or fill material shall not be placed on surfaces that are muddy, frozen, or contain frost or ice.

3. Requirements Prior to Backfilling: Excavations shall be backfilled as work permits, but not until completion of the following:

a. Acceptance of construction below finish grade including, where applicable, dampproofing, waterproofing, and perimeter insulation.

b. Inspection, testing, approval, and recording locations of underground utilities.

c. Removal of concrete formwork per Section 03100.

d. Removal of shoring and bracing, and backfilling of voids with satisfactory materials. Cut off temporary sheet piling driven below bottom of structures and remove in manner to prevent settlement of the structure or utilities, or leave in place, if required.

e. Removal of trash and debris.

f. Permanent or temporary horizontal bracing is in place on horizontally supported walls.

4. Backfill Layers: Backfill and fill materials shall be placed in layers not more than 8 inches in loose depth for material compacted by heavy compaction equipment, and not more than 4 inches in loose depth for material compacted by hand-operated tampers.

5. Jetting: Unless specified otherwise, jetting techniques shall not be employed to densify granular fill materials.

6. Uniform Backfill Lifts: Backfill and fill materials shall be placed evenly adjacent to structures, to required finish elevations. Care shall be taken to prevent wedging action of backfill against structures by carrying material uniformly around structure to approximately same elevation in each lift.

END OF SECTION

SECTION 02223

TRENCHING, BACKFILLING, AND COMPACTING

PART 1 - GENERAL

A. Description

This section describes materials, testing, and performance of trench excavation, backfilling, and compacting. All compaction testing shall be performed by the District as specified in the Special Provisions.

B. Related Work Specified Elsewhere

1. Pavement Removal and Replacement: 02578.

2. Concrete: 03300.

C. Submittals

1. Submit shop drawing in accordance with Section 01300.

2. Shop drawings shall be submitted showing excavation and shoring, bracing, or sloping for worker protection.

3. Submit a report from a testing laboratory shall be submitted verifying that backfill material conforms to the specified gradations or characteristics for pea gravel, granular material, imported sand, rock refill for foundation stabilization, and water.

D. Measurement and Payment

1. Payment for the work in this section shall be included within the appropriate pipeline or appurtenance bid item.

   Payment for foundation stabilization shall be made in accordance with the unit-price bid amount for any quantity of refill material from 0 to 100 cubic yards, based on the trench details shown on the plans. This item has been included in the bid form for work that may possibly be required to complete the project, but which cannot be reasonably predicted, and shall be the basis of payment for refill material for foundation stabilization if authorized in writing by the District's Representative.

   The unit price shall be for any quantity installed, complete in place, including all additional earthwork, disposal of all excess or waste material, and placing of the refill material. The Construction Manager shall be the sole judge as to

the necessity, the amount, and depth that may be required in any given situation. No additional payment shall be made for foundation stabilization that is not authorized by the District.

E. Protection of Existing Utilities and Facilities

1. General: The Contractor shall be responsible for the care and protection of all existing sewer pipelines, water pipelines, gas mains, storm drains, culverts, or other facilities and structures that may be encountered in or near the area of work.

2. Notification: It shall be the duty of the Contractor to notify each agency of jurisdiction and make arrangements for locating each agency's facilities prior to beginning construction. The Contractor shall notify Underground Services Alert (Dig Alert) at least two working days prior to construction at 1-800-422-4133.

3. Damage: In the event of damage to any existing facilities during the progress of the work due to the failure of the Contractor to exercise the proper precautions, the Contractor shall be responsible for the cost of all repairs and protection to said facilities. The Contractor's work may be stopped until repair operations are complete.

F. Protection of Landscaping

1. General: The Contractor shall be responsible for the protection of all the trees, shrubs, fences, and other landscape items adjacent to or within the work area, unless directed otherwise on the plans. In the event of damage to landscape items, the Contractor shall replace the damaged items in a manner satisfactory to the District Representative.

2. Restoration: After the completion of work in planted or improved areas within public or private easements, the Contractor shall restore such areas to original condition. Restoration shall include regrading, placement of 5-inches of topsoil, reseeding, and replacement of landscaping.

PART 2 - MATERIALS

A. Definition of Zones

1. Pavement Zone: The pavement zone shall include the asphaltic concrete and aggregate base pavement section placed over the street zone. This zone is often referred to as the “structural section” of the street or highway.

2. Trench Zone: The trench zone shall include the portion of the trench from the top of the pipe zone to the bottom of the pavement zone in paved areas or to the existing surface in unpaved areas.

3. Street Zone: The street zone is the top 12 inches of the trench zone and is immediately below the pavement zone in paved areas or areas to be paved.

4. Pipe Zone: The pipe zone shall include the full width of trench from the bottom of the pipe or conduit to a horizontal level 12-inches above the top of the pipe. Where multiple pipes or conduits are placed in the same trench, the pipe zone shall extend from the bottom of the lowest pipes to a horizontal level above the top of the highest or topmost pipe.

5. Pipe Base: The pipe base shall be defined as a 4 or 6-inch layer of material immediately below the pipe zone and extending over the full trench width.

B. Trench Zone

Vitrified clay pipe: Unless otherwise specified or shown on the plans, the pipe base and pipe zone backfill material shall be 3/4-inch crushed rock as specified herein.

The Contractor shall be able to use the following materials within the trench zone – paved areas in lieu of native material: crushed miscellaneous base, in accordance with the Standard Specifications for Public Works Construction 200-2.4; or one (1) sack slurry (as shown on trench detail on the Drawings). Native material shall be used in the trench zone – not beneath paving. Native material is not acceptable in public right-of-way.

C. Backfill--Pipe Zone and Pipe Base

Steel pipe, ductile iron pipe, PVC pressure pipe, and copper pipe: Unless otherwise specified or shown on the plans, the pipe base and pipe zone backfill material shall be imported sand as specified herein.

D. Imported Sand--Pipe Zone and Pipe Base

Imported sand used in the pipe zone/pipe base shall have the following gradation:

Sieve Size	Percent Passing by Weight
3/8”	100
No. 4	75-100
No. 30	12-50
No. 100	5-20
No. 200	0-15

Minimum sand equivalent shall be 30 per ASTM D 2419. Certification that the sand meets this requirement shall be provided.

E. Gravel and Crushed Rock

Gravel or crushed rock material shall conform to the California Standard Specifications for Public Works Construction, Section 200-1.2 and shall meet the following gradation:

	Designated Material Size			
	1-1/2-inch	1-Inch	3/4-Inch	3/8-Inch
Sieve Size	Percent Passing	Percent Passing	Percent Passing	Percent Passing
2-inches	100	--	--	--
1-1/2-inches	90-100	100	--	--
1-inch	20-55	90-100	100	--
3/4-inch	0-15	30-60	90-100	--
1/2-inch	--	0-20	30-60	100
3/8-inch	0-5	--	0-20	90-100
No. 4	--	0-5	0-5	30-60
No. 8	--	--	--	0-10

F. Refill Material for Foundation Stabilization

Refill material below the pipe shall be ¾-inch crushed rock material conforming to the ¾-inch size requirement for gravel or crushed rock.

G. Sand-Cement Slurry Refill Material for Foundation Stabilization in Pipe Base and Pipe Zone or Backfill for Street Zone and Trench Zone.

Sand-Cement slurry shall consist of one sack (94 pounds) of portland cement per cubic yard of sand and sufficient moisture for workability.

H. Pea Gravel

Pea gravel shall be defined as gravel, uniformly graded from coarse to fine with less than 10% passing a No. 200 sieve, less than 50% passing a No. 4 sieve, and having a maximum particle size of 3/4-inch.

I. Water for Compaction

Water used in compaction shall have a maximum chloride concentration of 500 mg/l, a maximum sulfate concentration of 500 mg/l, and shall have a pH of 7.0 to 9.0. Water shall be free of acid, alkali, or organic materials injurious to the pipe coatings.

J. Pavement Zone Materials

Pavement zone materials shall be as specified in Section 02578, Pavement Removal and Replacement unless otherwise specified by a jurisdictional agency permit.

PART 3 - EXECUTION

A. Testing for Compaction (shall be performed by the District)

1. Methods: The density of soil shall be determined in place by the sand cone method, ASTM D 1556, or by the nuclear method, ASTM D 2922 or D 3017.

2. Soil Moisture-Density Relationship: The laboratory moisture-density relations of soils shall be determined per ASTM D 1557.

3. Cohesionless Materials: The relative density of cohesionless materials shall be determined by ASTM D 4253 and D 4254.

4. Sampling: Backfill materials shall be sampled per ASTM D 75.

5. Relative Compaction: "Relative compaction" shall be expressed as the ratio, expressed as a percentage, of the in place dry density to the laboratory maximum dry density.

6. Compaction Compliance: Compaction shall be deemed to comply with the specifications when none of the tests falls below the specified relative compaction. When tests are conducted by the District, the Contractor shall notify the District 24-hours in advance of when backfill lifts are ready for testing, and shall pay the costs of any retesting of work not conforming to the specifications.

B. Compaction Requirements

Unless otherwise shown on the drawings or otherwise described in the specifications for the particular type of pipe installed, relative compaction in pipe trenches shall be as follows:

1. Pipe Base and Pipe Zone: Pipe base and pipe zone--90% relative compaction.

2. Trench Zone - Not Beneath Paving: Backfill in trench zone not beneath paving--90% relative compaction; backfill in trench zone within landscape areas – 85% relative compaction per Section 306.12 of Standard Specifications.

3. Trench Zone - Paved Areas: Backfill in trench zone in paved areas--90% relative compaction.

4. Street Zone: Backfill in street zone in paved areas--95% relative compaction, or as required by the jurisdictional agency.

5. Foundation Stabilization: Rock refill material for foundation stabilization--90% relative density.

6. Overexcavation: Rock refill for overexcavation--90% relative density.

7. Material Testing: All imported or native materials shall be tested before the start of compaction operations to determine the moisture density relationship for materials with cohesive components, and the maximum density for cohesionless materials. Variations in imported or native earth materials may require a number of base curves of the moisture-density relationship.

8. Testing Intervals: Unless noted otherwise, compaction tests shall be performed at random depths and at 200-foot intervals, and as directed by the District's Representative.

C. Material Replacement

Trenching and backfilling material which does not meet the specifications shall be removed and replaced at no additional expense to the District.

D. Sheeting, Shoring, and Bracing of Trenches

Trenches shall have sheeting, shoring, and bracing conforming to CAL/OSHA requirements and the Special Provisions. Lateral pressures for design of trench sheeting, shoring, and bracing shall be based on type of soil exposed in the trench, groundwater conditions, surcharge loads adjacent to the trench, and type of shoring that will be used in the trench.

E. Sidewalk, Pavement, and Curb Removal

Bituminous and concrete pavements regardless of the thickness and curbs and sidewalks shall be cut prior to excavation of the trenches in accordance with Section 02578, Pavement Removal and Replacement. Pavement and concrete materials shall be removed from the site and shall not be used for trench backfill.

F. Trench Width

For All Pipe Diameters (except services): Unless shown otherwise on the drawings, trench widths in the pipe zone shall be equal to the pipe outside diameter plus 12-inches minimum and 16 inches maximum on each side of the pipe. Trench width shall be the same from trench bottom to top.

G. Grade

Trenches shall be excavated to the lines and grades shown on the drawings with allowance for pipe thickness and for pipe base. If the trench is excavated below the

required grade, the portion of the trench excavated below the grade shall be refilled with refill material at no additional cost to the District. The refill material shall be placed over the full width of trench in compacted layers not exceeding 6-inches deep to the required grade with allowance for the pipe base. Hard spots that would prevent a uniform thickness of pipe base shall be removed. Before laying pipe sections, the grade shall be checked with a straightedge and any irregularities corrected. The trench bottom shall form a continuous and uniform bearing and support for the pipe at every point.

H. Pipe Base Thickness

Thickness of the pipe base shall be as shown on the drawings: 4-inches thick for pipes smaller than 12-inches in diameter and 6-inches thick for pipes 12-inches in diameter or greater.

I. Dewatering

1. Means and Devices: Suitable means and devices shall be provided and maintained to continuously remove and dispose of all water entering the trench excavation during the time the trench is being prepared for the pipe laying, during the laying of the pipe, and until the backfill at the pipe zone has been completed. These provisions shall apply during the noon hour as well as overnight. Water shall be disposed of in a manner to prevent damage to adjacent property. Trench water shall not be drained through the pipeline under construction. Groundwater shall not be allowed to rise around the pipe until jointing compound has firmly set.

2. De-watering shall commence when groundwater is first encountered and shall be continuous until such times as water can be allowed to rise. No concrete shall be poured in water, nor shall water be allowed to rise around the concrete or mortar until it has set at least eight (8) hours.

3. Notification: The District shall be notified 48 hours prior to commencement of dewatering. Water shall be discharged to a sewer system.

J. Storage of Excavated Material

During trench excavation, excavated material shall be stored only within the working area. Roadways or streets shall not be obstructed. The safe loading of trenches with excavated material shall conform to federal, state, and local codes.

K. Length of Open Trench

The maximum allowable length of open trench shall be 200 feet, or the distance necessary to accommodate the amount of pipe installed in a single day, whichever is less. The maximum amount of steel plates within travel lanes (for the whole project) at

one time is 200 feet. Sidewalks, driveways and other traveled ways shall be backfilled or adequately bridged to provide safe access and egress at the completion of each days work. The length of open trench may be restricted further as directed by the District.

L. Foundation Stabilization

After the required excavation has been completed, the District Representative shall inspect the exposed trench subgrade to determine the need for any additional excavation. It is the intent that additional excavation shall be conducted in all areas within the influence of the pipeline where unacceptable materials exist at the exposed subgrade. Overexcavation shall include the removal of all such unacceptable material that exists directly beneath the pipe base and to the depth required. The presence of unacceptable material may require excavating a wider trench. The width and depth of known areas to be overexcavated shall be shown on the drawings. The overexcavated portion of the trench shall be backfilled to the subgrade of the pipe base with refill material for foundation stabilization.

Foundation stabilization material shall be placed over the full width of the excavation and compacted in layers not exceeding 6-inches in depth, to the required grade.

M. Trench Backfilling and Compaction

1. General: Trench backfill shall conform to requirements of the detailed piping specification for the particular type of pipe and following.

2. Pipe Base: The specified thickness of pipe base material shall be placed over the full width of trench. The top of the pipe base shall be graded ahead of the pipe laying to provide firm, uniform support along the full length of pipe.

3. Bell Holes: Bell holes shall be excavated at each joint to permit proper assembly and inspection of the entire joint.

4. Pipe Zone: After the pipe has been bedded, pipe zone material shall be placed simultaneously on both sides of the pipe, keeping the level of backfill the same on each side. Material shall be carefully placed around the pipe so that the pipe barrel is completely supported and that no voids or uncompacted areas are left beneath the pipe. Particular care shall be taken in placing material on the underside of the pipe to prevent lateral movement during subsequent backfilling. Material placed within the pipe zone shall be compacted by hand tamping only, unless otherwise specified. Compaction by jetting shall be permitted only where required by the jurisdictional agency.

5. Trench Zone: Backfill material shall be carefully deposited onto the backfill previously placed in the pipe zone. Free fall of the material shall not be permitted until at least 2 feet of cover is provided over the top of the pipe.

Sharp, heavy pieces of material shall not be dropped directly onto the pipe or the tamped material around the pipe.

6. Trench Backfill: Trench backfill shall be compacted to the specified relative compaction. Compaction shall be performed by using mechanical compaction or hand tamping equipment. Consolidation by jetting or flooding shall be permitted only where required by the jurisdictional agency. High impact hammer-type equipment shall not be used except where the pipe manufacturer warrants in writing that such use will not damage the pipe.

7. Equipment: Axle-driven or tractor-drawn compaction equipment shall not be used within 5 feet of walls and structures.

8. Street Zone Backfill: Street zone backfill shall be done in accordance with the requirements and to the satisfaction of the City or agency having jurisdiction. Street zone backfill can be placed with mechanical compaction.

N. Import or Export of Backfill Material

1. Excess Material: Excess excavated soil material shall be removed and disposed of off the project site at no additional expense to the District. Excess soil material shall be disposed of in accordance with local regulations.

2. Imported Material: Any additional backfill material necessary to return all grades to plus or minus 0.2 feet from the grade encountered at the beginning of construction or as shown on the contract drawings shall be imported, placed, and compacted at no additional cost to the District. Only approved imported material is allowed.

O. Moisture Content of Backfill Material

During the compacting operations, optimum practicable moisture content required for compaction purposes shall be maintained in each lift of the backfill material. Moisture content throughout the lift shall be maintained at a uniform level. If placement is discontinued and proper moisture content not maintained, the upper layer shall be brought back to proper moisture content by sprinkling, cultivating and rolling the backfill material before placing new material. At the time of compaction, the water content of the material shall be at optimum water content plus or minus two percentage points. Material which contains excessive moisture shall not be worked to obtain the required compaction. Material having excessive moisture content may be dried by blading, discing, or harrowing to hasten the drying process.

END OF SECTION

SECTION 02312

MANHOLE SHAFT

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Perform all work necessary for excavating, sheeting, shoring and supports shown, specified and required to construct the 12-foot diameter manhole shaft as needed to complete the Work.

B. Design, furnish, install, and maintain support systems, including all bracing and associated items necessary to retain safe excavations and to control ground movements within specified limits. Upon completion of required shaft construction, completely remove support systems as specified, and restore shaft and staging site.

C. Sawcut and remove pavement, fences and signs within construction staging areas; design and construct shaft excavations and excavation support systems; dispose of materials in accordance with Laws and Regulations; control and dispose of surface water, ground water, and construction water in accordance with Laws and Regulations; and restore site.

D. Assume sole responsibility for sizing the shaft excavation and construct shaft adequate for all structures required.

E. Construct shaft as sited on the Contract Drawings unless the District approves otherwise.

F. Relocate, support, or bypass all identified utilities required to perform the work at no additional cost to the District.

G. Install full-scale dewatering well systems per Section 02140 when any shaft excavation proceeds beneath the groundwater table. This dewatering system shall have the capacity to lower the groundwater table at least 5-feet below the bottom of the shaft excavation.

1.02 RELATED REQUIREMENTS

A. Section 0130, Contractor Submittals

B. Section 02140, Dewatering

C. Section 02220, Structural Earthwork

D. Section 03461, Precast Reinforced Concrete Manholes

1.03 QUALITY ASSURANCE

A. Permits and Regulations

1. Obtain all applicable permits for earthwork, work in roads, right of way, etc., as required by local, state and federal agencies.

2. Comply with all construction dewatering discharge requirements specified in Section 02140.

B. Reference Standards and Codes: Comply with applicable provisions and recommendations of the following, except as otherwise shown or specified.

1. ASTM A 36, Specification for Structural Steel.

2. OSHA Standard, Title 29, Code of Federal Regulations, Part 1926, Section .650 (Subpart P - Excavations).

3. CAL/OSHA State of California Code of Regulations, Title 8, Industrial Relations, Chapter 4, Subchapter 4, Construction Safety Orders.

C. Initial Survey of Existing Improvements: Prior to beginning demolition, excavation or shaft construction, perform a sufficient level of surveying detailing the area so that all existing improvements can be returned to their original location and elevation.

1.04 SUBMITTALS

A. Submit the following in accordance with Section 01300 Contractor Submittals.

B. Submit shop drawings for shaft excavations, excavation support systems, and other related information as requested by the District. A Professional Engineer registered in the State of California who has a minimum of five years experience in the structural design of earth retaining structures shall prepare and apply his/her seal to the shop drawings. Submit the following in accordance with the requirements of Section 01330 Submittal Procedures.

1. Name and qualifications of Contractor's engineer responsible for excavation support system design.

2. Use submitted construction method to install excavation support system design.

3. Shop drawings and design calculations shall indicate arrangements of supports and construction sequence for proposed support system(s). Shows the elevation of struts, braces, or other supports as related to the depth of excavation at intermediate stages of construction. Provide details of working slab, drains, and sump construction. Indicate sizes, shapes, and material specifications for all support elements including lagging, if used. Calculations shall include estimates of likely deflections or deformations of the support system and shaft bottom, along with maximum tolerable values. Coordinate design and calculations with the requirements of the Contractor's dewatering submittal.

4. Thrust block design and details.

5. Quality control procedures. Address materials testing requirements, proof-test and performance test requirements for tiebacks, and excavation monitoring provisions.

6. Provide a site plan for each excavation indicating the location, excavation dimensions, site grading, and site development details for the excavation and all work areas, and the proposed limits of disturbance surrounding each excavation.

7. Provide protection for adjacent facilities and utilities. Address all utilities within 20 feet and all structures within 50 feet of excavations.

8. Site drainage and groundwater control details. Show details of the measures to control, treat, handle, and dispose of surface water runoff, groundwater, and construction water. Provide details of working slab, subdrains, and sump construction.

9. Details of materials handling, stockpiling, and disposal sites for excavated materials.

10. Monitoring system which shall evaluate stability, safety, ground movements, and any nearby facilities and structures that could be affected by the work.

11. Plans indicating removal of excavation supports and site restoration details.

12. Plans for environmental controls.

13. Copies of all documentation, releases, and permits required herein and necessary to complete the work. Documentation, releases, and permits include, but are not limited to, imported materials, material disposal, utility disturbances, and affected properties.

C. If required, submit the following:

1. Shop Drawings: A Registered Professional Civil Engineer in the State of California with at least 8 years of experience in designing similar systems shall prepare and stamp with his/her seal the dewatering system analyses, design, and shop drawings. Submittal includes the qualifications of the dewatering contractor, the Contractor's engineer, sampling service, and testing laboratory.

   a. The analyses shall include an evaluation of the anticipated subsurface conditions, required well spacing, diameter, depth, screen interval, backfill and filter pack, pump size, drawdown duration, drawdown and steady state, flow rates, desilting tank and settlements.

   b. Dewatering calculations shall include water drawdown curves for the portion of the pipeline to be installed.

2. Well construction logs that include descriptions of actual materials encountered, construction details, well development procedures and results, and deviations from original submitted design.

1.05 DESIGN CRITERIA

A. Contractor's Engineer

1. Design shaft excavation support systems and working slabs to withstand earth pressures, unrelieved hydrostatic pressures, bottom heave, equipment loads, applicable traffic and construction loads, and other surcharge loads to allow the safe construction of the manhole and adjacent piping without movement or settlement of the ground beyond specified tolerances, and to prevent damage to or movement of adjacent structures, streets, utilities or the newly installed pipeline or structures. Design excavation support systems compatible with the geologic conditions described in the Geotechnical Report including any adjacent slope support structures. Geotechnical Report summarizes the recommended lateral earth pressures.

2. Design the support system to minimize horizontal and vertical movements, and to protect adjacent utilities from damage. Design support system to maintain the stability of the excavation and to provide a factor of safety of at least 1.5 against sliding and against bottom heave.

3. Design a working slab for each shaft bottom to provide stable support for guide rails, thrust blocks, and other construction operations.

4. Design, install, operate, and maintain groundwater control system for excavations to control any groundwater inflows, to prevent piping or loss of ground, and to maintain stability of the excavation.
5. Provide temporary safety railing and fencing around shaft excavations.
6. Design excavation support systems in accordance with all applicable CAL/OSHA and OSHA requirements.
7. Review of the Contractor's plans and methods of construction does not relieve the Contractor of the responsibility to provide and to maintain an adequate support system achieving the specified requirements.

1.06 MATERIALS TRANSPORTATION, HANDLING AND STORAGE

A. Material Storage: Stockpile satisfactory excavated materials at locations approved by the District, until required for backfill or fill. Place, grade, and shape stockpiles for proper drainage.

B. Dispose of excess soil material and waste materials as specified herein.

PART 2 PRODUCTS

A. All timber and structural steel used for the supporting systems, whether new or used, shall be sound and free from defects which may impair their strength.

B. Structural Steel shall conform to ASTM A 36 or higher strength, unless approved otherwise.

C. All timber shall be structural grade with a minimum allowable flexural strength of 1,500 pounds per square inch (psi).

D. Shotcrete shall conform to the requirements of ACI 506.2. Minimum design compressive strength is as required but not less than 4,000 psi.

PART 3 EXECUTION

3.01 SHAFT SIZE AND LOCATION

A. Shaft Location

1. The shaft location and function are as shown on the Plans, unless otherwise approved by the District.

B. Shaft Size

1. Size the shaft. Shaft size shall be adequate for construction of any permanent structures indicated on the Plans and provide adequate room to meet the Contractor's operational requirements for manhole and adjacent piping construction and for backfill. Contain shaft excavations within the allowable work area shown in the Drawings.
2. Unauthorized Excavation

a. All excavations outside the lines and grades shown, together with the removal and disposal of the associated material, are at Contractor's sole expense.

b. Fills and compacts to at least 90% relative compaction with select backfill all unauthorized excavations at Contractor's sole expense.

3.02 UTILITY CONFLICTS / RELOCATION

A. Determine a plan of action, subject to the approval of the District, for protecting and relocating, bypassing or supporting all identified and unidentified utilities required to construct the manhole shaft necessary to complete the work. Handle identified utilities at no additional cost to the District. The shaft may be altered slightly from their planned locations dependent on the Contractor's plan to sink the shaft.

3.03 SHAFT CONSTRUCTION

A. General

1. Shaft construction methods shall always ensure the safety of the work, Contractor's employees, District employees and inspectors, the public, and adjacent property and improvements, whether public or private.

2. Provide shaft excavations with a gravel base and a concrete working slab equipped with a sump to pump out construction water and storm water.

3. Before beginning construction at any location, adequately protect existing structures, utilities, trees, shrubs, and other existing facilities. Design excavation support systems to limit deformations that could damage adjacent facilities including utilities and structures. Repair existing facilities at no additional cost to the District.

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

5. Install support system monitoring provisions as necessary to assure proper performance of the work, to monitor the support system and the excavation, and to adhere to Shop Drawings. Monitor performance of excavation support system for both horizontal and vertical deflections daily during excavation, and at intervals not to exceed seven days following the completion of excavation work. If monitoring data indicates that deflections have exceeded estimated values, notify the District immediately.

6. Install excavation support systems in accordance with approved Shop Drawings.

7. If settlement or deflections of supports or shaft bottom indicated that support system requires modification to prevent excessive movements, redesign and resubmit revised shop drawings and calculations to the District at no additional cost.

a. Stockpiling of excavated material within the park is not permitted.

b. The working slab may be left in place for manhole support, if the District approves the foundation prior to placement of the slab and no subsequent disturbance to the foundation occurs.

B. Soldier Beams and Plates/Wood Lagging

1. Install soldier beams by pre-boring or other pre-excavating methods to the tip elevation shown on the Shop Drawings. Provide casing, drilling mud, or other method of support to prevent caving of holes and loss of ground.

2. After soldier pile is seated plumb in the pre-bored hole, encase it with concrete from the tip to the bottom level of the final excavation. Encase the remaining portion of soldier pile with sand/cement slurry or other approved material. Concrete strength shall be in accordance with Shop Drawings and placed by means of a tremie system. Apply vibration through the pile.

3. Provide steel plates or wood lagging of sufficient thickness to withstand lateral earth pressures.

4. Install steel plates using a vibro-mechanical method. Install to sufficient depth to avoid piping failures or bottom heave.

5. Install wood lagging with no gaps between adjacent pieces. As installation progresses, backfill the voids between the excavation face and the lagging with sand or pea gravel packed into place. Pack all gaps between lagging/lagging and lagging/pile interface with materials such as excelsior, hay, burlap or geotextile fabric where necessary to allow drainage of groundwater without the loss of fines.

6. The timber employed as lagging for shafts shall be of structural grade with a minimum allowable flexural stress of 1100 psi, Douglas Fir or equal approved by the District.

7. Shotcrete, if used, shall be applied in accordance with ACI 506.2.

C. Internal Bracing Support System

1. The internal bracing support system shall include wailers, struts, and/or shores.

2. Provide struts with intermediate bracing as needed to enable them to carry maximum design load without distortion or buckling.

3. Include web stiffeners, plates, or angles as needed to prevent rotation, crippling, or buckling of connections and points of bearing between structural steel members. Allow for eccentricities caused by field fabrication and assembly.

4. Install and maintain all bracing support members in tight contact with each other and with the surface being supported.

5. Preload bracing members by jacking struts to 50 percent of the design load if necessary to control shoring movement. Preload bracing members in accordance with methods, procedures, and sequence as described on the Shop Drawings. Coordinates excavation work with installation of bracing and preloading. Use steel shims and steel wedges welded or bolted in place to maintain the preloading force in the bracing after release of the jacking equipment pressure. Install support and preload immediately after installation and prior to continuing excavation.

6. Uses procedures that produce uniform loading of bracing members without eccentricities or over stressing and distortion of members of system.

D. Corrugated Metal Pipe Shaft

1. The shaft shall be of sufficient size to facilitate the construction of the manhole and construction of any manhole structures.

2. Require dewatering for all shaft construction below the water table. Implement the dewatering system prior to beginning any work on the shaft's construction.

3. Collar the top 6 feet of excavation with steel. Fill top of excavation with appropriate slurry and keep filled until slurry can be safely removed.

4. Construct shafts using a mechanical auger with 6-inch maximum overcut when the corrugated metal pipe (CMP) casing is placed.

5. Fill the void between the CMP casing and manhole shaft with lean concrete backfill. Remove steel collar while filling annular void. Pour tremie bottom seal.

6. The shaft bottom may have either a watertight invert working slab or a dewatering system in place for the duration of the shaft's existence.

7. Cut and remove, prior to backfilling the shaft, the top 7 feet of the CMP casing.

3.04 BACKFILL

A. Compact manhole shaft excavations to a minimum of 90% relative compaction. The upper 18-inches of backfill in shafts below ground surface shall be a minimum of 95% relative compaction.

B. Place backfill in shafts in 12-inch compacted layers.

C. Keep excavations dry during backfilling operations. Bring backfill around pipelines and manholes up evenly on all sides.

D. Jetting and flooding backfill are not allowed.

E. Flowable fill is permitted with written permission of the District.

3.05 REMOVAL OF SUPPORT SYSTEM

A. Remove the top 7 feet of all sheeting and bracing from excavations when complete. Perform removal in a manner that avoids injury to the work, existing street, adjacent utilities or structures. Removal shall be equal on both sides of excavation to ensure no unequal loads on pipelines and manholes.

B. Defer removal of sheeting and bracing, where removal may cause soil to come into contact with concrete, until concrete has cured a minimum of 7 days.

3.06 RESTORATION

A. Backfill and Foundation

1. Furnish, place, compact, and backfill all shaft excavations in accordance with Section 02200 and Section 02223.

B. Site Restoration

1. Restore the work area disturbed by construction activities and repair any damage caused to existing utilities, to its original, or better, condition. Restore paved areas to original or better condition.

3.07 ENVIRONMENTAL CONTROLS

A. Ground Water Control: Provide ground water control and drainage from shafts per Section 02140 while work is in progress and until adjacent pipe joints have been properly sealed and the shaft is properly backfilled.

B. Remove water from excavation as fast as it collects.

C. Maintain the ground water level a minimum of 5 feet below the bottom of the excavation to provide a stable surface and slope conditions for construction operations, to maintain a stable subgrade for the permanent work, and to prevent damage to the work during all stages of construction.

D. Provide and maintain pumps, sumps, suction and discharge lines, power supply and other dewatering system components necessary to convey water away from excavations.

E. Obtain District Representative approval before shutting down dewatering system for any reason.

F. Surface Water Control: Divert surface water runoff from the shaft and protect the shafts from infiltration or flooding by surface water, including discharge from any dewatering operation. Extend jacking shaft lining system at all locations a minimum of 2 feet above existing, adjacent ground elevation.

3.08 WELL REMOVAL PROCEDURES

A. In accordance with California Department of Water Resources "California Well Standards – Bulletin 74-90," destroy dewatering wells required for construction of shafts. Submit documentation to the District for review prior to submission to the local permitting agency.

B. The top 5 feet shall be concrete. The pavement surface shall match existing adjacent surface material.

3.09 SAFETY

A. Safety is solely the Contractor's responsibility. Place security fencing around the Work area with appropriate signage and lighting. Construct a suitable guardrail barrier around the periphery of the shaft, meeting applicable safety standards. Properly maintain the barrier throughout the period the shaft remains open. Repair broken boards, supports, and structural members. In addition, provide a full cover or other security barrier for each access shaft where no construction activity exists or that is unattended by the Contractor's personnel.

3.10 RESTORING AND RESURFACING EXISTING FACILITIES AND DISPOSAL OF EXCAVATED MATERIALS

A. Restore pavement damaged by construction operations.

B. Haul away from the site material removed from the excavations that does not conform to the requirements for fill and also dispose of that material in compliance with Laws and Regulations at no additional cost to the District. Use highway legal trucks for the export of material from the site and to a site secured by the Contractor. No earth moving equipment or special construction equipment, as defined in Section 565 of the California Vehicle code is allowed for hauling material on public streets.

END OF SECTION

SECTION 02528

CONCRETE CURBS, GUTTERS AND SIDEWALKS

PART 1 - GENERAL

A. Description

This section describes materials and construction of concrete curbs, gutters, and sidewalks. Jurisdictional agency permits, where applicable, shall supersede this section.

B. Related Work Specified Elsewhere

1. Trenching, Backfilling, and Compacting: 02223.

2. Concrete Formwork: 03100.

3. Concrete Reinforcement: 03201.

4. Concrete: 03300.

C. Submittals

Shop drawings shall be submitted in accordance with Section 01300 and the requirements of Section 03300, Concrete, Part 1-C.

PART 2 - MATERIALS

A. Forms

1. General: Forms shall be as required in Section 03100 Concrete Formwork. Stakes and braces shall be provided to hold forms securely in place.

2. Sidewalk Forms: Sidewalk forms shall be 2-inch dressed lumber, straight and free from defects, or standard metal forms. Where short-radius forms are required, 1-inch dressed lumber of plywood may be used.

B. Aggregate Base Course

Crushed rock base shall be clean 3/4-inch and smaller crushed rock or crushed gravel, free from foreign material, and conforming to Crushed Aggregate Base as specified by Standard Specifications of Public Works Construction Section 200-2.2. An acceptable alternative to Crushed Aggregate Base is Crushed Miscellaneous Base as specified by Standard Specifications Section 200-2.4.

C. Expansion Joint Filler

Premolded expansion joint filler shall be 1/4-inch thick for curbs and 1/4-inch thick for sidewalks, or as required or allowed by the permitting agency.

D. Concrete

Conform to Section 03300, Concrete.

E. Reinforcing Steel

Conform to Section 03201, Concrete Reinforcement.

F. Excavation and Backfill

Conform to Section 02223, Trenching, Backfilling, and Compacting.

PART 3 - EXECUTION

A. Preparation of Subgrade

Subgrade shall be excavated and shaped to line, grade, and cross section. The top 12-inches of subgrade shall be compacted to 95% relative compaction. All soft material disclosed by excavating shall be removed and replaced with aggregate base as directed. The finished subgrade shall be within a tolerance of +/-0.02 of a foot of the grade and cross section shown and shall be smooth and free from irregularities at the specified relative compaction. The subgrade shall extend over the full width of the construction. The District Representative's approval of finished subgrades must be received prior to continuance of the work.

B. Placing Aggregate Base

After the subgrade for curbs, sidewalks, and roadway slabs is compacted and accepted, the Contractor shall place and spread aggregate base material, sprinkle with water, and compact to 95% relative density. The surface of the compacted base shall be at the proper level to receive concrete. Curbs and sidewalks shall be underlain by 4-inches or more of compacted aggregate base material.

C. Setting Forms

Forms shall conform to Section 03100, Concrete Formwork. Forms for a face-of-curb shall not have any horizontal joints within 7-inches of the top of the curb. Forms shall be braced to prevent change of shape or movement in any direction resulting from the weight of the concrete. Short-radius curved forms shall be constructed to exact radius. Tops of forms shall not depart from gradeline more than 1/8-inch when checked with a

10-foot straightedge. Alignment of straight sections shall not vary more than 1/8-inch in 10-feet.

D. Curb Construction

1. Jurisdictional Requirements: Curbs shall be reconstructed to original line and grade if removed. Curbs shall conform to the requirements of the respective jurisdictional agency.

2. Expansion Joints: Preformed asphalt-impregnated expansion joints shall be placed at 20-foot intervals, at the beginning and end of curved portions of the curb, at each change in thickness of section, at the end of curbs at buildings and other structures, and at connections to existing curbs.

3. Notification: The District's Representative shall be notified one day in advance of planned concrete placement.

4. Concrete Finish: When the concrete has set sufficiently to support its own weight, the front form shall be removed and exposed surfaces finished. The formed face shall be finished by rubbing with a burlap sack or similar device to produce a uniformly textured surface, free of form marks, honeycomb, and other defects. Defective concrete shall be removed and replaced at no expense to the District. Upon completion of the finishing, curing compound shall be applied to exposed surfaces of the curb. Curing shall continue for a minimum of five days.

5. Backfill: Seven days (minimum) after pouring the concrete, the curb shall be backfilled with earth free from rocks, 2-inches and larger, and other foreign material. Backfill shall be tamped firmly in place.

6. Alignment and Grade: Finished curb shall have a uniform grade and alignment. Any section of curb showing abrupt changes in alignment or grade, or which is more than 1/4-inch away from its intended location, as staked, shall be removed and reconstructed at no additional cost to the District.

7. Protection of Work: All concrete surfaces and/or structures shall be protected until the project containing the work is accepted.

E. Sidewalk Construction

1. General Requirements: Unless shown otherwise, sidewalks shall be placed in a single pour, 4-inches thick. Walks shall slope 1/4-inch per foot upward from the top of curb. Concrete shall be placed, processed, finished, and cured in conformance with the applicable requirements of ACI 614.
   For sidewalks within a City, sidewalk construction shall be in accordance with the jurisdictional agency's requirements.

2. New Sidewalk: Where new sidewalk is to abut existing concrete, the existing concrete shall be sawcut to a depth of 2-inches and the concrete chipped out to sound material and a plane surface.

3. Expansion Joints: Preformed expansion joints shall be placed at 20-foot intervals or less to match those in the adjacent curb, where the sidewalk ends at a curb, and around posts, poles, or other facilities located within the sidewalk. Expansion joints shall be placed between sidewalks and buildings or other structures.

4. Contraction Joints: Contraction joints shall be provided transversely to the walks at locations opposite the contraction joints in the curb and at 10-foot intervals along the sidewalk. These joints shall be 3/16-inch by 1-inch weakened plane joints. They shall be straight and at right angles to the top of the walk.

5. Notification: The District's Representative shall be notified one day in advance of planned concrete placement.

6. Concrete Finish: The top surface of the sidewalk shall receive a broom finish with a fine-hair broom in line with the length of the walk. All edges, joints, and markings shall be tooled. The walk shall be scored transversely at 5-foot intervals with a jointing tool. Upon completion of the finishing, an approved curing compound shall be applied to exposed surfaces. Sidewalks shall be protected from damage until final acceptance.

END OF SECTION

SECTION 02578

PAVEMENT REMOVAL AND REPLACEMENT

PART 1 - GENERAL

A. Description

This section describes materials, testing, removal, and replacement of asphalt concrete pavement, seal coat, aggregate base course, prime coat, tack coat, and portland cement concrete surfaces.

Work of this section shall be performed in accordance with the Standard Specifications for Public Works Construction (SSPWC), unless otherwise specified herein.

Jurisdictional agency permits, where applicable, shall supersede this section.

B. Related Work Specified Elsewhere

1. Trenching, Backfilling, and Compacting: 02223.

2. Concrete Curbs, Gutters, and Sidewalks: 02528.

3. Standard Specifications for Public Works Construction, latest edition.

C. Submittals

1. Shop drawings shall be submitted in accordance with Section 01300.

2. Submit information on material sources, designs, and quality certifications.

PART 2 - MATERIALS

A. Asphalt Concrete Paving

Asphalt concrete paving shall be Asphalt Rubberized Hot Mix (ARHM) as specified in SSPWC Section 203-11. Construction of the pavement is to be accomplished in a single course, ARHM-GG-C ½" PG 64-16 shall be used. Asphalt shall be performance grade PG64-16. Asphalt rubber binder shall be 7.5% to 8.7% (% weight of dry aggregate).

B. Emulsion-Aggregate Slurry

Materials for emulsion-aggregate slurry shall be as specified in SSPWC Subsection 203.5.

C. Aggregate for Asphalt Concrete

Aggregate base shall conform to the provisions of the latest edition of the SSPWC, Subsection 200-2.2, Crushed Aggregate Base. In the absence of available rock dust, sand of comparable gradation will be acceptable. Aggregate shall be asbestos free. Evaluation of gradation and sand equivalent test results shall conform to the provisions of SSPWC.

D. Aggregate Base Course

Aggregate base shall be crushed aggregate base as specified in Section 200-2.2 of the Standard Specifications for Public Works Construction.

E. Tack Coat

Asphalt emulsion shall be CSS1 or CSS-1h and shall conform to the requirements of SSPWC Section 203-3 Emulsified Asphalt.

F. Weed Killer

Weed killer shall be Karmex 80, as manufactured by Dupont Chemical Company, or Diuron 4L, as manufactured by Drexel Chemical Company, or approved equal.

PART 3 - EXECUTION

A. Pavement Removal

1. Asphalt Concrete Pavement Cutting Requirements: Asphalt concrete pavement shall initially be cut with a pavement cutter or other equipment at the limits of the excavation before the pavement is removed. After backfilling and compacting the excavation, asphalt concrete pavement shall be saw cut, full depth at a point not less than 9-inches outside the limits of the excavation or the previous pavement cut, whichever is greater, and the additional pavement removed. If the cut is within 3-feet of an existing joint or curb and gutter, the asphalt concrete pavement shall be replaced to the joint or curb and gutter.

   The original saw cutting of the trench for removal of existing pavement structural section can be either accomplished by saw cutting with a power-driven saw or grinding with an asphalt zipper or cold planer. The final saw cutting, in conjunction with the trench pavement replacement, shall be accomplished by the use of a power-driven saw. The depth of the cut shall be deep enough to produce a clean, straight break without loosening, cracking, or damaging adjoining asphalt so that there will be a good join between the existing pavement structural

section and the trench pavement replacement structural section. The use of a grinder (cold planer) shall not be allowed in lieu of power-driven saw.

2. Portland Cement Concrete Pavement Cutting Requirements: Concrete pavement, cross gutters, curbs and gutters, sidewalks, or driveways, shall be saw cut to a minimum depth of 1-1/2-inches at a point 1-foot beyond the edge of the excavation and the strip of improvement removed. Concrete pavement may initially be cut at the limits of the excavation by other methods prior to removal and the saw cut made after backfilling the excavation. If the saw cut falls within 3-feet of a concrete joint or pavement edge, the concrete shall be removed and replaced to the joint or edge.

3. Disposal of Material: All pavement and other improvements removed shall be disposed of off the site. The cost of such disposal shall be included in the appropriate bid item.

4. Final Pavement Saw Cuts: Final pavement saw cuts shall be straight along both sides of the trench, parallel to the pipeline alignment or excavation, and provide clean, solid, vertical faces free from loose material. Adjoining pavement which has been damaged or disturbed shall also be saw cut and removed. Saw cuts shall be parallel to the pipeline alignment or the roadway centerline or perpendicular to same.

B. Pavement Replacement

1. General: Producing, hauling, placing, compacting, and finishing of asphalt concrete shall conform to Section 302-5 of the Standard Specifications for Public Works Construction. Seal coat shall be applied to all new asphalt concrete paving, except open grade asphalt concrete.

2. Base Coarse, Final Course and Striping: Base course paving shall be complete at all times to a point not to exceed 200 feet behind any working heading. The final asphalt surface course shall be at least 2-inch thick and shall be placed within a period of two weeks after traffic has been returned to that portion of the street, unless otherwise noted on the Drawings. Temporary striping shall be applied after the base course of asphalt concrete pavement has been placed, in the same configuration as the existing permanent striping, so that traffic can be returned to normal patterns. Temporary striping shall be maintained until permanent striping is applied.

C. Preparation of Subgrade

Subgrade shall be excavated and shaped to line, grade, and cross section. The top 12-inches of subgrade shall be removed and recompacted to 95% relative compaction. All soft material disclosed by the compacting effort shall be removed and replaced. The finished subgrade shall be within a tolerance of +/-0.08 of a foot of the grade and cross

section shown, smooth and free from irregularities and at the specified relative compaction. The subgrade shall be considered to extend over the full width of the aggregate base course.

D. Placing Aggregate Base

Aggregate base shall be placed to thickness shown on the plans, to match existing, or per the applicable permit. Aggregate base shall be compacted to 95% relative compaction and installed in accordance with Section 301-2 of the Standard Specifications for Public Works Construction.

E. Placing Tack Coat

Tack coat shall be applied at the rate of 0.05 to 0.10 gallons per square yard to the surfaces to receive finish pavement per Section 302-5.4 of the Standard Specifications for Public Works Construction. Tack coat shall be applied to existing asphalt, metal, or concrete surfaces that will be in contact with new asphalt concrete paving.

F. Placing Asphalt Paving

Asphalt paving shall be applied to the thickness shown on the plans, as listed above, or per the applicable permit. Asphalt paving shall be installed in accordance with Section 302-5 of the Standard Specifications for Public Works Construction.

G. Applying Seal Coat

Seal coat shall be applied at the rate of 0.05 to 0.10 gallon per square yard.

H. Compaction of Base and Leveling Courses

Compaction and rolling of base and leveling courses shall begin at the outer edges of the surfacing and continue toward the center. Water shall be applied uniformly throughout the material to provide moisture for obtaining the specified compaction. Each layer shall be compacted to the specified relative compaction before the next layer is placed.

I. Surface Tolerance

Finished grade shall not deviate more than 0.02 foot in elevation from the grade indicated on the drawings. Slopes shall not vary more than 1/8-inch in 10 feet from the slopes shown on the drawings.

J. Concrete Curbs, Gutters, and Sidewalks

Concrete curbs, gutters, and sidewalks shall be replaced in accordance with Section 02528, Concrete Curbs, Gutters, and Sidewalks.

L. Emulsion-Aggregate Slurry

Certain street sections where shown on the plans or where required by the jurisdictional agency may be required to receive an asphaltic slurry seal in conformance with Section 302-4, Standard Specifications for Public Works Construction after the final asphalt surface course. The composition and aggregate grading for slurry shall be Type II of Subsection 203-5.3.

END OF SECTION

SECTION 02701

INSTALLATION OF GRAVITY SEWER PIPELINES

PART 1 – GENERAL

A. Description

This Section describes the installation of gravity sewer pipelines fabricated of Polyvinyl Chloride (PVC) Pipe.

B. Related Work Described Elsewhere

1. Trenching, Backfilling and Compacting: 02223.
2. Leakage and Infiltration Testing of Non-Pressure Pipelines: 02713.
3. PVC Gravity Sewer Pipe: 02715.
4. Cast-in-Place Concrete: 03300.
5. Precast Reinforced Concrete Manholes and Manhole Bases: 03461.

C. Submittals

1. Shop drawings shall be submitted in accordance with Section 01300 and the following:
2. Submit an installation schedule (tabulated layout) which includes:
    a. Order of installation and closures.
    b. Pipe centerline station and elevation at each change of grade and alignment.
    c. Locations of manholes.

PART 2 – MATERIALS

A. Installation Material

Refer to Section 02715, PVC gravity sewer for material requirements.

PART 3 – EXECUTION

A. Delivery and Temporary Storage of Pipe at Site

1. On-site Storage Limitation: On-site pipe storage shall be limited to a maximum of one week, unless exception is approved by the District.

2. Care of Pipe: At times when the pipe laying is not in progress, close the open end of the pipe with a tight-fitting cap or plug to prevent the entrance of foreign matter into the pipe. These provisions shall apply during the noon hours as well as overnight. In no event shall the sewers be used as drains for removing water which has infiltrated into the construction trenches.

B. Handling of Pipe

1. Moving Pipe: Lift pipes with handling beams or wide belt slings as recommended by the pipe manufacturer. Do not use cable slings. Handle pipe in a manner to avoid damage to the pipe. Do not drop or dump pipe from trucks or into trenches under any circumstances.

2. Inspection Pipe: Inspect the pipe and accessories for defects prior to lowering into the trench. Repair or replace any defective, damaged or unsound pipe. Remove dirt from the interior of the pipe before lowering into position in the trench.

C. Placement of Pipe in Trench

1. General: Lay all pipe without a break, upgrade from structure to structure, with the bell ends of the pipe upgrade. Lay pipe to the line and grade given so as to form a close concentric joint with the adjoining pipe and prevent sudden offsets of the flow line.

2. Trench Excavation: Dewatering, excavation, shoring, sheeting, bracing, backfill material placement, material compaction, compaction testing, and pipe laying requirements and limitations shall be in accordance with Section 02223, Trenching Backfilling, and Compacting.

3. Pipe Base Thickness: Unless shown otherwise on the drawings, pipe base material shall be 3/4-inch crushed rock for PVC pipe as specified in Section 02223, Trenching, Backfilling, and Compacting.

4. Subgrade at Joints: At each joint in the pipe, recess the pipe subgrade in firm bedding material so as to relieve the bell of the pipe of all load and to ensure continuous bearing along the pipe barrel.

5. Cleaning: Clean the interior of the sewer pipe of all dirt and superfluous materials as the work progresses.

6. Joints: Wipe the mating surfaces of the pipe to be joined clean of all dirt and foreign matter and apply a lubricant that is approved by the pipe manufacturer. Then, with the surfaces properly lubricated, position the spigot end of the pipe inside the bell and shove the joint home.

   For larger diameter pipe where a lever attachment is required, take the necessary precautions to ensure an undamaged pipe installation.

7. Pipe Alignment: Unless specified otherwise, pipeline line and grade shall be as shown on the plans. Measure grade along the pipe invert.

8. Short Lengths of VCP Pipe: When using VCP, use two 1-foot lengths of sewer pipe to provide curve flexibility and prevent cracking or shearing failures as shown on the plans or as may be required by the District during construction. The use of short lengths of pipe is particularly required, but not necessarily limited to these locations: (1) inlets and outlets to all manholes; (2) ends of steel casing pipe; (3) ends of concrete encasement; (4) vertical and horizontal curvilinear sewers; and (5) deep lateral connections.

9. Backfill: Place and compact backfill in accordance with the requirements of Section 02223, Trenching, Backfilling and Compacting, and as shown on the Plans.

D. Manholes and Manhole Bases

Construct pre-cast concrete manholes and manhole bases in accordance with Section 03461, Pre-cast Reinforced Concrete Manholes and Manhole Bases and as shown on the plans.

E. Concrete Encasement

Unless shown otherwise, concrete for encasement shall be reinforced or unformed or rough formed, and of the class as designated on the plans. Concrete shall be in accordance with Section 03300, Cast-in-Place Concrete. Use concrete used for encasing, cradling, bedding, cover for pipe, or other objects as shown on the Plans, or as directed by the District.

F. Cleaning

Before testing, thoroughly clean each pipe from manhole to manhole with a scrubbing ball, and remove all debris and trash from each manhole.

G. Leakage and Infiltration Test of Non-Pressure Pipelines

Test the pipe, manholes, and other appurtenances for leakage and infiltration per Section 02713, Leakage and infiltration Testing of Non-Pressure Pipelines.

H. Closed-Circuit Television Inspection

1. General: In addition to the regular leakage and infiltration test, inspect all new sewer lines using closed-circuit television equipment. Conduct the inspection after all utilities have been installed prior to paving. Conduct the inspection by using closed-circuit television camera equipment for the initial inspection. The work shall also include the cleaning of the sewer main prior to videotaping. Should any re-inspection be required due to defective work all costs of which shall be borne by the Contractor.

2. Labor: Furnish all labor and equipment necessary in conducting the cleaning and inspection.

3. Video: Close-circuit television inspection shall be performed on all newly construct sewer mains. Under no circumstances shall video operations be performed without the District present. During inspection, the operating technician shall, in addition to the videotape recoding of conditions include a verbal (audio) record of conditions on the tape. The technician shall also provide a log in writing of the location of laterals, defects, misalignments, and other conditions and data pertinent to the physical condition and operation of the sewer main. A footage counter shall locate conditions, defects and laterals. The video technician shall hold current National Association of Sewer Service Companies (NASSCO) certifications.

   At all points within the sewer showing defects, laterals and sewer appurtenances, the Contractor shall stop the camera, rotate (up to 360°), and/or tilt the camera lens to ensure adequate video coverage. The cameral shall be stopped and/or backed up to view and analyze conditions that appear unusual or uncommon to a sewer in good condition. There shall be no loss of video quality at any time.

   Contractor shall provide two copies of the videotape/DVD and five (5) hardcopy reproductions of all findings to the District.

4. Cleaning: Cleaning shall be performed in accordance with Section 500-3 of the Standard Specifications. Cleaning of the sewer main shall include removal of any debris or foreign objects introduced during construction. Such debris shall be vacuumed from the system and shall not be washed or otherwise deposited downstream. Cleaning apparatus shall be removed prior to insertion of the video camera. **Under no circumstances shall cleaning apparatus be use in direct conjunction with video operations.**

5. Plugging and/or Bypassing: If plugging and/or bypassing is deemed necessary, the Contractor shall be responsible for plugging manhole outlets and/or providing a bypass line for the effluent during videotaping. The sewer main shall be "in-service" at the time of the video inspection.

6. Repair of Defects: Even though the sewer line may have successfully passed the leakage and infiltration tests, repair any defects in the line to the satisfaction of the District.

I. Final Inspection

After paving has been completed and all manholes raised to grade (where required), make a final visual inspection. Furnish the necessary labor to assist the District in making the final inspection. Additional balling may be required if the lines are dirty, even though lines were previously balled. Furnish a responsible person or supervisor for the final inspection to remove manhole covers and to note any corrections required by the District in order to obtain final approval. Request final the District inspection through the District by giving at least one day's notice.

END OF SECTION

SECTION 02713

LEAKAGE AND INFILTRATION TESTING OF NON-PRESSURE PIPELINES

PART – 1 GENERAL

A. Description

This Section describes the requirements and procedures for leakage and infiltration testing of gravity sewer systems, in accordance with ANSI/ASTM C828, Low Pressure Air Test of Vitrified Clay Pipelines.

B. Related Work Specified Elsewhere

1. Vitrified Clay Pipe: 02710.

2. Hydrostatic Testing of Pressure Pipelines: 15042.

3. Ductile Iron Pipe and Fittings: 15056.

C. Testing

1. General: Make all tests in the presence of District.

2. Leakage: Test each section of sewer between two successive manholes for leakage. The leakage test shall be made on all sections of sewer.

3. Infiltration: The infiltration test shall be made where excessive groundwater is encountered. All pipelines on this project shall have an infiltration test performed.

4. Retesting: Even though a section may have previously passed the leakage or infiltration test, test each section of sewer subsequent to the last backfill compacting operation if, in the opinion of the District, heavy compaction equipment or any of the operations of the Contractor or others may have damaged or affected the structural integrity or watertightness of the pipe, structure, and appurtenances.

5. Other Utilities: District tests will not be made until after all the other utilities have been installed and their trench compaction verified.

6. Excessive Leakage or Infiltration: If the leakage or infiltration rate is greater than the amount specified, repair the pipe joints or, if necessary, remove and relay the pipe.

7. Acceptance: The sewer will not be accepted until the leakage or infiltration rate, as determined by test, is less than the maximum allowable.

8. Force mains: Force mains shall be pressure tested per Section 15042.

PART 2 – MATERIALS

Furnish all equipment and materials required for testing.

PART 3 – EXECUTION

A. Air Test for VCP Gravity Sewers

1. Test Section: Test each section of sewer between two successive manholes by plugging all pipe outlets with suitable test plugs. All test plugs shall be secured in place to prevent movement or slippage.

2. Addition of Air: Slowly add air until the internal pressure is raised to 4.0 pounds per square inch gage (psig). The compressor used to add air to the pipe shall have a blowoff valve set at 5 psig to ensure that at no time the internal pressure in the pipe exceeds 5 psig.

3. Internal Pressure: Maintain the internal pressure of 4 psig for at least two minutes to allow the air temperature to stabilize, then disconnect the air supply and allow the pressure allowed to decrease to 3.5 psig.

4. Minimum Time for Allowable Pressure Drop: Measure the time in seconds that is required for the internal air pressure to drop from 3.5 psig to 2.5 psig and compare the results with the minimum permissible pressure holding times indicated in the following tables.

5. Retest: If the pressure drop from 3.5 psig to 2.5 psig occurs in less time than specified, repair the pipe and, if necessary, replace and relay until the joints and pipe shall hold satisfactorily under this test.

B. Infiltration Test

1. Preparation of Test Section: Close the end of the sewer at the upper structure to prevent the entrance of water, and discontinue pumping of groundwater for at least three days, then test the section for infiltration.

2. Allowable Infiltration Rate: The infiltration shall not exceed 0.025 gpm per inch of diameter per 1,000 feet of main line sewer being tested, not including the length of laterals entering that section.

3. Excessive Infiltration: Where infiltration in excess of the allowable amount is discovered before completion and acceptance of the sewer, uncover the sewer immediately and reduce the amount of the infiltration to a quality within the specified amount of infiltration, before the sewer is accepted.

4. Individual Leaks: Even if the infiltration is less than the allowable amount, stop any individual leaks that may be observed shall be stopped as ordered by the District.

5. Completion of Tests: Complete all tests before the street or trench is resurfaced, unless otherwise directed by the District.

C. Deflection Test

General: Test all flexible and semi-rigid main line pipe for deflection, joint displacement, or other obstruction by passing a rigid mandrel through the pipe by hand, not less than 30 days after completion of the trench backfill, but prior to permanent resurfacing. The mandrel shall be a full circle, solid cylinder, or a cylinder, approved by the District as to design and manufacture. The circular cross section of the mandrel shall have a diameter of at least 95 percent of the specified average inside pipe diameter of the pipe.

D. Manhole Test

1. General: Test water tightness of manholes in connection with tests of sanitary sewers, or at the time the manhole is completed and backfilled.

2. Plugs: Plug all manhole inlets and outlets with approved stoppers or plugs.

3. Fill Level: Fill the manhole with water to 2-inches below the bottom of the tapered cone section, with a minimum depth of 4 feet and a maximum depth of 20 feet. The water shall stand in the manhole for a minimum of one hour to allow the manhole material to reach maximum absorption. Before the test is begun, refill the manhole to the original depth as needed.

4. Test Requirements: Record the drop in water surface after a period of from 15 minutes to one hour. The time of the test shall be determined by the District and may be varied to fit the various field conditions. The maximum allowable drop in the water surface shall be 1/2 inch for each 15-minute period of testing.

5. Visible Leaks: Even though the leakage is less than the specified amount, stop any leaks that may be observed, to the satisfaction of the District.

NATIONAL CLAY PIPE INSTITUE AIR TEST TABLES

MINIMUM HOLDING TIME IN SECONDS REQUIRED FOR PRESSURE TO DROP FROM 3 ½ TO 2 ½ PSIG

PIPE DIAMETER (FOR USE WHEN TESTING ONE DIAMETER ONLY)

LENGTH	4”	6”	8”	10”	12”	15”	18”	21”	24”	27”	30”	33”	36”	39”
25	4	10	18	28	40	62	89	121	158	200	248	299	356	418
50	9	20	35	55	79	124	178	243	317	401	495	599	713	837
75	13	30	53	83	119	186	267	364	475	601	743	898	1020	1105
100	18	40	70	110	158	248	356	485	634	765	851	935	1020	1105
125	22	50	88	138	198	309	446	595	680	765	851	935	1020	1105
150	26	59	106	165	238	371	510	595	680	765	851	935	1020	1105
175	31	69	123	193	277	425	510	595	680	765	851	935	1020	1105
200	35	79	141	220	317	425	510	595	680	765	851	935	1020	1105
225	40	89	158	248	340	425	510	595	680	765	851	935	1020	1105
250	44	99	176	275	340	425	510	595	680	765	851	935	1020	1105
275	48	109	194	283	340	425	510	595	680	765	851	935	1020	1105
300	53	119	211	283	340	425	510	595	680	765	851	935	1020	1105
350	62	139	227	283	340	425	510	595	680	765	851	935	1020	1105
400	70	158	227	283	340	425	510	595	680	765	851	935	1020	1105
450	79	170	227	283	340	425	510	595	680	765	851	935	1020	1105
500	88	170	227	283	340	425	510	595	680	765	851	935	1020	1105
550	97	170	227	283	340	425	510	595	680	765	851	935	1020	1105
600	104	170	227	283	340	425	510	595	680	765	851	935	1020	1105
650	113	170	227	283	340	425	510	595	680	765	851	935	1020	1105

END OF SECTION

SECTION 02715

PVC GRAVITY SEWER PIPE

PART 1 – GENERAL

A. Description

This section includes materials, testing, and installation of polyvinyl chloride (PVC) gravity sewer pipe and fittings.

B. Related Work Specified Elsewhere

1. Trenching, Backfilling and Compacting: 02223.

2. Installation of Gravity Sewer Pipelines: 02701.

3. Concrete: 03300.

4. Precast Concrete Manholes and Manhole Bases: 03461.

C. Submittals

1. Provide materials list showing material of pipe and fittings with ASTM references and grade.

2. Provide certificates of compliance with all standards referenced in this section.

D. Application

PVC SDR 35 shall be used for gravity sewer mains up to and including 12-inch in diameter, except as specifically called out on the project plans.

E. Sewer Force Mains

PVC sewer force mains shall be constructed in accordance with the requirements for PVC Distribution Pipe, Section 15064.

F. Inverted Siphons

Inverted siphons will be permitted only at those locations approved by the District.

PART 2 – MATERIALS

A. Pipe and Fittings

1. ASTM Requirements: Pipe, fittings, couplings, and joints shall be in conformance with the size, material and performance requirements of ASTM D 3034, SDR 35, and shall have gasketed joints. Pipe shall be made of PVC plastic having a cell classification of 12454-B, 12454-C, or 13364-B as defined in ASTM D 1784. Fittings shall be made of PVC plastic having a cell classification of 12454-B, 12454-C, or 13343-C. All pipe shall be of solid wall construction with smooth interior and exterior surfaces.

2. Manufacturer's Testing Certification: During production of the pipe, the manufacturer shall perform the specified tests for each pipe marking. A certification by the manufacturer indicating compliance with specification requirements shall be delivered with the pipe. The certification shall include the test result data.

3. Pipe Marking: All pipe, fittings, and couplings shall be clearly marked at an interval not to exceed 5-feet as follows:

   a. Nominal pipe diameter

   b. PVC cell classification

   c. Company, plant, shift, ASTM, SDR, and date designation

   d. Service designation or legend

   For fittings and couplings, the SDR designation is not required. All pipe shall have a home mark on the spigot end to indicate proper penetration when the joint is made.

4. Additional Pipe Tests Following Delivery: When pipe is delivered to the jobsite, the District representative may require additional testing to determine conformance with the requirements of pipe flattening, impact resistance, pipe stiffness, and extrusion quality. When testing is required, one test pipe shall be selected at random by the Director of Engineering from each 1,200 feet or fraction thereof of each size of pipe delivered to the jobsite but not less than one test pipe per lot. A lot shall be defined as pipe having the same identification marking. The length of specimen for each selected pipe shall be a minimum of 8-feet.

5. Pipe Retest: Pipe which is not installed within 120 days of the latest test shall not be used without prior approval of the District representative.

Fitting and Coupling End Configurations: The socket and spigot configurations for fittings and couplings shall be compatible with those used for the pipe.

7. Manufacturers: Pipe shall be as manufactured by Vinyltech, Diamond Plastics, Carlon, or approved equal. Fittings shall be as manufactured by GPK Products, or approved equal.

B. Gaskets for PVC Pipe

1. General: Unless otherwise specified, gaskets shall be manufactured from a synthetic elastomer, and shall be extruded or molded and cured in such a manner as to be dense, homogeneous and of smooth surface, free of pitting, blisters, porosity, and other imperfections. The compound shall contain not less than 50 percent by volume of first-grade synthetic rubber. The remainder of the compound shall consist of pulverized fillers free of rubber substitutes, reclaimed rubber, and deleterious substances. The tolerance for any diameter measured at any cross section shall be ±1/32-inch (.8mm).

2. Gasket Material Requirements: When required by the District representative, the contractor shall furnish test samples of gaskets from each batch used in the work. Gasket material shall meet the following requirements:

Property	Value	ASTM Test Method
Tensile Strength (min. psi)	2,000	D 412
Elongation at break (% min.)	350	D 412
Shore durometer, Type A (Pipe manufacturer shall select value suitable for type of joint)	40 to 65*	D 2240
Compression set (constant deflection) max % of original deflection	16	D 395
Compression strength after oven aging (96 hours, 158°F {70°C}) % of tensile strength before aging	80	D 573
Increase in Shore durometer hardness after oven aging. Maximum increase over original Shore durometer	10	D 2240
Physical requirements after exposure to ozone concentration (150 pphm. 70 hours, 140°F {40°C}), 20% strain)	No Cracks	D 1149

*This applies only to the sealing component of the gasket.

3. Splices: No more than one splice will be permitted in a gasket. A splice shall be made by applying a suitable cement to the ends and vulcanizing the splice in a full mold. The splice shall show no separation when subjected to the following tests:

4. Elongation Test: The part of the gasket which includes the splice shall withstand 100% elongation with no visible separation of the splice. While in the stretched position, the gasket shall be rotated in the spliced area minimum of 180 degrees in each direction in order to inspect for separation.

5. Bend Test: The portion of the unstretched gasket containing the splice shall be wrapped a minimum of 180 degrees and a maximum of 270 degrees around a rod of a diameter equal to the cross section diameter of the gasket.

PART 3 – EXECUTION

A. Related Installation Specification

PVC gravity sewer pipe shall be installed in accordance with the requirements of Section 02701, Installation of Gravity Sewer Pipelines.

END OF SECTION

SECTION 03100

CONCRETE FORMWORK

PART 1 GENERAL

A. Scope of Work

1. Formwork for cast-in-place concrete including all associated shoring, bracing, and anchorage required to provide a complete job.

2. Coordination and providing openings in concrete for other work.

3. Provide all form accessories required to perform a complete job.

4. Stripping of forms

B. References

ACI 301	Structural Concrete for Buildings
ACI 318	Building Code Requirements for Reinforced Concrete
ACI 347	Guide to Formwork for Concrete
PS 1	Construction and Industrial Plywood

C. Design Requirements

1. CONTRACTOR is solely responsible for design, engineering and construction of formwork, shoring and bracing to conform to design and code requirements; resultant concrete to conform to required shape, line and dimension.

2. Forming, shoring and bracing designs for footings shall be provided by the CONTRACTOR to meet all requirements specified here-in.

3. If requested by the ENGINEER, drawings and calculations shall be submitted verifying the selection of form ties, horizontal and vertical stiff-backs or braces for wall panels, forming and form openings, shoring of roof forms, or any other part of forming, shoring or bracing which may be considered critical by the ENGINEER.

4. The CONTRACTOR shall be solely responsible for the adequacy of the forming, shoring and bracing design.

5. Any formwork and falsework installed by CONTRACTOR shall be solely at CONTRACTOR's risk. The submittal of the design will not lessen or diminish the CONTRACTOR's liability.

D. Submittal for Review

1. Section 01300 – Contractor Submittal : Procedures for submittals.

2. Product Data: Provide data on components to be used to demonstrate form materials and accessories meet these specifications.

E. Quality Assurance

1. Perform Work in accordance with ACI 347, 301, and 318.

2. Falsework shall be designed under the direct supervision of a licensed Structural or Civil Engineer experienced in the design of this work and licensed in California.

F. Delivery, Storage and Protection

1. Section 01650 – Product Delivery, Storage, and Handling Requirement: Transport, handle, store and protect products.

2. Deliver void forms and installation instructions in manufacturer's packaging.

3. Store off ground in ventilated and protected manner to prevent deterioration from moisture.

PART 2 PRODUCTS

A. Form Materials

1. Form Materials: CONTRACTOR shall select form materials which will produce a smooth, even finish in all exposed surfaces. Form materials which may remain or leave residues on or in the concrete shall be certified as compliant with NSF Standard 61 – Drinking Water system Components.

B. Formwork Accessories

1. Form Release Agent: Shall be a product which will not stain concrete, or absorb moisture, or impair natural bonding. For steel forms, release agent shall prevent discoloration of the concrete due to rust. ATLAS BIO-GUARD (Atlas tech Products), CLEAN STRIP J1EF (Dayton Superior) or approved equal.

2. Corners: Chamfer all corners of concrete unless specifically noted otherwise. Provide chamfer strip secured in forms as required.

3. Nails, Spikes, Lag Bolts, Through Bolts, Anchors: Sized as required, of sufficient strength and character to maintain formwork in place while placing concrete.

PART 3 EXECUTION

A. Examination

1. Verify lines, elevation levels and centers before proceeding with formwork. Ensure that dimensions agree with drawings.

2. Clean surfaces of all forms to be in contact with concrete of all previous concrete or contaminants prior to erection.

B. Earth Form

1. Hand trim sides and bottom of earth forms. Remove loose soil prior to placing concrete. See typical details for additional requirements.

2. No forming stakes will be permitted in earth forms.

C. Erection - Formwork

1. Plumb and string lines shall be installed before concrete placement and shall be maintained during placement. Such lines shall be used by CONTRACTOR's personnel and by the ENGINEER and shall be in sufficient number and properly installed. During concrete placement, the CONTRACTOR shall continually monitor plumb and string line form positions and immediately correct deficiencies.

2. Erect formwork, shoring and bracing to achieve design requirements, in accordance with requirements of ACI 301.

3. Provide bracing to ensure stability of formwork. Shore or strengthen formwork subject to overstressing by construction loads.

4. Arrange and assemble formwork to permit dismantling and stripping. Do not damage concrete during stripping. The arrangement of the formwork shall permit the removal of remaining principal shores.

5. Provide worker protection from protruding reinforcement bars in accordance with applicable safety codes.

6. Obtain approval before framing openings in structural members, which are not indicated on Drawings.

7. Provide fillet and chamfer strips on external corners of slabs unless noted or shown otherwise.

8. Coordinate this section with other sections of work which require attachment of components to formwork.

9. If formwork is placed after reinforcement resulting in insufficient concrete cover over reinforcement, reinforcing shall be relocated to provide proper coverage.

10. Formwork shall be placed and secured to produce the concrete sections shown on the drawings.

11. Wall formwork shall be of sufficient strength and stiffness to permit the placement of the full wall height between vertical construction joints shown on the drawings without the need of additional horizontal construction joint.

D. Wall Footing Forms

1. All vertical wall footing sides shall be formed by methods acceptable to the DISTRICT and to the correct elevations and location shown on the Plans.

2. Under no circumstances shall forming be such that the drop of concrete in the forms will exceed 8 feet in any one place.

3. CONTRACTOR shall remove all wood splinters on concrete surfaces after stripping of wood forms.

4. Unless specifically called for on the Plans, no chamfer strips shall be placed in the corners of vertical construction joints of walls.

5. Every precaution shall be taken to ensure that all forms are in the proper alignment, plumb and that all form supports are secure and tight.

6. Construction Tolerances:

    a. Adequate time and cooperation shall be provided to the Inspector to verify the compliance of these requirements prior to closing up the forms or pouring concrete.

E. Application – Form Release Agent

1. Apply form release agent on formwork in accordance with manufacturer's recommendations.

2. Care shall be taken not to apply any form release agent to the reinforcing steel, anchoring devices or embedded items in the forms.

F. Inserts, Embedded Parts and Openings

1. Provide formed openings where required for items to pass through concrete work.

2. Locate and secure in place items, which will be cast directly into concrete prior to the placing of the concrete.

3. Coordinate with work of other sections in forming and placing openings, slots, recesses, sleeves, bolts, anchors, other inserts and components of the Work.

4. Install accessories in accordance with manufacturer's instructions, straight level, and plumb. Ensure items are not disturbed during concrete placement.

5. Provide temporary ports or openings in formwork where required to facilitate cleaning, inspection, placing and consolidating concrete.

6. Close temporary openings with tight fitting panels, flush with inside face of forms, and neatly fitted so joints will not be apparent in exposed concrete surfaces.

G. Form Cleaning and Maintenance

1. Clean forms as erection proceeds, to remove foreign matter within forms to provide a smooth even surface.

2. Clean formed cavities of debris prior to placing concrete.

3. Use compressed air to remove remaining foreign matter.

4. Maintain forms at all times in good condition, particularly as to size, shape, strength, rigidity, tightness and smoothness of surface. Form surfaces shall be treated with a nonstaining mineral oil or other lubricant acceptable to the ENGINEER. Any excess lubricant shall be satisfactorily removed before placing concrete. Where field oiling of forms is required, the CONTRACTOR shall perform the oiling at least two weeks in advance of their use. Care shall be exercised to keep oil off the surfaces of steel reinforcement and other metal items to be embedded in concrete.

H. Formwork Tolerances

1. Construct formwork to maintain tolerances as stated in this section. If not noted provide as required by ACI 301.

2. Camber slabs and beams in accordance with ACI 301.

I. Field Quality Control

1. Inspect erected formwork, shoring and bracing to ensure that work is in accordance with formwork design, and that supports, fastenings, wedges, ties, and items are secure and properly located.

2. Do not patch wood formwork.

J. Form Removal

1. Do not remove forms or bracing until concrete has gained sufficient strength to carry its own weight and imposed loads. The removal criteria given below, serve only as minimums. It is the sole responsibility of the CONTRACTOR to insure the concrete has sufficient strength for forms to be removed.

2. Forms on sides of footings and encasements may be removed after 24 hours.

3. Structural slab forms and shoring shall not be removed for a minimum of 10 days and only when concrete test breaks indicate the concrete placed for the slab has reached a minimum of 85% of its required 28-day compressive strength. The CONTRACTOR may mold and cure additional concrete cylinders per Section 03300.3.08 to verify the 85% strength has been achieved.

4. Loosen forms carefully. Do not wedge pry bars, hammers or tools against finish concrete surfaces scheduled for exposure to view.

5. Store removed forms such that surfaces to be in contact with fresh concrete will not be damaged. Discard damaged forms.

6. CONTRACTOR shall begin to apply curing compounds within one hour after stripping wall forms as outlined in Section 03300.03.09.

7. All formwork shall be removed before backfill is placed against the formed surface.

K. Falsework

The CONTRACTOR shall be responsible for the design, engineering, construction, maintenance, and safety of all falsework, including staging, walkways, forms, ladders, and similar appurtenances, which shall equal or exceed the applicable requirements of the provisions of the OSHA Safety and Health Standards for Construction, the requirements of the Construction Safety Orders of the California Division of Industrial Safety, and the requirements herein.

END OF SECTION

SECTION 03200

REINFORCEMENT STEEL

PART 1 GENERAL

A. SCOPE OF WORK

The CONTRACTOR shall furnish, fabricate, and place all concrete and masonry reinforcement steel, welded wire fabric, couplers, and concrete inserts for use in reinforced concrete and masonry construction and shall perform all appurtenant work, including all the wires, clips, supports, chairs, spacers, and other accessories, all in accordance with the Contract Documents.

B. REFERENCES

1. Codes: All codes, as referenced herein, are specified in Section 01090, "Reference Standards."

2. Commercial Standards:

ACI 315	Details and Detailing of Concrete Reinforcement
ACI 318	Building Code Requirements for Reinforced Concrete
CRSI MSP-1	Concrete Reinforcing Steel Institute Manual of Standard Practice
WRI	Manual of Standard Practice for Welded Wire Fabric
AWS D1.4	Structural Welding Code - Reinforcing Steel
ASTM A185	Specification for Welded Steel Wire Fabric, Plain, for Concrete Reinforcement
ASTM A615	Specification for Deformed and Plain Billet-Steel Bars for Concrete Reinforcement
ASTM A706	Low Alloy Steel Deformed Bars for Reinforcement
ASTM A767	Standard Specification for Zinc-Coated (Galvanized) Steel Bars for Concrete Reinforcement
ASTM A775	Specification for Epoxy-Coated Reinforcing Steel Bars
ASTM A780	Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings

C. SUBMITTALS

1. The CONTRACTOR shall furnish shop bending diagrams, placing lists, and drawings of all reinforcement steel prior to fabrication in DWG or Autodesk DWF format and in accordance with the requirements of Section 01300, "Contractor Submittals" All shop drawings shall be signed, sealed and stamp by an ENGINEER with a date of signature.

2. Details of the concrete reinforcement steel and concrete inserts shall be submitted by the CONTRACTOR at the earliest possible date after receipt of the Notice to Proceed. Said details of reinforcement steel for fabrication and erection shall conform to ACI 315 and the requirements specified and shown. 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. The shop drawings shall include bar placement diagrams which clearly indicate the locations and dimensions of each bar splice.

3. Where mechanical couplers are required or permitted to be used to splice reinforcement steel, the CONTRACTOR shall submit manufacturer's literature containing instructions and recommendations for installation for each type of coupler used. A current ICC evaluation report for the specific product proposed to be used, or certified test reports which verify the load capacity of each type and size of couplers to be used. Shop drawings shall be prepared which show the location of each coupler with details of how they are to be installed and secured in the formwork.

4. If reinforcement steel is spliced by welding at any location, the CONTRACTOR shall submit mill test reports which shall contain the information necessary for the determination of the carbon equivalent as specified in AWS D1.4. The CONTRACTOR shall submit a written welding procedure for each type of weld for each size of bar which is to be spliced by welding; merely a statement that AWS procedures will be followed is not acceptable.

D. QUALITY ASSURANCE

1. If requested by the ENGINEER, the CONTRACTOR shall provide samples from each heat of reinforcement steel delivered in a quantity adequate for testing. The OWNER will pay the costs of initial required tests. The CONTRACTOR shall bear the costs of additional tests due to material failing the initial tests.

2. If reinforcement steel is spliced by welding at any location, the CONTRACTOR shall submit certifications of procedure qualifications for each welding procedure used and certification of welder qualifications, for each welding procedure, and for each welder performing the work. Such qualifications shall be as specified in AWS D1.4.

3. If requested by the ENGINEER, the CONTRACTOR shall provide samples of each type of welded splice used in the work in a quantity and of dimensions adequate for testing. At the discretion of the ENGINEER, radiographic testing of direct butt welded splices will be performed. The CONTRACTOR shall provide assistance necessary to facilitate testing. The CONTRACTOR shall repair any weld which fails to meet the requirements of AWS D1.4. The costs of testing will be paid by the OWNER; except, the costs of all tests which fail to meet specified requirements shall be paid by the CONTRACTOR.

PART 2 PRODUCTS

A. REINFORCEMENT STEEL

1. Reinforcement Steel shall conform to the following requirements:

   a. Bar reinforcement shall conform to the requirements of ASTM A 615 for Grade 60 Billet Steel Reinforcement, unless noted otherwise

   b. Bar reinforcement to be welded shall meet the requirements of ASTM A 706 for Grade 60.

   c. Welded wire fabric reinforcement shall conform to the requirements of ASTM A 185. If the welded wire fabric has longitudinal wire of W4 size wire or smaller, it shall be either furnished in flat sheets or in rolls with a core diameter of not less than 10 inches. If the welded wire fabric has longitudinal wires larger than W4 size, it shall be furnished in flat sheets only.

2. Bar Support Accessories:

   a. Accessories shall include all necessary chairs, slab bolsters, concrete blocks, tie wires, dips, supports, spacers, and other devices to position reinforcement during concrete or grout placement. All bar supports shall meet the requirements of the CRSI Manual of Standard Practice including special requirements for supporting epoxy coated reinforcing bars. Wire bar supports shall be CRSI Class 1 for maximum protection with a 1/8-inch minimum thickness of plastic coating which extends at least 1/2-inch from the concrete surface. Plastic shall be gray in color.

   b. Concrete blocks (dobies), used to support and position reinforcement steel, shall have the same or higher compressive strength specified for the concrete in which it is located. Wire ties shall be embedded in concrete block bar supports.

3. Galvanized coated reinforcing, where specified or shown, shall conform to ASTM A767 – "Standard Specification for Zinc-Coated (Galvanized) Steel Bars for Concrete Reinforcement", Class 1

4. Epoxy coating for reinforcing and accessories, where specified or shown, shall conform to ASTM A 775 – "Standard Specification for Epoxy-Coated Reinforcing Steel Bars".

B. ACCESSORIES

1. Mechanical couplers shall be provided where shown or may be used where approved by the ENGINEER. The couplers shall have the tensile capacity equal to a minimum of 125 percent of the reinforcement bars yield strength being spliced.

2. Where the type of coupler used is composed of more than one component, all components required for a complete splice shall be supplied. This shall apply to all mechanical splices, including those splices intended for future connections.

3. The reinforcement steel and coupler used shall be compatible for obtaining the required strength of the connection. Straight threaded type couplers shall require the use of the next larger size reinforcing bar or shall be used with reinforcing bars with specially forged ends which provide upset threads which do not decrease the basic cross section of the bar.

4. Couplers shall be **Lenton Form Saver as manufactured by Erico Products; Dowel Bar Splicer System as manufactured by Richmond Screw Anchor Company;** or equal.

C. FABRICATION

1. General:

   a. Fabrication details shall be prepared in accordance with ACI 315 and ACI 318, except as modified by the Drawings. Stirrups and tie bars shall be bent around a pin having a diameter not less than 1-1/2-inch for No. 3 bars, 2-inch for No. 4 bars, and 2-1/2-inch for No. 5 bars or as specified on the Drawings. Bends for other bars shall be made around a pin having a diameter not less than 6 times the bar diameter, except for bars larger than 1 inch, in which case the bends shall be made around a pin of 8 bar diameters or as specified on the Drawings. Bars shall be bent cold.

b. 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 as specified under Section 01330, "Submittal Procedure."

c. Reinforcement shall not be straightened or rebent in a manner which will reduce the strength of the material. Bars with kinks or bends not shown shall not be used. All bars shall be bent cold, unless otherwise permitted by the ENGINEER. No bars partially embedded in concrete shall be field-bent except as shown or specifically permitted by the ENGINEER.

2. Fabricating Tolerances: Bars used for concrete reinforcement shall meet the following requirements for fabricating tolerances:

a. Sheared length: $\pm$ 1 inch

b. Depth of truss bars: + 0, - 1/2 inch

c. Stirrups, ties, and spirals: $\pm$ 1/2 inch

d. All other bends: $\pm$ 1 inch

3. Welded Splices:

a. Welded splices shall be provided where shown and where approved by the ENGINEER. All welded splices of reinforcement steel shall develop a tensile strength which exceeds 125 percent of the yield strength of the reinforcement bars which are connected.

b. All materials required to conform to the welded splice requirements of AWS D1.4 shall be provided.

D. EPOXY GROUT

Epoxy for grouting reinforcing bars shall be specifically formulated for such application, for the moisture condition, application temperature, and orientation of the hole to be filled. Epoxy grout shall meet the requirements found in Section 03600, "Grout."

PART 3 EXECUTION

A. PLACEMENT

1. All reinforcement steel, welded wire fabric, couplers, and other appurtenances shall be fabricated, and placed in accordance with the requirements of the Building Code and the supplementary requirements specified herein.

2. Reinforcement steel shall be accurately positioned as shown, and shall be supported and wired together to prevent displacement, using annealed iron wire ties or suitable clips at intersections. All reinforcement steel shall be supported by concrete, plastic or metal supports, spacers or metal hangers which are strong and rigid enough to prevent any displacement of the reinforcement steel. Where concrete is to be placed on the ground, supporting concrete blocks (or dobies) shall be used, in sufficient numbers to support the

bars without settlement, but in no case shall such support be continuous. All concrete blocks used to support reinforcement steel shall be tied to the steel with wire ties embedded in the blocks. For concrete over or in formwork, the CONTRACTOR shall furnish concrete, metal, plastic, or other acceptable bar chairs and spacers to maintain the required clearances.

3. Limitations on the use of bar support materials shall be as follows.

   a. Concrete Dobies: Permitted at all locations except where architectural finish is required.

   b. Wire Bar Supports: Permitted only at slabs over dry areas, interior dry wall surfaces, and exterior wall surfaces.

   c. Plastic Bar Supports: Permitted at all locations except on grade.

4. Tie wires shall be bent away from the forms in order to provide the specified concrete coverage.

5. Reinforcement in masonry shall be secured against displacement prior to grouting by wire positioners or other suitable devices at intervals not exceeding 180 bar diameters.

6. Bars additional to those shown which may be found necessary or desirable by the CONTRACTOR for the purpose of securing reinforcement in position shall be provided by the CONTRACTOR at its own expense.

7. Unless otherwise specified, reinforcement placing tolerances shall be within the limits specified in Section 26.6.2.1 of ACI 318 except where in conflict with the requirements of the Building Code.

8. Bars may be moved as necessary to avoid interference with other reinforcement steel, conduits, or embedded items. If bars are moved more than one bar diameter, or enough to exceed the above tolerances, the resulting arrangement of bars shall be as acceptable to the ENGINEER.

9. Welded wire fabric reinforcement placed over horizontal forms shall be supported on slab bolsters. Slab bolsters shall be spaced not more than 30 inches on centers, shall extend continuously across the entire width of the reinforcement mat, and shall support the reinforcement mat in the plane shown.

10. Welded wire fabric placed over the ground shall be supported on wired concrete blocks (dobies) spaced not more than 3 feet on centers in any direction. The construction practice of placing welded wire fabric on the ground and hooking into place in the freshly placed concrete shall not be used.

11. Galvanized coated reinforcing bars shall be stored, transported, and placed in such a manner as to avoid damaging of the galvanized coating. In-place galvanized reinforcing bars shall be inspected for coating damage, and all coating damage due to fabrication or handling shall be repaired in accordance with ASTM A780 – “Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings” prior to placing concrete.

12. Epoxy coated reinforcing bars shall be stored, transported, and placed in such a manner as to avoid damaging of the epoxy coating. Non-abrasive slings made of nylon and similar materials shall be used. Specially coated bar supports shall be used. All chips or cracks in the epoxy coating shall be repaired with a compatible epoxy repair material prior to placing concrete.

13. Accessories supporting reinforcing bars shall be spaced such that there is no deflection of the accessory from the weight of the supported bars. When used to space the reinforcing bars from wall forms, the forms and bars shall be located so that there is no deflection of the accessory when the forms are tightened into position.

B. SPACING OF BARS

1. The clear distance between parallel bars (except in between multiple layers of bars in beams) shall be not less than the nominal diameter of the bars nor less than 1-1/3 times the maximum size of the coarse aggregate, nor less than one inch.

2. Where reinforcement in beams or girders is placed in 2 or more layers, the clear distance between layers shall be not less than one inch and the bars of the upper layers placed directly above the bars of the bottom layer.

3. The clear distance between bars shall also apply to the distance between a contact splice and adjacent splices or bars.

C. SPLICING

1. General:

   a. Reinforcement bar splices shall only be used at locations shown. When it is necessary to splice reinforcement at points other than where shown, the character of the splice shall be as acceptable to the ENGINEER and shall be specified on the submitted shop drawings.

   b. Unless otherwise indicated, dowels shall match the size and spacing of the spliced bar.

2. Splices of Reinforcement:

   a. The length of lap for reinforcement bars, unless otherwise shown shall be in accordance with ACI 318, Section 25.5.2.1 for a Class B splice.

   b. Laps of welded wire fabric shall be in accordance with the ACI 318. Adjoining sheets shall be securely tied together with No. 14 tie wire, one tie for each 2 running feet. Wires shall be staggered and tied in such a manner that they cannot slip.

3. Couplers which are located at a joint face shall be a type which can be set either flush or recessed from the face as shown. The couplers shall be sealed during concrete placement to completely eliminate concrete or cement paste from entering.

   Couplers intended for future connections shall be recessed a minimum of 1/2 inch from the concrete surface. After the concrete is placed, the coupler shall be plugged with

plastic plugs which have an O-ring seal and the recess filled with sealant to prevent any contact with water or other corrosive materials.

4. Unless noted otherwise, mechanical coupler shall have the same size bar on each side of the coupler.

END OF SECTION

SECTION 03251

JOINTS IN CONCRETE

PART 1 GENERAL

A. Scope of Work

The CONTRACTOR shall construct all joints in concrete at the locations shown. Joints required in concrete structures are of various types and will be permitted only where shown, unless specifically accepted by the ENGINEER in writing.

B. Reference Specifications, Codes and Standards

1. Federal Specifications:

TT-S-0227E(3)	Sealing Compound, elastomeric type, Multi-component for Caulking, Sealing, and Glazing Buildings and Other Structures.

2. Commercial Standards:

ASTM A775	Specification for Epoxy-Coated Reinforcing Steel Bars
ASTM C920	Specification for Elastomeric Joint Sealants
ASTM D412	Test Methods for Rubber Properties in Tension
ASTM D624	Test Method for Rubber Property -- Tear Resistance
ASTM D746	Test Method for Brittleness Temperature of Plastics and Elastomers by Impact
ASTM D747	Test Method for Apparent Bending Modulus of Plastics by Means of a Cantilever Beam
ASTM D1056	Specification for Flexible Cellular Materials -- Sponge or Expanded Rubber
ASTM D1752	Specification for Preformed Sponge Rubber and Cork Expansion Joint Fillers for Concrete Paving and Structural Construction
ASTM D2240	Test Method for Rubber Property -- Durometer Hardness
ASTM D2241	Specification for Poly (Vinyl Chloride) (PVC) Pressure-Rated Pipe (SDR-Series)

C. Types of Joints

1. Construction Joints: When fresh concrete is placed against a hardened concrete surface, the joint between the two pours is called a construction joint. Unless otherwise specified, all joints in water bearing members shall be provided with a waterstop and/or sealant groove of the shape specified and shown. The surface of the first pour may also be required to receive a coating of bond breaker as shown.

2. Control Joints: The function of the control joint is to provide a weaker plane in the concrete, where shrinkage cracks will probably occur. A groove, of the shape and dimensions shown, is formed or saw-cut in the concrete. This groove is afterward filled with a joint sealant material as specified in Part 2 entitled "Joint Sealant."

D. Contractor Submittals

1. Joint Sealant: Prior to ordering the sealant material, the CONTRACTOR shall submit to the ENGINEER for the ENGINEER's review, sufficient data to show general compliance with the requirements of the Contract Documents.

2. Test Certification: Certified test reports from the sealant manufacturer on the actual batch of material being supplied indicating compliance with the above requirements shall be furnished the ENGINEER before the sealant is used on the job.

3. Shipping Certification: The CONTRACTOR shall provide written certification from the manufacturer as an integral part of the shipping form, to show that all of the material shipped to this project meets or exceeds the physical property requirements of the Contract Documents. Supplier certificates are not acceptable.

E. Quality Assurance

1. Construction Joint Sealant: The CONTRACTOR shall prepare adhesion and cohesion test specimens as specified herein prior to beginning the installation of any sealant joints on the project. The same personnel who shall be performing the sealant joint installation for the project shall prepare the test specimen. If there is a change in personnel installing the sealant joint, the new personnel shall prepare an acceptable test specimen prior to starting work on the project.

2. Test Procedure: The sealant material shall show no signs of adhesive or cohesive failure when tested in accordance with the following procedure in laboratory and field tests:

   a. Sealant specimen shall be prepared between 2 concrete blocks (1-inch by 2-inch by 3-inch). Spacing between the blocks shall be 1-inch. Coated spacers (2-inch by 1-1/2-inch by 1/2-inch) shall be used to insure sealant cross-sections of 1/2-inch by 2 inches with a width of 1-inch.

   b. Sealant shall be cast and cured according to manufacturer's recommendations except that curing period shall be not less than 24 hours.

   c. Following curing period, the gap between blocks shall be widened to 1-1/2-inch. Spacers shall be used to maintain this gap for 24 hours prior to inspection for failure.

3. Specimen Acceptance Criteria: If the sealant material fails to fully and properly cure after the manufacturer's recommended curing time for the job conditions of the WORK hereunder, it shall be completely removed; the groove shall be thoroughly sandblasted to remove all traces of the previously installed sealant and primer, and the joint shall be re-sealed with the specified joint sealant. All costs of such removal, joint treatment, re-sealing, and appurtenant work shall be at the expense of the CONTRACTOR.

4. Contractor Qualifications: A specialty contractor who has a successful record of performance in similar installations shall install all sealant.

5. Manufacturer’s Representative: Before work is commenced a representative of the sealant manufacturer shall instruct the work crew as to the proper method of application of the specific system to be installed. The instruction from the manufacturer

representative shall include instructions on the proper method and degree of mixing required for the products used.

F. Guarantee

The CONTRACTOR shall provide a 5-year written guarantee of the entire sealant installation against faulty and/or incompatible materials and workmanship, together with a statement that it agrees to repair or replace, to the satisfaction of the DISTRICT at no additional cost to the DISTRICT, any such defective areas which become evident within said 5-year guarantee period.

PART 2 PRODUCTS

A. General

All joint materials specified herein that may come in contact with potable water shall be classified as acceptable for potable water use by the National Sanitation Foundation (NSF), after a maximum of 30 days of installation.

B. Joint Sealant

1. Joint sealant shall be polyurethane polymer designed for bonding to concrete in a continuous submerged condition in water. No material will be accepted which has an unsatisfactory history for bond or durability when used in joints of water retaining structures.

2. Joint sealant material shall meet the following requirements (@ 73 degrees F and 50 percent R.H.):

Work Life	45 - 180 minutes
Time to Reach 20 Shore "A" Hardness (at 77 degrees F, 200 gr quantity)	24 hours, maximum
Ultimate Hardness (ASTM D 2240)	20 - 45 Shore "A"
Tensile Strength (ASTM D 412)	200 psi, minimum
Ultimate Elongation (ASTM D 412)	400 percent, minimum
Tear Resistance (Die C ASTM D 624)	75 pounds per inch of thickness, minimum
Color	Light Gray

All sealants, wherever shown, or required hereunder shall be **PSI-270 as manufactured by Polymeric Systems Inc.; Elastothane 227R as manufactured by Pacific Polymers; Sikaflex 2C, as manufactured by Sika Corporation;** or equal.

C. Sealant Primer

Product Compatibility: The same manufacturer supplying the sealant shall manufacture the primer used.

D. Bond Breaker

Bond breaker shall be **Super Bond Breaker as manufactured by Burke Company, San Mateo, California; Select Cure CRB as manufactured by Select Products Co., Upland, California;** or equal. It shall contain a fugitive dye so that areas of application will be readily distinguishable.

PART 3 EXECUTION

A. General

1. Joint Location: Construction joints, and other types of joints, shall be provided where shown. When not shown, construction joints shall be proposed by the Contractor to the ENGINEER in writing. This can be provided as part of another submittal (i.e. reinforcing steel shop drawings). The location of all joints, of any type, shall be submitted for acceptance by the ENGINEER.

2. Joint Preparation: Special care shall be used in preparing concrete surfaces at joints where bonding between two sections of concrete is required. Unless otherwise shown, bonding will be required at all horizontal joints in walls (where horizontal joints are permitted). Surfaces shall be prepared in accordance with the requirements of Section 03300, "Cast-in-Place Concrete."

B. Construction Joint

1. Sealant Groove: Water bearing floor slabs, and elsewhere as shown, shall be provided with grooves which shall be filled with a construction joint sealant.

2. Sealant Application: The material used for forming the grooves shall be left in the grooves until just before the grooves are cleaned and filled with joint sealant. After removing the forms from the grooves, all laitance and fins shall be removed, and the grooves shall be sandblasted. The grooves shall be thoroughly dried, after which they shall be blown out; immediately thereafter, they shall be primed, bond breaker tape placed in the bottom of the groove, and filled with the construction joint sealant.

3. Sealant will not be permitted to be used without the recommended manufacturer's primer. Care shall be used to completely fill the sealant grooves.

4. The primer and sealant shall be placed strictly in accordance with the printed recommendations of the manufacturer, taking special care to properly mix the sealant prior to application. The sides of the sealant groove shall not be coated with bond breaker, curing compound, or any other substance which would interfere with proper bonding of the sealant. All sealant shall achieve final cure at least 7 days before the structure is filled with water.

C. Control Joint

1. After the concrete surface has cured to a point when it will not tear when cut with a concrete saw, the concrete shall be cut with a saw blade the size indicated on the Project

Drawings or 3/8” thick if not indicated. The cut shall be a minimum of 1 ½” deep or as indicated on the Project Drawings.

2. The joint shall not be located within a deepened section of slab or footing. It is permissible for the sawcut to run transverse to a deepen section.

3. After the concrete has cured, the sawcuts in the concrete surface shall be clean out with compressed air and filled with a polyurethane sealant in a continuous bead. The sealant selected shall be appropriate for the exposure of the joint.

END OF SECTION

SECTION 03300

CAST-IN-PLACE CONCRETE

PART 1 GENERAL

A. Scope of Section

1. The CONTRACTOR shall furnish all materials for concrete in accordance with the provisions of this Section and shall form, mix, place, cure, repair, finish, and do all other work as required to produce finished concrete, in accordance with the requirements of the Contract Documents.

2. The requirements specified herein are minimum requirements only and shall not be interpreted as all inclusive. It is the responsibility of the CONTRACTOR to employ the necessary practices based on the referenced ACI Standards to ensure the completion of quality concrete construction, of the strengths specified within the Construction Documents, and relatively free of cracks.

3. The following types of concrete shall be covered in the Section:

   Structural Concrete: Concrete to be used in all structures except where noted otherwise in the Contract Documents.

4. The term "hydraulic structure" used in these specifications shall refer to environmental engineering concrete structures for the containment, treatment, or transmission of water, wastewater, or other fluids.

B. References

1. Codes: All codes, as referenced herein.

2. Federal Specifications:

UU-B-790A (1) (2)	Building Paper, Vegetable Fiber (Kraft, Waterproofed, Water Repellant and Fire Resistant)

3. Commercial Standards:

ACI 117	Standard Tolerances for Concrete Construction and Materials
ACI 214	Recommended Practice for Evaluation of Strength Test Results of Concrete
ACI 301	Specifications for Structural Concrete for Buildings
ACI 305R	Hot Weather Concreting
ACI 306R	Cold Weather Concreting
ACI 308	Standard Specifications for Curing Concrete
ACI 309	Consolidation of Concrete
ACI 315	Details and Detailing of Concrete Reinforcement
ACI 318	Building Code Requirements for Reinforced Concrete
ASTM C31	Practices for Making and Curing Concrete Test Specimens in the Field
ASTM C33	Specification for Concrete Aggregates

ASTM C39	Test Method for Compressive Strength of Cylindrical Concrete Specimens
ASTM C94	Specification for Ready-Mixed Concrete
ASTM C136	Method for Sieve Analysis of Fine and Coarse Aggregates
ASTM C143	Test Method for Slump of Hydraulic Cement Concrete
ASTM C150	Specification for Portland Cement
ASTM C156	Test Methods for Water Retention by Concrete Curing Materials
ASTM C157	Test Method for Length Change of Hardened Hydraulic Cement Mortar and Concrete
ASTM C 192	Method of Making and Curing Concrete Test Specimens in the Laboratory
ASTM C260	Specification for Air-Entraining Admixtures for Concrete
ASTM C309	Specifications for Liquid Membrane-Forming Compounds for Curing Concrete
ASTM C494	Specification for Chemical Admixtures for Concrete
ASTM C1077	Practice for Laboratories Testing Concrete and Concrete Aggregates for use in Construction & Criteria for Laboratory Evaluation
ASTM D1751	Specification for Preformed Expansion Joint Fillers for Concrete Paving and Structural Construction (Non-extruding and Resilient Bituminous Types)
ASTM D2419	Test Method for Sand Equivalent Value of Soils and Fine Aggregate
ASTM E119	Method for Fire Tests of Building Construction and Materials

C. Submittals

1. Mix Designs: Prior to beginning the WORK and within 14 days of the notice to proceed, the CONTRACTOR shall submit to the ENGINEER, for review, preliminary concrete mix designs which shall show the proportions and gradations of all materials proposed for each class and type of concrete specified herein in accordance with Section 01300 – Contractor Submittal. All mix designs shall be signed, sealed and stamped by a California licensed Civil or Structural Engineer with a date of signature. The mix designs shall be checked by an independent testing laboratory acceptable to the ENGINEER. The anticipated compressive strength of the concrete in each mix design shall be proven with laboratory 7-day, 14-day and, 28-day compressive tests on trial batches, or submit test reports of 7-day, 14-day, and 28-day compressive tests of the mix where the same mix has been used on two previous similar structures. All costs related to such checking shall be borne by the CONTRACTOR. Since laboratory trial batches require 35 calendar days to complete, the CONTRACTOR may consider testing more than one mix design for each class of concrete. The materials used in any mix design submitted shall for review shall be from the same source as those that will be actually furnished for this project (i.e., cement manufacturer, aggregates, admixtures, etc.)

2. Delivery Tickets: Where ready-mix concrete is used, the CONTRACTOR shall furnish delivery tickets at the time of delivery of each load of concrete. Each ticket shall show the state certified equipment used for measuring and the total quantities, by weight, of cement, sand, each class of aggregate, admixtures, and the amounts of water in the aggregate added at the batching plant, and the amount allowed to be added at the site for the specific design mix. In addition, each ticket shall state the mix number, total yield in cubic yards, and the time of day, to the nearest minute, corresponding to the times when the batch was dispatched, when it left the plant, when it arrived at the site, when unloading began, and when unloading was finished.

3. Provide the following submittals in accordance with ACI 301:

a. Mill tests for cement.

b. Admixture certification. Chloride ion content must be included.

c. Aggregate gradation and certification.

d. Materials and methods for curing.

D. Quality Assurance

1. General:

   a. Tests on component materials and for compressive strength and shrinkage of concrete will be performed as specified herein. Test for determining slump will be in accordance with the requirements of ASTM C 143.

   b. The cost of all laboratory tests on cement, aggregates, and concrete, will be borne by the DISTRICT. However, the CONTRACTOR shall be charged for the cost of any additional tests and investigation on work performed which does not meet the specifications. The laboratory must meet or exceed the requirements of ASTM C 1077.

   c. Concrete for testing shall be supplied by the CONTRACTOR at no cost to the DISTRICT, and the CONTRACTOR shall provide assistance to the ENGINEER in obtaining samples, storing, and disposal and cleanup of excess material.

2. Field Compression Tests:

   a. Compression test specimens will be taken during construction from the first placement of each class of concrete and every 100 cubic yards thereafter as selected by the ENGINEER to insure continued compliance with these specifications. Each set of test specimens will be a minimum of 5 cylinders.

   b. Compression test specimens for concrete shall be made in accordance with section 9.2 of ASTM C 31. Specimens shall be 6-inch diameter by 12-inch high cylinders.

   c. Compression tests shall be performed in accordance with ASTM C 39. One test cylinder will be tested at 7 days and 2 at 28 days. The remaining cylinders will be held to verify test results, if needed.

3. Evaluation and Acceptance of Concrete:

   a. Evaluation and acceptance of the compressive strength of concrete shall be according to the requirements of ACI 318 Section 26.12, and as specified herein.

   b. A statistical analysis of compression test results will be performed according to the requirements of ACI 214. The standard deviation of the test results shall not exceed 640 psi, when ordered at equivalent water content as estimated by slump.

   c. If any concrete fails to meet these requirements, immediate corrective action shall be taken to increase the compressive strength for all subsequent batches of the type of concrete affected.

d. When the standard deviation of the test results exceeds 640 psi, the average strength for which the mix is designed shall be increased by an amount necessary to satisfy the statistical requirement that the probability of any test being more than 500 psi below or the average of any 3 consecutive tests being below the specified compressive strength is 1 in 100. The required average strength shall be calculated by Criterion No. 3 of ACI 214 using the actual standard of deviation.

4. All concrete which fails to meet the ACI requirements and these specifications, is subject to removal and replacement at the cost of the CONTRACTOR. Shrinkage Tests:

a. Drying shrinkage tests will be made for the trial batch specified in the Paragraph in Part 2 entitled "Trial Batch and Laboratory Tests," the first placement of each class of concrete, and during construction to insure continued compliance with these Specifications.

b. Drying shrinkage specimens shall be 4-inch by 4-inch by 11-inch prisms with an effective gage length of 10 inches, fabricated, cured, dried and measured in accordance with ASTM C 157 – *Test Method for Length Change of Hardened Hydraulic Cement Mortar and Concrete*, modified as follows: specimens shall be removed from molds at an age of 23 ±1 hours after trial batching, shall be placed immediately in water at 70 degrees F ±3 degrees F for at least 30 minutes, and shall be measured within 30 minutes thereafter to determine original length and then submerged in saturated lime water at 73 degrees F ±3 degrees F. Measurement to determine expansion expressed as a percentage of original length shall be made at age 7 days. This length at age 7 days shall be the base length for drying shrinkage calculations ("0" days drying age). Specimens then shall be stored immediately in a humidity control room maintained at 73 degrees F ±3 degrees F and 50 percent ±4 percent relative humidity for the remainder of the test. Measurements to determine shrinkage expressed as percentage of base length shall be made and reported separately for 7, 14, 21, and 28 days of drying after 7 days of moist curing.

c. The drying shrinkage deformation of each specimen shall be computed as the difference between the base length (at "0" days drying age) and the length after drying at each test age. The average drying shrinkage deformation of the specimens shall be computed to the nearest 0.0001 inch at each test age. If the drying shrinkage of any specimen departs from the average of that test age by more than 0.0004-inch, the results obtained from that specimen shall be disregarded. Results of the shrinkage test shall be reported to the nearest 0.001 percent of shrinkage. Compression test specimens shall be taken in each case from the same concrete used for preparing drying shrinkage specimens. These tests shall be considered a part of the normal compression tests for the project. Allowable shrinkage limitations shall be as specified in Part 2, herein.

5. Construction Tolerances: The CONTRACTOR shall set and maintain concrete forms and perform finishing operations so as to ensure that the completed work is within the tolerances specified herein. Surface defects and irregularities are defined as finishes and are to be distinguished from tolerances. Tolerance is the specified permissible variation from lines, grades, or dimensions shown. Where tolerances are not stated in the specifications, permissible deviations will be in accordance with ACI 117 – *Standard Tolerance for Concrete Construction and Materials*.

The following construction tolerances are hereby established and apply to finished walls and slab unless otherwise shown:

Item	Tolerance
Variation of the constructed linear outline from the established position in plan.	In 10 feet: 1/4-inch; In 20 feet or more: 1/2-inch
Variation from the level or from the grades shown.	In 10 feet: 1/4-inch; In 20 feet or more: 1/2-inch
Variation from the plumb	In 10 feet: 1/4-inch; In 20 feet or more: 1/2-inch
Variation in the thickness of slabs	Minus 1/4-inch; Plus 1/2-inch
Variation in the locations and sizes of slabs	Plus or minus 1/4-inch

PART 2 PRODUCTS

A. Concrete Materials

1. General:

   Materials shall be delivered, stored, and handled so as to prevent damage by water or breakage. Only one brand of cement shall be used. Cement reclaimed from cleaning bags or leaking containers shall not be used. All cement shall be used in the sequence of receipt of shipments.

2. All materials furnished for the work shall comply with the requirements of Section 4.0 of ACI 301, as applicable.

3. Storage of materials shall conform to the requirements of Section 4.1.4 of ACI 301.

4. Materials for concrete shall conform to the following requirements:

   a. Cement shall be standard brand **Portland Cement** conforming to ASTM C 150 for Type II/V, including Table 2 optional requirements. A minimum of 85 percent of cement by weight shall pass a 325 screen. A single brand of cement shall be used throughout the work, and prior to its use, the brand shall be acceptable to the ENGINEER. The cement shall be suitably protected from exposure to moisture until used. Cement that has become lumpy shall not be used. Sacked cement shall be stored in such a manner so as to permit access for inspection and sampling. Certified mill test reports, including fineness, for each shipment of cement to be used shall be submitted to the ENGINEER if requested regarding compliance with these Specifications.

   b. Water for mixing and curing shall be potable, clean, and free from objectionable quantities of silty organic matter, alkali, salts and other impurities. The water shall be considered potable, for the purposes of this Section only, if it meets the

requirements of the local governmental agencies. Agricultural water with high total dissolved solids (over 1000 mg/l TDS) shall not be used.

c. Aggregates shall be obtained from pits acceptable to the ENGINEER, shall be non-reactive, and shall conform to ASTM C 33. Maximum size of coarse aggregate shall be as specified herein. Lightweight sand for fine aggregate will not be permitted.

1) Coarse aggregates shall consist of clean, hard, durable gravel, crushed gravel, crushed rock or a combination thereof. The coarse aggregates shall be prepared and handled in two or more size groups for combined aggregates with a maximum size greater than 3/4-inch. When the aggregates are proportioned for each batch of concrete the two size groups shall be combined. See the Paragraph in Part 2 entitled "Trial Batch and Laboratory Tests" for the use of the size groups.

2) Fine aggregates shall be natural sand or a combination of natural and manufactured sand that are hard and durable. When tested in accordance with ASTM D 2419, the sand equivalency shall not be less than 75 percent for an average of three samples, nor less than 70 percent for an individual test. Gradation of fine aggregate shall conform to ASTM C 33. The fineness modulus of sand used shall not be over 3.00.

3) Combined aggregates shall be well graded from coarse to fine sizes, and shall be uniformly graded between screen sizes to produce a concrete that has optimum workability and consolidation characteristics. Where a trial batch is required for a mix design, the final combined aggregate gradations will be established during the trial batch process.

4) When tested in accordance with ASTM C 33, the ratio of silica released to reduction in alkalinity shall not exceed 1.0.

5) When tested in accordance with ASTM C 33, the fine aggregate shall produce a color in the supernatant liquid no darker than the reference standard color solution.

6) When tested in accordance with ASTM C 33, the coarse aggregate shall show a loss not exceeding 42 percent after 500 revolutions, or 10.5 percent after 100 revolutions.

7) When tested in accordance with ASTM C 33, the loss resulting after five cycles shall not exceed 10 percent for fine or coarse aggregate when using sodium sulfate.

d. Ready-mix concrete shall conform to the requirements of ASTM C 94.

e. Admixtures: All admixtures shall be compatible and by a single manufacturer capable of providing qualified field service representation. Admixtures shall be used in accordance with manufacturer's recommendations. If the use of an admixture is producing an inferior end result, the CONTRACTOR shall discontinue use of the admixture. Admixtures shall not contain thiocyanates or more than 0.05 percent chloride ion, and shall be non-toxic after 30 days.

1) Air-entraining agent meeting the requirements of ASTM C 260, shall be used. Sufficient air-entraining agent shall be used to provide a total air content of 3 to 5 percent. The DISTRICT 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 content shall be tested at the point of placement. Air entraining agent shall be **MasterAir Series by Master Builders Solutions US LLC; Daravair by W.R. Grace; Sika AEA-15 by Sika Corporation;** or equal.

2) Set controlling and water reducing admixtures: Admixtures may be added at the CONTRACTOR's option to control the set, effect water reduction, and increase workability. The addition of an admixture shall be at the CONTRACTOR's expense. The use of an admixture shall be subject to acceptance by the ENGINEER. Concrete containing an admixture shall be first placed at a location determined by the ENGINEER. Admixtures specified herein shall conform to the requirements of ASTM C 494. The required quantity of cement shall be used in the mix regardless of whether or not an admixture is used.

   a) Concrete shall not contain more than one water reducing admixture. Concrete containing an admixture shall be first placed at a location determined by the ENGINEER.

   b) Set controlling admixture shall be either with or without water-reducing properties. Where the air temperature at the time of placement is expected to be consistently over 80 degrees F, a set retarding admixture such as **Plastocrete by Sika Corporation; MasterPozzolith Series by Master Builders Solutions US LLC; Daratard by W.R. Grace;** or equal shall be used. Where the air temperature at the time of placement is expected to be consistently under 40 degrees F, a non-corrosive set accelerating admixture such as **Plastocrete 161FL by Sika Corporation; MasterSet FP 20 by Master Builders Solutions US LLC; Daraset by W.R. Grace;** or equal shall be used.

   c) Normal range water reducer shall conform to ASTM C 494, Type A. **WRDA 79 by W.R. Grace; MasterPozzolith Series or MasterPolyheed Series by Master Builders Solutions US LLC; Plastocrete 161 by Sika Corporation; or equal**. The quantity of admixture used and the method of mixing shall be in accordance with the Manufacturer's instructions and recommendations.

   d) High range water reducer shall conform to ASTM C 494, Type F or G. **Daracem 100 or WDRA 19 by W.R. Grace; Sikament FF or Sikament 86 by Sika Corporation; Rheobuild 1000 or MasterGlenium Series by Master Builders Solutions US LLC; or equal.** High range water reducer shall be added to the concrete after all other ingredients have been mixed and initial slump has been verified. No more than 14 ounces of water reducer per sack of cement shall be used. Water reducer shall be

considered as part of the mixing water when calculating water cement ratio.

e) If the high range water reducer is added to the concrete at the job site, it may be used in conjunction with the same water reducer added at the batch plant. Concrete shall have a slump of 3 inches ± 1/2-inch prior to adding the high range water reducing admixture at the job site. The high range water reducing admixture shall be accurately measured and pressure injected into the mixer as a single dose by an experienced technician. A standby system shall be provided and tested prior to each day's operation of the job site system.

f) Concrete shall be mixed at mixing speed for a minimum of 30 mixer revolutions after the addition of the high range water reducer.

g) Flyash: Flyash shall conform to ASTM C618, Class F, and not exceed 20% of the total cementitious material weight used in the concrete mix design.

B. Curing Materials

1. Materials for curing concrete as specified herein shall conform to the following requirements and ASTM C 309:

   a. All curing compounds shall be white pigmented and resin based. Sodium silicate compounds shall not be allowed. Concrete curing compound shall be **Kurez by Euclid Chemical Company; MasterKure CC Series Solvent Based as manufactured by Master Builders Solutions US LLC; L&M Cure R; or equal**. Water based resin curing compounds shall be used only where local air quality regulations prohibit the use of a solvent based compound. Water based curing compounds shall be **Aqua-Cure by Euclid Chemical Company; Masterkure CC Series Water Based by Master Builders Solutions US LLC; L&M Cure R-2; or equal.**

   b. Polyethylene sheet for use as concrete curing blanket shall be white, and shall have a nominal thickness of 6 mils. The loss of moisture when determined in accordance with the requirements of ASTM C 156 shall not exceed 0.055 grams per square centimeter of surface.

   c. Polyethylene-coated waterproof paper sheeting for use as concrete curing blanket shall consist of white polyethylene sheeting free of visible defects, uniform in appearance, having a nominal thickness of 2 mils and permanently bonded to waterproof paper conforming to the requirements of Federal Specification UU-B-790A (1) (2). The loss of moisture, when determined in accordance with the requirements of ASTM C 156, shall not exceed 0.055 gram per square centimeter of surface.

   d. Polyethylene-coated burlap for use as concrete curing blanket shall be 4-mil thick, white opaque polyethylene film impregnated or extruded into one side of the burlap. Burlap shall weigh not less than 9 ounces per square yard. The loss of

moisture, when determined in accordance with the requirements of ASTM C 156, shall not exceed 0.055 grams per square centimeter of surface.

e. Curing mats for use in Curing Method 6 as specified herein, shall be heavy shag rugs or carpets or cotton mats quilted at 4 inches on center. Curing mats shall weigh a minimum of 12 ounces per square yard when dry.

f. Evaporation retardant shall be a material such as **MasterKure ER50 as manufactured by Master Builders Solutions US LLC; Eucobar as manufactured by Euclid Chemical Company; E-CON as manufactured by L & M Construction Chemicals, Inc. or equal.**

C. Non-Waterstop Joint Materials

1. Materials for non-waterstop joints in concrete shall conform to the following requirements:

a. Preformed joint filler shall be a non-extruding, resilient, bituminous type conforming to the requirements of ASTM D 1751.

b. Elastomeric joint sealer shall conform to the requirements of Section 07900 – Joint Sealers.

c. Mastic joint sealer shall be a material that does not contain evaporating solvents; that will tenaciously adhere to concrete surfaces; that will remain permanently resilient and pliable; that will not be affected by continuous presence of water and will not in any way contaminate potable water; and that will effectively seal the joints against moisture infiltration even when the joints are subject to movement due to expansion and contraction. The sealer shall be composed of special asphalts or similar materials blended with lubricating and plasticizing agents to form a tough, durable mastic substance containing no volatile oils or lubricants and shall be capable of meeting the test requirements set forth hereinafter, if testing is required by the ENGINEER.

D. Miscellaneous Materials

1. Dampproofing agent shall be an asphalt emulsion, such as **Hydrocide 600 by ChemRex Sonneborn; Damp-proofing Asphalt Coating by Euclid Chemical Company; Sealmastic by W. R. Meadows Inc., or equal.**

2. Bonding agents shall be epoxy adhesives conforming to the following products for the applications specified:

3. For bonding freshly-mixed, plastic concrete to hardened concrete, **Sikadur 32 Hi-Mod Epoxy Adhesive, as manufactured by Sika Corporation; Concresive Liquid (LPL), as manufactured by ChemRex MBT; BurkEpoxy MV as manufactured by Edoco Burke; or equal.**

4. For bonding hardened concrete or masonry to steel, **Sikadur 31 Hi-Mod Gel as manufactured by Sika Corporation; BurkEpoxy NS as manufactured by Edoco Burke; Concresive Paste (LPL) as manufactured by ChemRex MBT; or equal.**

E. Concrete Design Requirements

1. General: Concrete shall be composed of cement, admixtures, aggregates and water. These materials shall be of the qualities specified. The exact proportions in which these materials are to be used for different parts of the work will be determined during the trial batch. In general, the mix shall be designed to produce a concrete capable of being deposited so as to obtain maximum density and minimum shrinkage and, where deposited in forms, to have good consolidation properties and maximum smoothness of surface. The aggregate gradations shall be formulated to provide fresh concrete that will not promote rock pockets around reinforcing steel or embedded items. The proportions shall be changed whenever necessary or desirable to meet the required results at no additional cost to the DISTRICT. All changes shall be subject to review by the ENGINEER.

2. Fine Aggregate Composition: In mix designs for structural concrete, the percentage of fine aggregate in total aggregate by weight, shall be as indicated in the following table.

Fine Aggregate	
Fineness Modulus	**Maximum Percent**
2.7 or less	41
2.7 to 2.8	42
2.8 to 2.9	43
2.9 to 3.0	44

For other concrete, the maximum percentage of fine aggregate of total aggregate, by weight, shall not exceed 50.

3. Water-Cement Ratio and Compressive Strength: The minimum compressive strength and cement content of concrete shall be not less than that specified in the following tabulation.

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Type of Work	Min 28-Day Compressive Strength (psi)	Max Size Aggregate (in)	Minimum Cement per cu yd (lbs)	Max W/C Ratio (by weight)
Structural Concrete:				
Foundations and all other concrete items not specified elsewhere.	4,000	1	564	0.45
Other Concretes:				
Sitework concrete	3,000	1	470	0.50
Lean concrete	2,000	1	376	0.60

NOTE: The CONTRACTOR is cautioned that the limiting parameters specified above are not a mix design. Additional cement or water reducing agent may be required to achieve workability demanded by the CONTRACTOR'S construction methods and aggregates. The CONTRACTOR is responsible for any costs associated with furnishing concrete with the required workability.

4. Adjustments to Mix Design: The mixes used shall be changed whenever such change is necessary or desirable to secure the required strength, density, workability, and surface finish and the CONTRACTOR shall be entitled to no additional compensation because of such changes.

F. Consistency

1. The quantity of water entering into a batch of concrete shall be just sufficient, with a normal mixing period, to produce a concrete which can be worked properly into place without segregation, and which can be compacted by the vibratory methods herein specified to give the desired density, impermeability and smoothness of surface. The quantity of water shall be changed as necessary, with variations in the nature or moisture content of the aggregates, to maintain uniform production of a desired consistency. The consistency of the concrete in successive batches shall be determined by slump tests in accordance with ASTM C 143. The slumps shall be as follows:

Part of Work	Slump (in)
All concrete, unless note otherwise	3 inches ± 1 inch
With high range water reducer added	7 inches ± 2 inches
Pea gravel mix	7 inches ± 2 inches

Ductbanks	5 inches ± 1 inch

G. Trial Batch and Laboratory Tests

1. Before placing any concrete, a testing laboratory designated by the ENGINEER shall prepare a trial batch of each class of structural concrete, based on the preliminary concrete mixes submitted by the CONTRACTOR. During the trial batch the aggregate proportions may be adjusted by the testing laboratory using the two coarse aggregate size ranges to obtain the required properties. If one size range produces an acceptable mix, a second size range need not be used. Such adjustments shall be considered refinements to the mix design and shall not be the basis for extra compensation to the CONTRACTOR. All concrete shall conform to the requirements of this Section, whether the aggregate proportions are from the CONTRACTOR's preliminary mix design, or whether the proportions have been adjusted during the trial batch process. The trial batch shall be prepared using the aggregates, cement and admixture proposed for the project. The trial batch materials shall be of a quantity such that the testing laboratory can obtain 3 drying shrinkage, and 6 compression test specimens from each batch. Trial batch testing required shall be performed at the expense of the CONTRACTOR.

2. The determination of compressive strength will be made by testing 6-inch diameter by 12-inch high cylinders; made, cured and tested in accordance with ASTM C 192 and ASTM C 39. Three compression test cylinders will be tested at 7 days and 3 at 28 days. The average compressive strength for the 3 cylinders tested at 28 days for any given trial batch shall not be less than 125 percent of the specified compressive strength.

3. A sieve analysis of the combined aggregate for each trial batch shall be performed according to the requirements of ASTM C 136. Values shall be given for percent passing each sieve.

H. Shrinkage Limitation

1. The maximum concrete shrinkage for specimens cast in the laboratory from the trial batch, as measured at 21-day drying age or at 28-day drying age shall be 0.036 percent or 0.042 percent, respectively. The CONTRACTOR shall only use a mix design for construction that has first met the trial batch shrinkage requirements. Shrinkage limitations apply only to structural concrete to be used in water-containing structures.

2. The maximum concrete shrinkage for specimens cast in the field shall not exceed the trial batch maximum shrinkage requirement by more than 25 percent.

3. If the required shrinkage limitation is not met during construction, the CONTRACTOR shall take any or all of the following actions, at no additional cost to the DISTRICT, for securing the specified shrinkage requirements. These actions may include changing the source of aggregates, cement and/or admixtures; reducing water content; washing of aggregate to reduce fines; increasing the number of construction joints; modifying the curing requirements; or other actions designed to minimize shrinkage or the effects of shrinkage.

I. Measurement of Cement and Aggregate

1. 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.

2. Weighing tolerances:

Material	Percent of Total Weight
Cement	1
Aggregates	3
Admixtures	3

J. Measurement of Water

1. The quantity of water entering the mixer shall be measured by a suitable water meter or other measuring device of a type acceptable to the ENGINEER and capable of measuring the water in variable amounts within a tolerance of one percent. The water feed control mechanism shall be capable of being locked in position so as to deliver constantly any specified amount of water to each batch of concrete. A positive quick-acting valve shall be used for a cut-off in the water line to the mixer. The operating mechanism must be such that leakage will not occur when the valves are closed.

K. Ready -Mixed Concrete

1. At the CONTRACTOR'S option, ready-mixed concrete may be used meeting the requirements as to materials, batching, mixing, transporting, and placing as specified herein and in accordance with ASTM C 94, including the following supplementary requirements.

2. Ready-mixed concrete shall be delivered to the site of 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.

3. Truck mixers shall be equipped with electrically-actuated counters by which the number of revolutions of the drum or blades may be readily verified. The counter shall be of the resettable, recording type, and shall be mounted in the driver's cab. The counters shall be actuated at the time of starting mixers at mixing speeds.

4. 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. All materials including mixing water shall be in the mixer drum before actuating the revolution counter for determining the number of revolution of mixing.

5. Truck mixers and their operation shall be such that the concrete throughout the mixed batch as discharged is within acceptable limits of uniformity with respect to consistency, mix, and grading. If slump tests taken at approximately the 1/4 and 3/4 points of the load during discharge give slumps differing by more than one inch when the specified slump is 3 inches or less, or if they differ by more than 2 inches when the specified slump is more than 3 inches, the mixer shall not be used on the work unless the causing condition

is corrected and satisfactory performance is verified by additional slump tests. All mechanical details of the mixer, such as water measuring and discharge apparatus, condition of the blades, speed of rotation, general mechanical condition of the unit, and clearance of the drum, shall be checked before a further attempt to use the unit will be permitted.

6. Each batch of ready-mixed concrete delivered at the job site shall be accompanied by a delivery ticket furnished to the ENGINEER in accordance with the Paragraph in Part 1 entitled "Delivery Tickets."

7. 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

A. Proportioning and Mixing

1. Proportioning: Proportioning of the concrete mix shall conform to the requirements of Section 4.2.3 - "Proportioning" of ACI 301.

2. Mixing: Mixing of concrete shall conform to the requirements of Section 4.3.1 of said ACI 301 Specifications.

3. Slump: Maximum slumps shall be as specified herein.

4. Retempering: Retempering of concrete or mortar which has partially hardened shall not be permitted.

B. Preparation of Surfaces for Concreting

1. General: Earth surfaces shall be thoroughly wetted by sprinkling, prior to the placing of any concrete, and these surfaces shall be kept moist by frequent sprinkling up to the time of placing concrete thereon. The surface shall be free from standing water, mud, and debris at the time of placing concrete.

2. Joints in Concrete: Concrete surfaces upon or against which concrete is to be placed, where the placement of the concrete has been stopped or interrupted so that, as determined by the ENGINEER, the new concrete cannot be incorporated integrally with that previously placed, are defined as construction joints. The surfaces of horizontal joints shall be given a compacted, roughened surface for good bond. Except where the Drawings call for joint surfaces to be coated, the joint surfaces shall be cleaned of all laitance, loose or defective concrete, foreign material, and roughened to a minimum 1/4-inch amplitude. Such cleaning and roughening shall be accomplished by hydroblasting or sandblasting (exposing aggregate) followed by thorough washing. All pools of water shall be removed from the surface of construction joints before the new concrete is placed.

3. After the surfaces have been prepared all approximately horizontal construction joints shall be covered with a 6-inch lift of a rich pea gravel mix, as specified hereinbefore. The

mix shall be placed and spread uniformly. Wall concrete shall follow immediately and shall be placed upon the fresh pea gravel mix.

4. 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.

5. Embedded Items: No concrete shall be placed until all formwork, installation of parts to be embedded, reinforcement steel, and preparation of surfaces involved in the placing have been completed and accepted by the ENGINEER at least 4 hours before placement of concrete. All surfaces of forms and embedded items that have become encrusted with dried grout from concrete previously placed shall be cleaned of all such grout before the surrounding or adjacent concrete is placed.

6. All inserts or other embedded items shall conform to the requirements herein.

7. All reinforcement, anchor bolts, sleeves, inserts, and similar items shall be set and secured in the forms where shown 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.

8. Casting New Concrete Against Old: Where concrete is to be cast against old concrete (any concrete which is greater than 60 days of age), the surface of the old concrete shall be thoroughly cleaned and roughened by hydro-blasting or sandblasting (exposing aggregate). The joint surface shall be coated with an epoxy bonding agent unless indicated otherwise by the ENGINEER.

9. No concrete shall be placed in any structure until all water entering the space to be filled with concrete has been properly cut off or has been diverted by pipes, or other means, and carried out of the forms, clear of the work. No concrete shall be deposited underwater nor shall the CONTRACTOR allow still water to rise on any concrete until the concrete has attained its initial set. Water shall not be permitted to flow over the surface of any concrete in such manner and at such velocity as will injure the surface finish of the concrete. Pumping or other necessary dewatering operations for removing ground water, if required, will be subject to the review of the ENGINEER.

10. Corrosion Protection: Pipe, conduit, dowels, and other ferrous items required to be embedded in concrete construction shall be so positioned and supported prior to placement of concrete that there will be a minimum of 2 inches clearance between said items and any part of the concrete reinforcement. Securing such items in position by wiring or welding them to the reinforcement will not be permitted.

11. Openings for pipes, inserts for pipe hangers and brackets, and the setting of anchors shall, where practicable, be provided for during the placing of concrete.

12. Anchor bolts shall be accurately set and shall be maintained in position by templates while being embedded in concrete.

13. Cleaning: The surfaces of all metalwork to be in contact with concrete shall be thoroughly cleaned of all dirt, grease, loose scale and rust, grout, mortar, and other foreign substances immediately before the concrete is placed.

C. Handling, Transporting and Placing

1. General: Placing of concrete shall conform to the applicable requirements of Chapter 5 of ACI 301 and the requirements of this Section. No aluminum materials shall be used in conveying any concrete.

2. Non-Conforming Work or Materials: Concrete which upon or before placing is found not to conform to the requirements specified 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 by and at the expense of the CONTRACTOR.

3. Unauthorized Placement: No concrete shall be placed except in the presence of duly authorized representative of the ENGINEER. The CONTRACTOR shall notify the

4. Casting New Concrete Against Old: An epoxy adhesive bonding agent shall be applied to the old surfaces according to the manufacturer's written recommendations.

5. Conveyor Belts and Chutes: All ends of chutes, hopper gates, and all 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 specified 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. All conveyor belts and chutes shall be covered.

6. Placement in Slabs: Concrete placed in sloping slabs shall proceed uniformly from the bottom of the slab to the top, for the full width of the placement. As the work progresses, the concrete shall be vibrated and carefully worked around the slab reinforcement, and the surface of the slab shall be screeded in an up-slope direction.

7. Temperature of Concrete: The temperature of concrete when it is being placed shall be not more than 90 degrees F nor less than 55 degrees F for sections less than 12 inches thick nor less than 50 degrees for all other sections. Concrete ingredients shall not be heated to a temperature higher than that necessary to keep the temperature of the mixed concrete, as placed, from falling below the specified minimum temperature. When the temperature of the concrete is 85 degrees F or above, the time between the introduction of the cement to the aggregates and discharge shall not exceed 45 minutes. If concrete is placed when the weather is such that the temperature of the concrete would exceed 90 degrees F, the CONTRACTOR shall employ effective means, such as precooling of aggregates and mixing water using ice or placing at night, as necessary to maintain the temperature of the concrete, as it is placed, below 90 degrees F. The CONTRACTOR shall be entitled to no additional compensation on account of the foregoing requirements.

8. Cold Weather Placement:

    a. Placement of concrete shall conform to ACI 306.1 - Standard Specification for Cold Weather Concreting, and the following.

    b. Remove all snow, ice and frost from the surfaces, including reinforcement, against which concrete is to be placed. Before beginning concrete placement,

thaw the subgrade to a minimum depth of 6 inches. All reinforcement and embedded items shall be warmed to above 32 degrees F prior to concrete placement.

c. Maintain the concrete temperature above 50 degrees F for at least 3 days after placement.

D. Pumping of Concrete

1. General: If the pumped concrete does not produce satisfactory end results, the CONTRACTOR shall discontinue the pumping operation and proceed with the placing of concrete using conventional methods.

2. Pumping Equipment: The pumping equipment must 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.

3. The minimum diameter of the hose (conduits) shall be in accordance with ACI 304.2R.

4. Pumping equipment and hoses (conduits) that are not functioning properly, shall be replaced.

5. Aluminum conduits for conveying the concrete shall not be permitted.

6. Field Control: Concrete samples for slump, air content, and test cylinders will be taken at the placement (discharge) end of the line.

E. Order of Placing Concrete

1. The order of placing concrete in all parts of the work shall be acceptable to the ENGINEER. In order to minimize the effects of shrinkage, the concrete shall be placed in units as bounded by construction joints shown. The placing of units shall be done by placing alternate units in a manner such that each unit placed shall have cured at least 5 days for hydraulic structures and 2 days for all other structures before the contiguous unit or units are placed, except that the corner sections of vertical walls shall not be placed until the 2 adjacent wall panels have cured at least 10 days for hydraulic structures and 4 days for all other structures.

2. The surface of the concrete shall be level whenever a run of concrete is stopped. To insure a level, straight joint on the exposed surface of walls, a wood strip at least 3/4-inch thick shall be tacked to the forms on these surfaces. The concrete shall be carried about 1/2-inch above the underside of the strip. About one hour after the concrete is placed, the strip shall be removed and any irregularities in the edge formed by the strip shall be leveled with a trowel and all laitance shall be removed.

F. Tamping and Vibrating

1. As concrete is placed in the forms or in excavations, it shall be thoroughly settled and compacted, throughout the entire depth of the layer which is being consolidated, into a dense, homogeneous mass, filling all corners and angles, thoroughly embedding the reinforcement, eliminating rock pockets, and bringing only a slight excess of water to the exposed surface of concrete during placement. Vibrators shall be Group 3 (per ACI 309) high speed power vibrators (8000 to 12,000 rpm) of an immersion type in sufficient

number and with (at least one) standby units as required. Group 2 vibrators may be used only at specific locations when accepted by the ENGINEER.

G. Finishing Concrete Surfaces

1. 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 shown are defined as tolerances and are specified in Part 1, herein. These tolerances are to be distinguished from irregularities in finish as described herein. Aluminum finishing tools shall not be used.

2. Formed Surfaces: No treatment is required after form removal except for curing, repair of defective concrete, and treatment of surface defects. Where architectural finish is required, it shall be as specified or as shown.

3. Unformed Surfaces: After proper and adequate vibration and tamping, all unformed top surfaces of slabs, floors, walls, and curbs shall be brought to a uniform surface with suitable tools. Immediately after the concrete has been screeded, it shall be treated with a liquid evaporation retardant. The retardant shall be used again after each work operation as necessary to prevent drying shrinkage cracks. The classes of finish specified for unformed concrete surfaces are designated and defined as follows:

   a. Finish U2 - After sufficient stiffening of the screeded concrete, surfaces shall be float finished with wood or metal floats or with a finishing machine using float blades. Excessive floating of surfaces while the concrete is plastic and dusting of dry cement and sand on the concrete surface to absorb excess moisture will not be permitted. Floating shall be the minimum necessary to produce a surface that is free from screed marks and is uniform in texture. Surface irregularities shall not exceed 1/4-inch. Joints and edges shall be tooled where shown or as determined by the ENGINEER.

   b. Finish U3 - After the floated surface (as specified for Finish U2) has hardened sufficiently to prevent excess of fine material from being drawn to the surface, steel troweling shall be performed with firm pressure such as will flatten the sandy texture of the floated surface and produce a dense, uniform surface free from blemishes, ripples, and trowel marks. The finish shall be smooth and free of all irregularities.

   c. Finish U4 - Steel trowel finish (as specified for Finish U3) without local depressions or high points. In addition, the surface shall be given a light hairbroom finish with brooming perpendicular to drainage unless otherwise shown. The resulting surface shall be rough enough to provide a nonskid finish.

4. Unformed surfaces shall be finished according to the following schedule:

UNFORMED SURFACE FINISH SCHEDULE

Area	Finish
Grade slabs and foundations to be covered with concrete or fill material	U1
Floors to be covered with grouted tile or topping grout	U2

Slabs which are water bearing with slopes 10 percent and less	U3
Sloping slabs which are water bearing with slopes greater than 10 percent	U4
Slabs not water bearing	U4
Slabs to be covered with built-up roofing	U2
Interior slabs and floors to receive architectural finish	U3
Top surface of walls	U3

5. Floor Sealer/Hardener (Surface Applied):

   a. Floors to receive hardener shall be cured, cleaned, and dry with all work above them completed. Not less than 60 days shall have elapsed between casting floors and application of sealer/hardener. Apply zinc and/or magnesium fluosilicate evenly, using 3 coats, allowing 24 hours between coats.

   b. The first coat shall be 1/3 strength, second coat 1/2 strength, and third coat 2/3 strength. Each coat shall be applied so as to remain wet on the concrete surface for 15 minutes. If sodium silicate is used, it shall be applied evenly, using 3 coats, allowing 24 hours between coats, and the material shall be applied full strength at the rate of one gallon per 300 square feet. Approved proprietary hardeners shall be applied in conformance with the manufacturer's instruction. After the final coat is completed and dry, surplus hardener shall be removed from the surface by scrubbing and mopping with water.

   c. Floor hardener shall be applied where shown.

H. Curing and Dampproofing

1. General: All concrete shall be cured for not less than 7 days after placing, in accordance with the methods specified herein for the different parts of the work, and described in detail in the following paragraphs:

Surface to be Cured or Dampproofed	Method
Unstripped forms	1
Wall sections with forms removed	6
Construction joints between footings and walls, and between floor slab	2
Encasement concrete and thrust blocks	3
All concrete surfaces not specifically provided for elsewhere in this Paragraph	4
Floor slabs on grade in hydraulic structures	5
Slabs not on grade	6

2. Method 1: Wooden forms shall be wetted immediately after concrete has been placed and shall be kept wet with water until removed. If steel forms are used the exposed concrete surfaces shall be kept continuously wet until the forms are removed. If forms are removed within 7 days of placing the concrete, curing shall be continued in accordance with Method 6, herein.

3. Method 2: The surface shall be covered with burlap mats which shall be kept wet with water for the duration of the curing period, until the concrete in the walls has been placed. No curing compound shall be applied to surfaces cured under Method 2.

4. Method 3: The surface shall be covered with moist earth not less than 4 hours, nor more than 24 hours, after the concrete is placed. Earthwork operations that may damage the concrete shall not begin until at least 7 days after placement of concrete.

5. Method 4: The surface shall be sprayed with a liquid curing compound.

    a. It shall be applied in accordance with the manufacturer's printed instructions at a maximum coverage rate of 200 square feet per gallon and in such a manner as to cover the surface with a uniform film which will seal thoroughly.

    b. Where the curing compound method is used, care shall be exercised to avoid damage to the seal during the 7-day curing period. Should the seal be damaged or broken before the expiration of the curing period, the break shall be repaired immediately by the application of additional curing compound over the damaged portion.

    c. Curing compound shall not be applied to surface that will subsequently receive additional concrete. Wherever curing compound may have been applied by mistake to surfaces against which concrete subsequently is to be placed and to which it is to adhere, said compound shall be entirely removed by wet sandblasting just prior to the placing of new concrete.

    d. Where curing compound is specified, it shall be applied as soon as the concrete has hardened enough to prevent marring on unformed surfaces, and within 2 hours after removal of forms from contact with formed surfaces. Repairs required to be made to formed surfaces shall be made within the said 2-hour period; provided, however, that any such repairs which cannot be made within the said 2-hour period shall be delayed until after the curing compound has been applied. When repairs are to be made to an area on which curing compound has been applied, the area involved shall first be wet-sandblasted to remove the curing compound, following which repairs shall be made as specified herein.

    e. At all locations where concrete is placed adjacent to a panel which has been coated with curing compound, the previously coated panel shall have curing compound reapplied to an area within 6 feet of the joint and to any other location where the curing membrane has been disturbed.

    f. Prior to final acceptance of the WORK, all visible traces of curing compound shall be removed from all surfaces in such a manner that does not damage surface finish.

6. Method 5:

a. Until the concrete surface is covered with curing compound, the entire surface shall be kept damp by applying water using nozzles that atomize the flow so that the surface is not marred or washed. The concrete shall be given a coat of curing compound in accordance with Method 4, herein. Not less than one hour nor more than 4 hours after the coat of curing compound has been applied, the surface shall be wetted with water delivered through a fog nozzle, and concrete-curing blankets shall be placed on the slabs. The curing blankets shall be polyethylene sheet, polyethylene-coated waterproof paper sheeting or polyethylene-coated burlap. The blankets shall be laid with the edges butted together and with the joints between strips sealed with 2-inch wide strips of sealing tape or with edges lapped not less than 3 inches and fastened together with a waterproof cement to form a continuous watertight joint.

b. The curing blankets shall be left in place during the 7-day curing period and shall not be removed until after concrete for adjacent work has been placed. Should the curing blankets become torn or otherwise ineffective, the CONTRACTOR shall replace damaged sections. During the first 3 days of the curing period, no traffic of any nature and no depositing, temporary or otherwise, of any materials shall be permitted on the curing blankets. During the remainder of the curing period, foot traffic and temporary depositing of materials that impose light pressure will be permitted only on top of plywood sheets 5/8-inch minimum thickness, laid over the curing blanket. The CONTRACTOR shall add water under the curing blanket as often as necessary to maintain damp concrete surfaces at all times.

7. Method 6: This method applies to both walls and slabs.

a. The concrete shall be kept continuously wet by the application of water for a minimum period of at least 7 consecutive days beginning immediately after the concrete has reached final set or forms have been removed.

b. Until the concrete surface is covered with the curing medium, the entire surface shall be kept damp by applying water using nozzles that atomize the flow so that the surface is not marred or washed.

c. Heavy curing mats shall be used as a curing medium to retain the moisture during the curing period. The curing medium shall be weighted or otherwise held in place to prevent being dislodged by wind or any other causes and to be substantially in contact with the concrete surface. All edges shall be continuously held in place.

d. The curing blankets and concrete shall be kept continuously wet by the use of sprinklers or other means both during and after normal working hours.

e. Immediately after the application of water has terminated at the end of the curing period, the curing medium shall be removed, any dry spots shall be rewetted, and curing compound shall be immediately applied in accordance with Method 4, herein.

f. The CONTRACTOR shall dispose of excess water from the curing operation to avoid damage to the work.

8. Dampproofing:

a. The exterior surface of all buried roof slabs shall be dampproofed as follows.

b. Immediately after completion of curing the surface shall be sprayed with a dampproofing agent consisting of an asphalt emulsion. Application shall be in 2 coats. The first coat shall be diluted to 1/2 strength by the addition of water and shall be sprayed on so as to provide a maximum coverage rate of 100 square feet per gallon of dilute solution. The second coat shall consist of an application of the specified material, undiluted, and shall be sprayed on so as to provide a maximum coverage rate of 100 square feet per gallon. Dampproofing material shall be as specified herein.

c. As soon as the asphalt emulsion, applied as specified herein, has taken an initial set, the entire area thus coated shall be coated with whitewash. Any formula for mixing the whitewash may be used which produces a uniformly coated white surface and which so remains until placing of the backfill. Should the whitewash fail to remain on the surface until the backfill is placed, the CONTRACTOR shall apply additional whitewash.

I. Protection

1. The CONTRACTOR shall protect all concrete against injury until final acceptance by the DISTRICT.

2. Fresh concrete shall be protected from damage due to rain, hail, sleet, or snow. The CONTRACTOR shall provide such protection while the concrete is still plastic and whenever such precipitation is imminent or occurring.

J. Curing in Cold Water

1. Water curing of concrete may be reduced to 6 days during periods when the mean daily temperature in the vicinity of the worksite is less than 40 degrees F; provided that, during the prescribed period of water curing, when temperatures are such that concrete surfaces may freeze, water curing shall be temporarily discontinued.

2. Concrete cured by an application of curing compound will require no additional protection from freezing if the protection at 50 degrees F for 72 hours is obtained by means of approved insulation in contact with the forms or concrete surfaces; otherwise the concrete shall be protected against freezing temperatures for 72 hours immediately following 72 hours protection at 50 degrees F. Concrete cured by water curing shall be protected against freezing temperatures for 3 days immediately following the 72 hours of protection at 50 degrees F.

3. Discontinuance of protection against freezing temperatures shall be such that the drop in temperature of any portion of the concrete will be gradual and will not exceed 40 degrees F in 24 hours. In the spring, when the mean daily temperature rises above 40 degrees F for more than 3 successive days, the specified 72-hour protection at a temperature not lower than 50 degrees F may be discontinued for as long as the mean daily temperature remains above 40 degrees F; provided, that the concrete shall be protected against freezing temperatures for not less than 48 hours after placement.

4. Where artificial heat is employed, special care shall be taken to prevent the concrete from drying. Use of unvented heaters will be permitted only when unformed surfaces of concrete adjacent to the heaters are protected for the first 24 hours from an excessive

carbon dioxide atmosphere by application of curing compound; provided, that the use of curing compound for such surfaces is otherwise permitted by these Specifications.

K. Treatment of Surface Defects

1. As soon as forms are removed, all exposed surfaces shall be carefully examined and any irregularities shall be immediately rubbed or ground in a satisfactory manner in order to secure a smooth, uniform, and continuous surface. Plastering or coating of surfaces to be smoothed will not be permitted. No repairs shall be made until after inspection by the ENGINEER. In no case will extensive patching of honeycombed concrete be permitted. Concrete containing minor voids, holes, honeycombing, or similar depression defects shall have them repaired as specified herein. Concrete containing extensive voids, holes, honeycombing, or similar depression defects, shall be completely removed and replaced. All repairs and replacements herein specified shall be promptly executed by the CONTRACTOR at its own expense.

2. Defective surfaces to be repaired shall be cut back from trueline a minimum depth of 1/2-inch over the entire area. Feathered edges will not be permitted. Where chipping or cutting tools are not required in order to deepen the area properly, the surface shall be prepared for bonding by the removal of all laitance or soft material, and not less than 1/32-inch depth of the surface film from all hard portions, by means of an efficient sandblast. After cutting and sandblasting, the surface shall be wetted sufficiently in advance of shooting with shotcrete or with cement mortar so that while the repair material is being applied, the surfaces under repair will remain moist, but not so wet as to overcome the suction upon which a good bond depends. The material used for repair proposed shall consist of a mixture of one sack of cement to 3 cubic feet of sand. For exposed walls, the cement shall contain such a proportion of Atlas white portland cement as is required to make the color of the patch match the color of the surrounding concrete.

3. Holes left by tie-rod cones shall be reamed with suitable toothed reamers so as to leave the surfaces of the holes clean and rough. These holes then shall be repaired in an approved manner with dry-packed cement grout. Holes left by form-tying devices having a rectangular cross-section, and other imperfections having a depth greater than their least surface dimension, shall not be reamed but shall be repaired in an approved manner with dry-packed cement grout.

4. All repairs shall be built up and shaped in such a manner that the completed work will conform to the requirements of this Section, as applicable, using approved methods which will not disturb the bond, cause sagging, or cause horizontal fractures. Surfaces of said repairs shall receive the same kind and amount of curing treatment as required for the concrete in the repaired section.

5. Prior to filling any structure with water, all cracks that may have developed shall be "vee'd" as shown and filled with sealant conforming to the requirements of Section 03251 - Joints in Concrete. This repair method shall be done on the water bearing face of members. Prior to backfilling, faces of members in contact with fill, which are not covered with a waterproofing membrane, shall also have cracks repaired as specified herein.

L. Patching Holes in Concrete

1. Patching Small Holes:

a. Holes which are less than 12 inches in their least dimension and extend completely through concrete members, shall be filled as specified herein.

b. Small holes in members which are water-bearing or in contact with soil or other fill material, shall be filled with non-shrink grout. Where a face of the member is exposed to view, the non-shrink grout shall be held back 2 inches from the finished surface. The remaining 2 inches shall then be patched according to the Paragraph in Part 3 entitled "Treatment of Surface Defects."

c. Small holes through all other concrete members shall be filled with non-shrink grout, with exposed faces treated as above.

2. Patching Large Holes:

a. Holes which are larger than 12 inches in their least dimension, shall have a keyway chipped into the edge of the opening all around, unless a formed keyway exists. The holes shall then be filled with concrete as specified herein.

b. Holes which are larger than 24 inches in their least dimension and which do not have reinforcing steel extending from the existing concrete, shall have reinforcing steel set in grout in drilled holes. The reinforcing added shall match the reinforcing in the existing wall unless shown.

3.14 Care and Repair of Concrete

The CONTRACTOR shall protect all concrete against injury or damage from excessive heat, lack of moisture, overstress, or any other cause until final acceptance by the DISTRICT. 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.

END OF SECTION

SECTION 03400

PRECAST CONCRETE

PART 1 GENERAL

A. The Requirement

1. The CONTRACTOR shall furnish all tools, equipment, materials, and supplies and shall perform all labor required to complete the precast concrete work in accordance with the Contract Documents.

2. This Section covers the design, fabrication, delivery and installation of all precast concrete units, including connections, complete, in place, as shown and specified.

B. Codes and Standards

1. Codes: All codes, as referenced herein.

2. Commercial Standards:

ANSI/ACI 315	Concrete Reinforcement
ANSI/ACI 318	Concrete Construction
ANSI/AWS A5.4	Welding Rods and Electrodes
AWS B2.1	
ANSI/AWS D1.1	Welding and Cutting
ANSI/AWS D1.4	Welding and Cutting
AWS D12.1	
ASTM A184	Specification for Fabricated Deformed Steel Bar Mats for Concrete Reinforcement
ASTM A185	Specification for Steel Welded Wire, Fabric, Plain, for Concrete Reinforcement
ASTM A193	Specification for Alloy-Steel and Stainless Steel Bolting Materials for High-Temperature Service
ASTM A194	Specification for Carbon and Alloy Steel Nuts for Bolts for High-Pressure and High-Temperature Service
ASTM A351	Specification for Steel Castings, Austenitic, for High-Temperature Service
ASTM A497	Specification for Welded Deformed Steel Wire Fabric for Concrete Reinforcement
ASTM A580	Specification for Stainless and Heat-Resisting Steel Wire
ASTM A615	Specification for Deformed and Plain Billet-Steel Bars for Concrete Reinforcement
ASTM A666	Specification for Austenitic Stainless Steel, Sheet, Strip, Plate, and Flat Bar for Structural Applications
ASTM A775	Specifications for Epoxy-Coated Reinforcing Steel Bars
ASTM C33	Specification for Concrete Aggregates
ASTM C67	Method for Sampling and Testing Brick and Structural Clay Tile
ASTM C127	Test Method for Specific Gravity and Absorption of Coarse Aggregate
ASTM C128	Test Method for Specific Gravity and Absorption of Fine Aggregate

ASTM C150	Specification for Portland Cement
ASTM C173	Test Method for Air Content of Freshly Mixed Concrete by the Volumetric Method
ASTM C204	Test Method for Fineness of Portland Cement by Air Permeability Apparatus
ASTM C231	Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method
ASTM C260	Specification for Air-Entraining Admixtures for Concrete
ASTM C311	Method for Sampling and Testing Fly Ash or Natural Pozzolans for Use as a Mineral Admixture in Portland Cement Concrete
ASTM C494	Test Method for Shear Fatigue of Sandwich Core Materials
ASTM D2240	Test Method for Rubber Property -- Durometer Hardness
PCI MNL-116	
PCI MNL-117	
PCI MNL-121	

C. Contractor Submittals

1. Submittals shall be made in accordance with Section 01300, "Contractor Submittals."

2. Shop Drawings:

   a. Shop drawings shall show details in accordance with ACI 315 and ACI 318 including installation details and design computations.

   b. Shop drawings, including design computations, shall be stamped and signed by a structural engineer registered in the State and shall be approved by the ENGINEER.

   c. Shop drawings shall indicate precast unit identification marks, location of units in the WORK, elevations, fabrication details, welding details, reinforcement, connections, dimensions, interface with adjacent members, and special handling instructions in sufficient detail to cover manufacture, handling, and erection. Shop drawings shall include erection drawings.

   d. Shop drawings shall be divided into complete separate submittals for each structure. Each complete submittal shall consist of a panel schedule and shop drawings.

      1) Panel Schedule: Showing all exterior elevations of the building, including all precast concrete enclosure faces exposed to view, in its associated shop drawing submittal. Elevations at a minimum scale of 1/8" = 1'0" shall be drawn, identifying the type and location of each panel by a number which corresponds to the panel number appearing on an associated shop drawing; this same number shall be permanently marked on the back of each panel as they are fabricated.

      2) Shop Drawings: Showing all elevations, dimensions, horizontal and vertical sections, openings, inserts, reinforcing, anchorage devices, details, design computations, and other requirements for each different type of panel to be incorporated into the portion of the project covered by the submittal. Drawings shall be 24 inches x 36 inches maximum.

3. Small Samples:

   a. Two 72-inch by 72-inch samples of precast concrete unit finish shall be submitted, as required for the project. Each sample shall show matrix color, surface color, surface texture, and panel back finish.

   b. The face of each sample shall contain at least two areas of approved size and shape which have been chipped out and then patched and repaired and one form joint; the color, texture and appearance of patched areas and form joint shall match that of adjacent surface.

   c. Samples will be inspected for color and texture match to the samples selected by the ENGINEER, uniformity of color and texture throughout the panel and acceptability of patching and joint treatment. Exposed face of samples shall be tested for efflorescence in accordance with ASTM C 67; rating shall not be more than "slightly effloresced."

   d. If the ENGINEER rules a sample, or samples, to be unacceptable, the CONTRACTOR shall fabricate and resubmit additional samples at no additional cost to the DISTRICT.

   e. When approved, one sample will be kept at the ENGINEER's field office and the other shall be picked up by the CONTRACTOR and returned to the manufacturing plant. These sample panels will be used as a comparison to judge acceptability of the full-size panel samples and, where necessary, the production precast units.

4. Full-Size Panel Samples at Manufacturing Plant:

   a. After the small samples and shop drawings have been approved, and prior to fabricating panels for the project, a full-size panel of specified color and each finish shall be produced and erected at the manufacturing plant for inspection and approval by the ENGINEER.

   b. The full-size panels shall be fabricated utilizing tools, forms, materials and techniques proposed and the dimensions, profile cross section, color and texture required for the project. Panels will be inspected for color and texture to match approved samples, uniformity of color and texture throughout the panel, accuracy and sharpness of shape, acceptability of patched and repaired areas, and form joint treatment.

   c. If the ENGINEER rules a sample to be unacceptable, the CONTRACTOR shall fabricate additional revised panel(s) at no additional cost to the DISTRICT. When approved, panels shall be preserved, remain at the plant, and become the job standard against which all panels will be compared as they come off the production line.

5. Full-Size Panel Samples at Project Site: From the first loads of acceptable panels for the Project, the ENGINEER will select one panel of each texture which is scheduled to be erected in a prominent location. If the ENGINEER chooses, panels may be selected from a later load. The selected panel(s) together with the 72-inch by 72-inch panel kept at the ENGINEER's field office, will become the jobsite standard against which all panels will be compared.

6. Mix Proportions: Prior to commencing operations, including fabrications of the precast for any mock-up, a statement shall be submitted giving the nominal maximum aggregate size and proportions of all ingredients that will be used in the manufacture of concrete. The statement shall include test results from an approved testing laboratory, certifying that the proportions selected will produce concrete of the properties required. No substitutions shall be made in materials used in the concrete mix without approval and additional tests to verify that the concrete properties are satisfactory. A copy shall be submitted of concrete mix with each set of samples.

7. Test Reports: Tests for compressive strength of concrete shall be performed by an independent commercial testing laboratory. Copies of test reports including all test data and all test results shall be submitted.

8. Certificates of Compliance: Certificates of compliance shall be submitted attesting that materials and products meet or exceed specified requirements.

9. Manufacturer's Qualifications: Prior to commencing operations, a statement shall be submitted giving the qualifications of the precast concrete Manufacturer, and evidence that the Manufacturer and plant are PCI certified.

D. Quality Assurance

1. General Requirements: Design members under direct supervision of a professional structural engineer experienced in design of precast concrete units, registered in the State and conforming to requirements of PCI MNL-121 and to ACI 318.

   a. Precast Manufacturer and erectors shall be qualified in accordance with PCI MNL-117 and MNL-116.

   b. Welding shall be in accordance with AWS D1.1, AWS D12.1, AWS B2.1, and AWS A5.4.

   c. Manufacture, Transportation and Installation: The Manufacturer shall specialize in providing architectural precast products and services normally associated with precast concrete construction with high quality architectural finishes similar to that indicated on drawings, using procedures complying with PCI MNL-116 and MNL-117, and PCI plant certified for at least 2 years.

2. Sample:

   a. Prebid samples representing the color, surface, texture and panel back finish specified and required for this project can be viewed at the ENGINEER's office, by bidders and precast concrete Manufacturers prior to submitting bids.

   b. It shall be the CONTRACTOR's responsibility to assure that all precast architectural concrete conforms to specified requirements for quality and appearance. The only appearance criterion is that all precast architectural finishes provided for this project conform in appearance, when viewed from a distance of 20 feet, to the design, color, and texture as represented by the prebid sample except that closeup inspection shall not exhibit any evidence of "bugholes" on exposed surfaces exceeding 1/8-inch and in quantity not more than 2 average per square foot.

3. Sample Construction:

   a. A typical precast concrete combination sectioned wall and related perimeter window assembly shall be constructed and provided by the CONTRACTOR. This sample construction, after approval, shall serve for comparison as a sample of construction requirements for the rest of the building.

   b. The precast concrete units shall structurally support the window assemblies and include anchorage inserts for windows as indicated. Use of drilled-in anchorage inserts for window supports and anchorage of other items is prohibited. Sample construction shall be sealed and finished as required for completed wall.

   c. The sample construction shall demonstrate precast concrete units and window framing, sealants, anchorage, and other elements of construction. The sample construction will be inspected and judged for compliance with requirements and visual appearance including, but not limited to, uniformity of color and texture, acceptability of patching and repair, and conformance to required tolerances. If the sample does not provide an acceptable window assembly or meet visual appearance or tolerance requirements as determined by the ENGINEER, the CONTRACTOR shall modify, repair, or reconstruct the sample at no additional cost.

E. Design Requirements

1. General: The precast concrete panel and connection designs shown represent minimum precast construction requirements. The Manufacturer shall verify the panel and connection designs for all handling, erection, and service conditions, and shall provide any additional materials necessary to meet the design conditions.

2. Standards and Loads: The precast panel and connection design and construction shall conform to all applicable codes and AISC Specification for the Design, Fabrication and Erection of Structural Steel for Buildings. The precast or prefabricated, nonbearing, nonshear wall panels and connections which are attached to or enclose the exterior, shall resist, in addition to initial handling and erection loads and dead loads, the following forces:

   a. Wind pressure and load combinations relative to panel design in accordance with CBC 2022, Exposure B, 102 mph]

   b. Seismic loads relative to panel design (Fp = (SDS x I / R) x Wp) are as follows: I=1.25

   c. The design shall be based on a differential temperature of 50 degrees F between interior and exterior faces of the units and an 80 degrees (+40 degrees from erected temperature) average panel temperature differential.

   d. Stresses due to restrained volume changes caused by shrinkage and temperature differentials shall be accounted for.

3. Connections: Prior to submitting shop drawings, the CONTRACTOR shall verify the precast connection designs shown against the aforementioned and following design criteria and provide any additional materials necessary to meet the design conditions.

a. The panel joints shall be designed to accommodate an in-plane movement between stories of 0.005 times the story height in inches but not less than 3/4-inch.

b. Panel connections shall accommodate building movement and permit panels to move freely so as not to resist in plane deformation of the main frame structural system. Adjustment shall be provided to accommodate misalignment of structure without permanent distortion, damage to components, racking of joint connection, breakage of seals, or moisture penetration.

4. Concrete Mix: The concrete mix shall be designed by the Manufacturer and approved by the ENGINEER, using the materials and quantities specified to meet all of the requirements of this specification.

a. Proportioning of Concrete Mixes: Mixes shall be proportioned by weight except water and admixtures may be batched by volume if desired. Trial mixes and testing to meet requirements of the strengths of concrete specified is the CONTRACTOR's responsibility. Design mix shall contain similar materials as those proposed for use in the WORK.

b. Admixtures: Concrete shall contain an air entraining admixture in proportion so as to provide 4 percent plus or minus 1 percent total air in the concrete as determined by ASTM C 173 or C 231. Set retarding admixtures may be used provided cement content is not reduced. Water reducing admixtures may be used provided they are used in the mix design studies. High-range water reducers (superplasticizers) shall be used only where specifically called for in this Section, otherwise superplasticizers shall not be used without written approval from the ENGINEER. No admixture may contain chlorides, bromides, or fluorides.

c. Water: Clean, potable water. The CONTRACTOR shall provide tests to assure that no more than 200 parts per million total aggregated content of chlorides, bromides, and fluorides are present.

d. If a variance from the Local Authority is required for the precast concrete mix design, the CONTRACTOR shall be responsible for submitting and obtaining the 5,000-psi precast concrete mix variance. The admixtures used in the mix design shall be used in approved combinations and proportions in accordance with the local requirements.

5. Formwork: Formwork shall be designed to withstand high-frequency vibration and to ensure finished units.

6. Pickup Points and Boxouts: Pickup points, boxouts, and inserts on panel faces and surfaces to be exposed are prohibited except as approved.

F. Delivery, Storage and Handling

1. General: Precast members shall be handled to position consistent with their shape and design; they shall be lifted and supported from design incorporated support points and provided with strong backs and other devices as required. Lifting or handling equipment shall be capable of maintaining units during manufacture, storage, transportation, erection, and in position for fastening.

2. Blocking and supports, lateral restraints and protective materials during transport and storage shall be clean, nonstaining, without causing harm to exposed surfaces, including temporary support to prevent bowing and warping. Lateral restraints shall be provided to prevent undesirable horizontal movement. Edges and exposed faces of members shall be protected to prevent straining, chipping, or spalling of concrete.

3. Units shall be marked with date of production and final position in structure in location not visible after erection.

4. Precast units shall be stored off the ground in a manner to prevent warpage and they shall be protected from weather, marring, and overload.

5. Stainless Steel Hardware: Stainless steel hardware shall be transported, handled, stored, and protected in wood crates.

PART 2 PRODUCTS

A. Concrete Materials

1. Cement: ASTM C 150, Type II/V, "low alkali," white color. "Low alkali" requirement may be waived if not reactive as defined in Appendix to ASTM C 33. Submit laboratory test reports.

2. Aggregate: ASTM C 33, 1/2-inch max coarse aggregate size, fine aggregate ratio to total aggregate volume = 0.35 min, 0.55 max.

   a. Water Absorption, Coarse: ASTM C 127.

   b. Water Absorption, Fine: ASTM C 128.

3. Reinforcing Steel: ASTM A 615, Grade 60, deformed epoxy coated in accordance with ASTM A 775.

4. Welded Wire Fabric:

   a. Plain: ASTM A 185, epoxy coated.

   b. Deformed Steel: ASTM A 497, epoxy coated.

   c. Fabricated Steel Bar or Rod Mats: ASTM A 184, epoxy coated.

5. Tie Wire: ASTM A 580, Type 316L, cold finished annealed, **Huntington Alloy Co. "Monel"** or **"Inconel."**

6. Air Entrainment Admixture: ASTM C 260.

7. Water Reducing or Retarding Admixtures: ASTM C 494, Type C, D, or F/G, with no chloride, bromide, and fluoride ingredients.

8. Silica Fume Slurry Admixture: 45 to 50 percent silica fume, water, and superplasticizer as dispersant. Silica Fume: 85 percent amorphous silicon dioxide in accordance with ASTM C 311; loss on ignition shall not exceed 6 percent and moisture shall not exceed 3

percent in accordance with ASTM C 311. Surface area not less than 10,000 square meters per kilogram at bed porosity of 0.50 in accordance with ASTM C 204.

Reduce water in mix by 5.6 to 9.5 lbs for each gallon of slurry added to mix, as recommended by slurry Manufacturer used.

9. Pigment: Pure mineral type, color-resistant to alkalis, nonfading. Color as required to produce finished concrete matching color and appearance of prebid sample and the 72-inch by 72-inch sample at the ENGINEER's field office.

B. Support Devices

1. Connecting and Support Devices: ASTM A 666, Type 316L stainless steel.

2. Bolts: ASTM A 193, Grade B8M (Type 316).

3. Nuts and Washers: ASTM A 194, Grade 8M (Type 316).

4. Weld Filler Metal for Stainless Steel: Stainless steel to stainless steel; AWS A5.4, Grade 316L filler metal; stainless steel to carbon steel, AWS A5.4, Grade 309 filler metal, 3/32-inch diameter.

5. Primer: Zinc-dust, zinc oxide primer in a phenolic resin spare varnish vehicle, TT-P-641 Type III (for galvanized surfaces).

C. Accessories

1. Plates, Angles, Anchors, and Studs: ASTM A 666, Type 316L stainless steel.

2. Austenitic Steel Castings for Embedments and Anchorage Assemblies: ASTM A 351, Type CF3M, with Type 316 stainless steel bolts, nuts, and washers.

3. Reglets: Plastic, shaped and flanged to remain in place once cast; tape closed to prevent concrete intrusion.

4. Bearing Pads: Neoprene, molded to size or cut from molded sheet, 70-80 Type A durometer, ASTM D 2240.

5. Sealant: Specified in Section [07920], "Sealants and Calking."

D. Forms

1. Forms: Manufacturer's standard with smooth, hard, dense, and rigid casting surface; without bow, warpage, oil canning, or other imperfections.

2. Form Release Agent: Manufacturer's standard, nonstaining, nonpetroleum based; compatible with concrete surface sealer.

3. Surface Sealer: Clear, flat, penetrating, non-yellowing, non-clouding solution; high concentration of organosilane in an aqueous alcoholic vehicle which is designed to provide water repellent concrete surfaces from which graffiti can be easily removed. Oil-type silicones, paraffins, waxes, vinyls, modified urethanes, or acrylics shall not be used. Sealant shall be tested by Manufacturer and proved compatible with surface sealer.

E. Mix

Silica Fume Concrete: Minimum 5,000 psi, 28-day compressive strength; aggregate 3/8-inch max; water - 305 lbs per cu yd; cement - 763 lbs per cu yd; w/c ratio 0.40 max; slump range 3 inches to 5 inches with silica fume slurry; air entrainment 4 percent plus or minus 1 percent; 7.5 percent dry silica fume by weight of cement, provided through specified silica fume slurry; add superplasticizer to achieve desired working slump for precast concrete as may be required by silica fume slurry Manufacturer. Add colorant as required to achieve match with ENGINEER's sample. Moist cure by spray mist.

F. Fabrication

1. General: Precast concrete units shall be fabricated by a licensed shop in accordance with ACI 318, PCI MNL-116 (structural features), PCI MNL-117 (nonstructural features, surface treatments, patching, and tolerances). Plant records and quality control program shall be maintained during production of precast units. Records and access to plant shall be available to the ENGINEER upon request.

    a. Rigid molds shall be used, constructed to maintain precast unit uniform in shape, size, and finish, free from castings and dents, gouges, oil canning, or other irregularities that will adversely affect appearance or strength of units. Consistent quality shall be maintained during manufacture.

    b. Equipment for handling epoxy-coated reinforcing bars shall have protected contact areas. Bundles of coated bars shall be lifted at multiple pickup points to prevent bar-to-bar abrasion from sags in the bundles. Coated bars or bundles of coated bars shall not be dropped or dragged. Coated bars shall be stored on protective cribbing. The maximum amount of damage shall not exceed 2 percent of the surface area of each bar.

    c. Reinforcing steel, anchors, inserts, plates, angles, and other cast-in-place items shall be embedded as indicated on shop drawings. Reinforcement shall be fabricated and placed in conformance with ACI 318. No tack welding of or to reinforcement permitted. Welding when allowed shall conform to AWS D1.4 requirements. No carbon steel chairs, spacers, nails or tie wire shall be used in positioning reinforcing and embedments.

    d. Adequate reinforcing steel shall be provided to control cracking. Maximum permissible crack width:

        1) Surfaces exposed to weather: 0.005 inch.

        2) Surfaces exposed to view but not weather: 0.01 inch

    e. Connecting devices, plates, angles, items fit to steel framing members, inserts, bolts, and accessories shall be fabricated to permit initial placement and final attachment.

    f. Anchors, inserts, lifting devices, and other accessories shall be placed and embedded in accordance with approved shop drawings, accurately positioned in their designed location and anchored to prevent dislocation during panel construction. Flashing reglets shall be placed and embedded continuous and straight, with lifting devices to permit removal after erection.

g. Units shall be moist cured with water mist to develop concrete quality and to minimize surface drying and appearance blemishes such as nonuniformity, staining, or surface cracking.

h. Precast units shall be removed from formwork using procedures conforming to PCI MNL-117. Minor patching in plant acceptable, providing structural adequacy and appearance of units are not impaired. Each precast unit shall be identified with corresponding code on erection drawings, in location not visible to finished work.

i. Repair of damaged epoxy coating, when required, shall be made with patching material conforming to ASTM A 775. Repair shall be in accordance with the material Manufacturer's recommendations.

2. Fabrication and Tooling of Stainless Steel Connections and Embedments: All tools used during fabrication shall be made of stainless steel. Use of carbon steel tools is prohibited.

a. Welding of stainless steel shall conform to AWS A5.4, AWS B2.1 and AWS D1.1, using tungsten inert gas procedures and 316L filler metal for stainless steel to stainless steel and 309 filler metal for stainless steel to carbon steel. Surfaces shall be sanded smooth (do not grind), and oxidized discoloration removed (blue heat tint). Threaded parts of stainless steel bolts shall be lubricated with graphite suspended in alcohol (Neo-Lube) every time that nut is run on or off the threads. No other lubricant is acceptable.

b. Erection slings, cables, blocking, hardware and restraints shall be nonmetallic or stainless steel. Cribbing or crating shall be wood.

G. Finish of Precast Units

1. Backs and Sides (Unexposed Edges): Smooth, dense, uniform surface free from blemishes. Defects in backs and sides (unexposed edges) shall be repaired as approved.

2. Faces: Appearance, color, and texture finish of all panels shall match appearance, color and texture of the approved sample panels constructed by the CONTRACTOR. Panels that do not match will be rejected. Repairs will be acceptable only if structural adequacy and appearance of product are not impaired and the repair and surrounding area match the approved sample panels at the ENGINEER's field office.

3. Mechanical finishing of panels at precast plant shall be at essentially the same age (or strength) of concrete to assure finished appearance is uniform from panel to panel.

4. To reduce possibility of stains occurring during transportation and erection, sealer shall be applied at the plant as recommended by Manufacturer and the precaster and shall be guaranteed in writing that sealer will not alter or yellow the original precast concrete color in any way and that it is compatible with the joint sealants to be used on the project. Seal finish surfaces of precast units to be exposed in completed work as follows: apply a uniform coat of surface sealer in accordance with Manufacturer's written instructions. Apply sealer by method and in quantity required to provide coverage specified by sealer Manufacturer. Forty-eight hours after application of sealer, apply water to face of each panel in sufficient quantity to determine if full sealer coverage was achieved. Panels not fully sealed shall be resealed and retested. A second coat shall be applied at the jobsite after erection and cleanup in accordance with the Manufacturer's instructions.

PART 3 EXECUTION

A. Installation

1. Examination: The CONTRACTOR shall verify that building structure, anchors, devices, and openings are ready to receive work of this Section. Beginning of installation means acceptance of existing condition.

2. Preparation: The CONTRACTOR shall provide for erection procedures and induced loads, during erection, maintain temporary bracing in place until final support is provided, provide necessary hoisting equipment and safety and protective devices.

3. Erection: The units shall be erected in accordance with approved shop/erection drawings without damage to shape or finish or adjacent work. Damaged panels shall be replaced or repaired. Unless otherwise shown, members shall be erected level and plumb within allowable tolerances.

    a. The CONTRACTOR shall align and maintain uniform horizontal and vertical joints as erection progresses, provide approved shims and wedges as required, and when members required adjustment beyond design or tolerance criteria, discontinue affected work. Units shall be secured in place and field welds, scratches and otherwise damaged steel surfaces shall be touched up.

    b. Field fabrication and erection of stainless steel shall conform to the procedures outlined in the paragraph entitled "Fabrication and Tooling of Stainless Steel Connectors and Embedments."

    c. The vertical units shall be set dry, without grout, attaining joint dimension with lead or plastic shims and spacers.

    d. Pickup points, boxouts, inserts and bearing surfaces shown shall be grouted with non-shrink grout in accordance with Section [03315], "Grout." The color and texture of concrete surfaces of adjacent areas shall be finished to match in the same plane.

4. Tolerances: In accordance with requirements of PCI MNL-117 unless otherwise indicated.

    1. Variation from Plane of Location: 1/4-inch in 10 feet and 3/8-inch in 100 feet maximum, compensating not cumulative.

    2. Offset from True Alignment between Two Connecting Members: 1/4-inch maximum.

    3. Out of Square: 1/8-inch in 10 feet maximum, noncumulative.

    4. Variation in Dimensions Indicated in Shop Drawings: Plus or minus 1/8-inch.

    5. Misalignment of Anchors, Inserts, Openings: 1/8-inch, maximum.

    6. Bowing or Warpage of Units: 1/700 of panel dimension.

    7. Exposed Joint Dimension: 3/4-inch plus or minus 1/8-inch.

8. Location of Reglets: 1/4-inch from true position.

5. Joint Sealing: Specified in Section [07920], "Sealants and Calking."

B. Cleaning

1. Not sooner than 72 hours after joints are sealed, faces and other exposed surfaces of precast units shall be cleaned using a cleaning detergent recommended by the sealer manufacturer and water applied with a soft bristle brush, and thoroughly rinsed using clean water or other approved procedures.

2. Units shall be cleaned when temperature and humidity conditions are such that surfaces dry rapidly (e.g., 70 degrees F and rising, 50 percent RH or less).

3. Discolorations which cannot be removed by these procedures shall be considered defective work, and repaired or replaced as directed by ENGINEER.

C. Protection

Adjacent surfaces shall be protected from damage during sealing and cleaning operations and against damage, disfiguration or discoloration from subsequent operations. Noncombustible shielding shall be used during welding operations.

END OF SECTION

SECTION 03600

GROUT

PART 1 GENERAL

A. Scope of Work

1. The CONTRACTOR shall furnish all materials for grout in accordance with the provisions of this Section and shall form, mix, place, cure, repair, finish, and do all other work as required to produce finished grout, in accordance with the requirements of the Contract Documents.

2. The following types of grout shall be covered in this Section:

   a. Non-Shrink Grout: This type of grout is to be used wherever grout is shown in the Contract Documents, unless another type is specifically referenced.

   b. Cement Grout

   c. Epoxy Grout

B. References, Specifications Codes and Standards

1. Specifications, codes, and standards shall be as specified in Section 03310, Cast-in-Place Concrete," and referred to herein.

2. Commercial Standards:

CRD-C621	Corps of Engineers Specification for Non-shrink Grout
ASTM C109	Test Method for Compressive Strength of Hydraulic Cement Mortars (Using 2-in or 50-mm Cube Specimens)
ASTM C531	Test Method for Linear Shrinkage and Coefficient of Thermal Expansion of Chemical- Resistant Mortars, Grouts, and Monolithic Surfacings
ASTM C579	Test Methods for Compressive Strength of Chemical-Resistant Mortars and Monolithic Surfacings
ASTM C827	Test Method for Early Volume Change of Cementitious Mixtures
ASTM C1107	Standard Specification for Packaged Dry, Hydraulic-Cement Grout (Non-shrink)
ASTM D696	Test Method for Coefficient of Linear Thermal Expansion of Plastics

C. Contractor Submittals

1. The CONTRACTOR shall submit certified test results verifying the compressive strength, shrinkage, and expansion requirements are within the limits specified herein.

2. Manufacturer's literature containing instructions and recommendations on the mixing, handling, placement and appropriate uses for each type of non-shrink and epoxy grout used in the work.

D. Quality Assurance

1. Field Tests:

   a. Compression test specimens will be taken during construction from the first placement of each type of grout, and at intervals thereafter as selected by the ENGINEER to insure continued compliance with these specifications. The specimens will be made by the ENGINEER or its representative.

   b. Compression tests and fabrication of specimens for cement grout and non-shrink grout will be performed as specified in ASTM C 109 at intervals during construction as selected by the ENGINEER. A set of three specimens will be made for testing at 7 days, 28 days, and each additional time period as appropriate.

   c. Compression tests and fabrication of specimens for epoxy grout will be performed as specified in ASTM C 579, Method B, at intervals during construction as selected by the ENGINEER. A set of three specimens will be made for testing at 7 days, and each earlier time period as appropriate.

   d. All grout, already placed, which fails to meet the requirements of these specifications, is subject to removal and replacement at the cost of the CONTRACTOR.

   e. The cost of all laboratory tests on grout will be borne by the OWNER, but the CONTRACTOR shall assist the ENGINEER in obtaining specimens for testing. However, the CONTRACTOR shall be charged for the cost of any additional tests and investigation on work performed which does not meet the specifications. The CONTRACTOR shall supply all materials necessary for fabricating the test specimens.

2. Construction Tolerances: Construction tolerances shall be as specified in the Section 03300 - Cast-in-Place Concrete, except as modified herein and elsewhere in the Contract Documents.

PART 2 PRODUCTS

A. Cement Grout

1. Cement Grout: Cement grout shall be composed of one part cement, three parts sand, and the minimum amount of water necessary to obtain the desired consistency. Where needed to match the color of adjacent concrete, white portland cement shall be blended with regular cement as needed. The minimum compressive strength at 28 days shall be 4000 psi.

2. Cement grout materials shall be as specified in Section 03300, "Cast-in-Place Concrete."

3. Application: Cement grout shall be used at all locations where “dry pack” material is specified on the Contract Documents.

B. Prepackaged Grouts

1. Non-Shrink Grout:

   a. Non-shrink grout shall be a prepackaged, inorganic, non-gas-liberating, non-metallic, cement-based grout requiring only the addition of water. 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 specified herein shall be as recommended by the manufacturer for the particular application required for this project.

   b. Class A non-shrink grouts shall have a minimum 28 day compressive strength of 7000 psi; shall have no shrinkage (0.0 percent) and a maximum 4.0 percent expansion in the plastic state when tested in accordance with ASTM C-827; and shall have no shrinkage (0.0 percent) and a maximum of 0.2 percent expansion in the hardened state when tested in accordance with CRD C 621.

   c. Class B non-shrink grouts shall have a minimum 28 day compressive strength of 5000 psi and shall meet the requirements of CRD C 621.

   d. Application:

      1) Class A non-shrink grout shall be used for the repair of all holes and defects in concrete members which are water bearing or in contact with soil or other fill material, grouting under all equipment base plates, and at all locations where "grout" is specified in the contract documents; except, for those applications for Class B non-shrink grout and epoxy grout specified herein. Class A non-shrink grout may be used in place of Class B non-shrink grout for all applications.

      2) Class B non-shrink grout shall be used for the repair of all holes and defects in concrete members which are not water-bearing and not in contact with soil or other fill material, grouting under all base plates for structural steel members, and grouting railing posts in place.

   e. Manufacturers and Product:

      1) Class A Grout

         a) Five Star "Five Star Fluid Grout 100"

         b) Masterbuilders "Masterflow 928"

         c) Approved equal

      2) Class B Grout

         a)Five Star "Five Star Grout"

         b) Masterbuilders "Set Grout"

         c)Approved equal

2. Epoxy Grout:

a. Epoxy grout shall have the ability to be poured, be non-shrinking and a 100 percent solids system. The epoxy grout system shall have three components: resin, hardener, and specially blended aggregate, all premeasured and prepackaged. The resin component shall not contain any non-reactive diluents. Resins containing butyl glycidyl ether (BGE) or other highly volatile and hazardous reactive diluents are not acceptable. Variation of component ratios is not permitted unless specifically recommended by the manufacturer. Manufacturer's instructions shall be printed on each container in which the materials are packaged. Epoxy grout shall be **Masterflow 648 CP by Master Builders Technologies; Conbextra EPR by Fosroc Ltd.; Sikadur 42 Grout-Pak by Sika Products.**

b. The chemical formulation of the epoxy grout shall be that recommended by the manufacturer for the particular application.

c. The mixed epoxy grout system shall have a minimum working life of 45 minutes at 75 degrees F.

d. The epoxy grout shall develop a compressive strength of 5000 psi in 24 hours and 10,000 psi in seven days when tested in accordance with ASTM C 579, Method B. There shall be no shrinkage (0.0 percent) and a maximum 4.0 percent expansion when tested in accordance with ASTM C 827.

e. The epoxy grout shall exhibit a minimum effective bearing area of 95 percent. This shall be determined by a test consisting of filling a 2-inch diameter by 4-inch high metal cylinder mold covered with a glass plate coated with a release agent. A weight shall be placed on the glass plate. At 24 hours after casting, the weight and plate shall be removed and the area in plan of all voids measured. The surface of the grout shall be probed with a sharp instrument to locate all voids.

f. The peak exotherm of a 2-inch diameter by 4-inch high cylinder shall not exceed 95 degrees F when tested with 75 degree F material at laboratory temperature. The epoxy grout shall exhibit a maximum thermal coefficient of 30×10^{-6} inches/inch/degree F when tested according to ASTM C 531 or ASTM D 696.

g. Application: Epoxy grout shall be used to embed all anchor rods and reinforcing steel required to be set in grout, and for all other applications required in the Contract Documents.

C. Curing Materials

Curing materials shall be as specified in Section 03300, "Cast-in-Place Concrete" for cement grout and as recommended by the manufacturer of prepackaged grouts.

D. Consistency

The consistency of grouts shall be that necessary to completely fill the space to be grouted for the particular application. Dry pack consistency is such that the grout is plastic and moldable but will not flow. Where "dry pack" is called for in the Contract Documents, it shall mean a grout of that consistency; the type of grout to be used shall be as specified herein for the particular application.

E. Measurements of Ingredients

1. Measurements for cement grout shall be made accurately by volume using containers. Shovel measurement shall not be allowed.

2. Prepackaged grout shall be mixed with the recommended volume of water in order to achieve the desired grout consistency.

PART 3 EXECUTION

A. General

1. All surface preparation, curing, and protection of cement grout shall be as specified in Section 03310, "Cast-in-Place Concrete." The finish of the grout surface shall match that of the adjacent concrete.

2. The manufacturer of Class A non-shrink grout and epoxy grout shall provide on-site technical assistance upon request.

3. Base concrete or masonry must have attained its design strength before grout is placed, unless authorized by the ENGINEER.

4. Grout samples shall be taken as specified in subsection 1.04A of this Section.

B. Concrete Patch and Repair

See Section 03310 for concrete repair and patching requirements.

C. Grouting Materials

1. Prepackage Grouts: All mixing, surface preparation, handling, placing, consolidation, curing, and other means of execution for prepackaged grouts shall be done according to the instructions and recommendations of the manufacturer.

2. Base Plate Grouting:

   a. For base plates, the original concrete shall be blocked out or finished off a sufficient distance below the plate to provide for a one-inch minimum thickness of grout or a thickness as shown on the Drawings.

   b. 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 concrete surface shall be filled with non-shrink grout. The mixture shall be a trowelable consistency and tamped or rodded solidly into the space between the plate and the base concrete. A backing board or stop shall be provided at the back side of the space to be filled with grout. 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.

D. Consolidation

Grout shall be placed in such a manner so as to assure that the space to be grouted is completely filled. The consistency of the grout when applied shall meet the requirements stated.

E. Anchor Rod or Reinforcing Steel Embedment

1. See Section 03200 – REINFORCEMENT STEEL for dowel embedment requirements, use epoxy grout unless specifically directed otherwise.

2. Embedment of anchor rods shall be the same as required for the reinforcing steel bars.

END OF SECTION

SECTION 03740

EPOXY ADHESIVE INJECTION OF CRACKS IN CONCRETE MEMBERS

PART 1 GENERAL

A. Scope of Work

This section covers the repair of cracks in concrete by the injection of an epoxy resin adhesive. The criteria to be used to determine if a crack is to be repaired by the method covered in this section shall be all cracks 0.02 inches in width and larger in a water containment structure.

B. References

ASTM D695	Test method for Compressive Properties of Rigid Plastics
ASTM C881	Epoxy-Resin-Base Bonding Systems for Concrete

C. Qualifications

1. Epoxy injection shall be performed by a certified applicator.

2. CONTRACTOR's/SUBCONTRACTOR's operator engaged in the epoxy injection process shall have a minimum of 5 years successful operator experience in the methods of restoring concrete structures utilizing the specific epoxy injection process indicated. Operator's experience shall include previous repairs of cracked or damaged concrete structures, the technical knowledge of correct material selection and use, and the operation, maintenance, and troubleshooting of equipment.

D. Quality Assurance

1. Codes and Regulatory Agencies. Perform all work in compliance with all federal, state, and local codes and regulatory agencies.

2. Equipment. Submit records showing that CONTRACTOR has owned and operated the epoxy injection equipment to be used to perform the work, or similar epoxy injection equipment, for a minimum of 2 years.

3. Manufacturer's Representative. Product manufacturer's technical representative shall provide the CONTRACTOR such aid and instruction as is required to obtain proper application of the product. CONTRACTOR shall make all arrangements and pay all costs to have manufacturer's authorized representative on the job site at the beginning of all major phases of the work, including joint preparation and installation of epoxy grout, to ensure proper procedures and quality control techniques are employed.

E. Submittals

1. Product Data. Submit manufacturer's technical data and installation instructions for each material, including manufacturer's trade name, all independent laboratory tests, performance data, method of application, storage requirements, safety data sheet, container sizes, and mixing instructions.

2. Operator experience. Provide a list of at least five projects that have been completed within the last 5 years utilizing the specific epoxy injection process indicated. The list shall include project name and location; client's name, address and telephone number; name of project consultant.

PART 2 MATERIALS AND EQUIPMENT

A. Epoxy Resin Adhesive for Injection

1. Epoxy adhesive grout shall be a 100 percent solids 2-component, water insensitive, low-viscosity epoxy resin. Epoxy shall be suitable for grouting both dry and damp cracks. Epoxy shall develop a minimum tensile strength (ASTM D638) of 6,000 psi and a minimum compressive strength (ASTM D695) of 8,000 psi. The product shall meet the requirements of ASTM C 881, Type I-V.

2. Manufacturers and Products:

   a. Select Products, SELECT BOND GP-4440, Costa Mesa, CA.

   b. Sika, Sikadur 35, Hi-Mod LV, Santa Fe Springs, CA

   c. Approved equal

B. Surface Seal

1. The surface seal material is that material used to confine the injection adhesive in the fissure during injection and cure.

2. The surface seal material shall be a two-component, 100% solids, moisture-tolerant, high strength, rapid-curing, epoxy, smooth-paste adhesive to firmly hold injection fittings in place and to resist injection pressures adequately to prevent leakage during injection.

3. The material shall be from the same manufacturer of the epoxy resin adhesive and be of a compatible material and conform to ASTM C 881.

4. Manufacturers and Products:

   a. Select Products, SELECT BOND GP-3000, Costa Mesa, CA.

   b. Sika, Sikadur 33, Santa Fe Springs, CA

   c. Approved equal

C. Equipment for Injection

1. The equipment used to meter and mix the two injection adhesive components and inject the mixed adhesive into the crack shall be portable, positive displacement type pumps with interlock to provide positive ratio control of exact proportions of the two components at the nozzle. The pumps shall be electric, or air powered and shall provide in-line metering and mixing.

2. The injection equipment shall have automatic pressure control capable of discharging the mixed adhesive at any pre-set pressure up to 200 psi plus or minus 5 psi and shall be equipped with a manual pressure control override.

3. The injection equipment shall have the capability of maintaining the volume ratio for the injection adhesive prescribed by the manufacturer of the adhesive within a tolerance of plus or minus 5 percent by volume at any discharge pressure up to 200 psi.

PART 3 EXECUTION

A. Preparation

1. Surface adjacent to cracks or other areas of application shall be cleaned of dirt, dust, grease, oil, efflorescence, or other foreign matter which may be detrimental to the integrity of the bond between the epoxy and the injection surface. Acids and corrosives shall not be permitted.

2. Entry ports shall be provided along the crack at intervals of not more than the thickness of the concrete at that location. Ports shall be compatible with pressure injection equipment.

3. Surface seal material shall be applied to the face of the crack between the entry ports. For through cracks, surface seal shall be applied to both faces.

4. Enough time for the surface seal material to gain adequate strength shall pass before proceeding with the injection.

B. Epoxy Injection

1. Injection of epoxy adhesive shall begin at lower entry port and continue until there is an appearance of epoxy adhesive at the next entry port adjacent to the entry port being pumped.

2. When epoxy adhesive travel is indicated by appearance at the next adjacent port, injection shall be discontinued on the entry port being pumped, and epoxy injection shall be transferred to the next adjacent port where epoxy adhesive has appeared.

3. Epoxy adhesive injection shall be performed continuously until cracks are completely filled.

4. If port to port travel of epoxy adhesive is not indicated, the work shall immediately be stopped and the OWNER notified.

C. Finishing

1. When cracks are completely filled, epoxy adhesive shall be cured to sufficient time to allow removal of surface seal without any draining or runback of epoxy material from cracks.

2. Surface seal material and injection adhesive runs or spills shall be removed from concrete surfaces.

3. The face of the crack shall be finished flush to the adjacent concrete showing no indentations or protrusions caused by the placement of entry ports.

D. Pressure Test

1. The mixing head of the injection equipment shall be connected and the equipment run until clear uniformly mixed material flows into the purge pail. The operator shall engage the equipment shut-off nozzle valve and subsequently bump the on-off switch while monitoring pressure on psi gauge until the pressure reaches 200 psi. Pressure gauge shall be monitored for one minute. If pressure is maintained between 190-200 psi, check valves shall be considered to be functioning properly and the injection may proceed. If pressure drops below 190 psi, CONTRACTOR shall be required to have new seals installed on the check valves and the equipment shall be subsequently retested.

2. The pressure test shall be run for each injection unit at the beginning and after meal break of every shift that the unit is used in the work of crack repair.

3. The adequacy and accuracy of the equipment shall be solely the responsibility of the CONTRACTOR.

E. Ratio Test

1. The epoxy mixture ratio shall be monitored continuously while injecting by placing a strip of masking tape on the sides of the A and B full height. After filling reservoirs, the A and B levels shall be marked and monitored while running injection machine into purge pail for a period of one minute.

2. The ratio test shall be run for each injection unit at the beginning and after mal break of every shift that the unit is used in the work of crack repair.

F. Proof of Ration and Pressure Test

1. At all times during the course of the work the CONTRACTOR shall keep complete and accurate records of the pressure and ratio tests specified above available to the DISTRICT.

2. In addition, the DISTRICT at any time without prior notification of the CONTRACTOR, may request the CONTRACTOR to conduct the tests specified above in the presence of the DISTRICT.

END OF SECTION

SECTION 04100

MORTAR AND MASONRY GROUT

PART 1 GENERAL

A. Scope of Work

The CONTRACTOR shall furnish all materials for mortar and masonry grout in accordance with the provisions of this Section and shall mix, place, cure, repair, finish, and do all other work as required to produce finished mortar and masonry grout, in accordance with the requirements of the Contract Documents.

B. References

1. American Concrete Institute/American Society of Civil Engineers/The Masonry Society (ACI/ASCE/TMS)

   ACI 530.1/ASCE 6/TMS 402-16, Specifications for Masonry Structures

2. American Society for Testing and Materials (ASTM):

   a. C 91 - Specification for Masonry Cement
   b. C 109 - Test Method for Compressive Strength of Hydraulic Cement Mortars
   c. C 143 - Test Method for Slump of Hydraulic Cement Concrete
   d. C 144 - Specification for Aggregate for Masonry Mortar.
   e. C 150 - Specification for Portland Cement.
   f. C 207 - Specification for Hydrated Lime for Masonry Purposes.
   g. C 270 - Specification for Mortar for Unit Masonry.
   h. C 404 - Specification for Aggregates for Masonry Grout.
   i. C 476 - Specification for Grout for Masonry.
   j. C 780 - Test Method for Preconstruction and Construction Evaluation of Mortars for Plain and Reinforced Unit Masonry.
   k. C 1019 - Test Method for Sampling and Testing Grout
   l. C1093 - Accreditation of Testing Agencies for Masonry
   m. E 329 – Specification for Agencies Engaged in Construction Inspection, Testing, or Special Inspection

C. Definitions

Alkali: Sum of sodium oxide and potassium oxide calculated as sodium oxide.

D. Performance Requirements

Compressive Strength:

a. Mortar: Minimum 1,800 pounds per square inch at 28 days.

b. Grout: Minimum 2,000 pounds per square inch at 28 days.

E. Submittals

1. Shop Drawings.
2. Product Data.
3. Samples: Include mortar color channels.
4. Design Data: Design Mixes.
5. Mortar Strength Test Results.
6. Grout Strength Test Results.

F. Project Conditions

Environmental Requirements:

a. Cold Weather Requirements: The cold weather construction provisions of ACI 530.1/ASCE 6/TMS 402, Article 1.8 C, shall be implemented when the ambient temperature falls below 40 degrees Fahrenheit.

b. Hot Weather Requirements: The hot weather construction provisions of ACI 530.1/ASCE 6/TMS 402, Article 1.8 D, shall be implemented when the ambient temperature exceeds 100 degrees Fahrenheit, or 90 degrees Fahrenheit with a wind velocity greater than 8 mph.

PART 2 MATERIALS

A. Materials

1. Materials for Mortar and Grout: Do not change source of materials which will affect the appearance of finished work after the work has started unless acceptable to Engineer.

2. Portland Cement: ASTM C 150, Type II, low alkali, containing maximum 0.6 percent total alkali.

3. Hydrated Lime: ASTM C 207, Type S.

4. Fine Aggregate: ASTM C 144, sand.

5. Coarse Aggregate: ASTM C 404, coarse, size Number 8.

6. Water Repellent Admixture: Manufacturers: One of the following or equal:

   a. Sika Corp., Red Label.

7. Color Admixture: Type containing maximum 15 percent limeproof, inorganic compounds, unless recommended otherwise by manufacturer, and maximum 3 percent carbon black by weight of cement, with:

a. Factory blend for full color saturation of mortar joint.

b. Packaging for unitized jobsite mixing at ratio of 1 unit of color per sack of portland cement.

8. Other Admixtures: Prohibited, unless accepted by the Engineer.

9. Water: Clean, clear and potable, free of oil, soluble salts, chemicals, and other deleterious substances.

B. Mortar

1. Mortar Mixing:

a. Mix on jobsite in accordance with ASTM C 270, Type S, to meet performance requirements.

b. Mix in mechanical mixer and only in quantities needed for immediate use.

c. Mix for minimum 3 minutes, and maximum of 5 minutes after materials have been added to mixer.

2. Measurement for ingredients for mortar shall be either by volume or weight. Measure by one of the following methods:

a. If ingredients are measured by volume, measurement of sand shall be accomplished by the use of a container of known capacity.

b. Shovel count.

c. If ingredients are measured by weight, measurement of sand shall be based on the dry weight of sand of 80 pounds per cubic foot.

3. Water shall be mixed with the dry ingredients in sufficient amount to provide a workable mixture which will adhere to the vertical surfaces of masonry units.

a. Use no mortar which has been standing for more than 1 hour after being mixed.

b. Whenever 90 minutes has elapsed since last batch was mixed, completely empty mixer drum of materials and wash down before placing next batch of materials.

C. Grout

1. Grout Strength Testing:

a. Perform compressive strength tests of grout in accordance with ASTM C 1019 by an independent testing laboratory acceptable to the Engineer.

b. One (1) strength test shall be the average of three (3) specimens from the same sample, tested at 28 days.

c. Cost of tests shall be paid by the Contractor.

2. Grout Mixing:

a. Mix on jobsite in accordance with ASTM C 476 or in transit mixer to meet performance requirements with 8 to 10 inch slump.

b. Fly ash additives are not allowed.

c. Use within 90 minutes after addition of mixing water.

d. Mix for minimum of 5 minutes after ingredients are added and until uniform mix is attained. Grout shall have sufficient water added to produce pouring consistency without segregation.

e. Minimum 28-day compressive strength: 2,000 psi.

3. Mix grout with coarse aggregate for cavity walls with horizontal dimension of 2 inches or more, and hollow cell masonry units with minimum 4 inch cell dimensions in both horizontal directions.

PART 3 EXECUTION

A. Installation

Install as specified in Section 04220.

B. Field Quality Control

1. Test mortar in accordance with ASTM C 780.

a. Make at least 2 test specimens of mortar and grout.

END OF SECTION

SECTION 04220

CONCRETE MASONRY UNITS

PART 1 GENERAL

A. Description

Section Includes: Concrete unit masonry.

B. Related Sections

Section 04100 Mortar and Masonry Grout
Section 07190 Water Repellents.
Section 07900 Joint Sealers.
Section 08110 Steel Doors and Frames.

C. References

ASTM C33	Specification for Concrete Aggregates
ASTM C90	Specification for Hollow Load-Bearing Concrete Masonry Units
ASTM C140	Method of Sampling and Testing Concrete Masonry Units
ASTM C331	Specification for Lightweight Aggregates for Concrete Masonry Units
ASTM C426	Test Method for Drying Shrinkage of Concrete Block
IBC	International Building Code

D. Definitions

1. Custom Level of Quality: Top rank, nearly free of chips, cracks or other imperfections detracting from appearance when discernible and identified from distance of 15 feet under diffused lighting, obtainable only by skilled journeymen. Five percent of shipment may contain slight cracks or small chips, not larger than 1/2 inch in any direction.

2. Standard Level of Quality: High quality, but conventional, nearly free of chips, cracks or other imperfections detracting from appearance when discernible and identified from distance of 20 feet under diffused lighting. When level of quality is not specified, Standard Level of Quality shall be assumed.

3. Economy Level of Quality: Low quality with slight mismatching of textures and colors on exposed surfaces with no reduction in structural integrity leading to cracking, leaking, collapse or other failure in basic structural nature. Where units are used in exposed wall construction, faces that are exposed shall not show chips, cracks, or other imperfections when viewed from distance of 25 feet under diffused lighting. Ten percent of shipment may contain slight cracks or small chips, not larger than 1 inch in any direction.

4. in any direction.

E. Submittals

1. Shop Drawings: Include elevations of each wall indicating type and layout of units.

2. Samples: Include samples of stretcher units in sufficient quantity to illustrate color range.

3. Test Reports.

F. Quality Assurance

Manufacturer: Concrete masonry units shall be produced by a firm currently certified in the quality control program of the California Concrete Masonry Technical Committee.

G. Delivery, Storage, And Handling

1. Transport and handle concrete masonry units as required to prevent discoloration, chipping, and breakage.

2. Locate storage piles, stacks, and bins to protect materials from heavy traffic.

3. Remove chipped, cracked, and otherwise defective units from jobsite upon discovery.

H. Project Conditions

1. Environmental Requirements:

   a. Cold Weather Requirements: In accordance with International Building Code. Provide adequate equipment for heating masonry materials when air temperature is below 40 degrees Fahrenheit.

   b. Hot Weather Requirements: When ambient air temperature exceeds 100 degrees Fahrenheit, or when ambient air temperature exceeds 90 degrees Fahrenheit and wind velocity is greater than 8 miles per hour, implement hot weather protection procedures. Wet mortar board before loading and cover mortar to retard drying when not being used. Do not spread mortar beds more than 48 inches ahead of placing masonry units. Place masonry units within one minute of spreading mortar.

I. Sequencing And Scheduling

Order concrete masonry units well before start of installation to assure adequate time for manufacturing and minimum 28 days for curing before start of installation.

PART 2 MATERIALS

A. Hollow Load Bearing Concrete Masonry Units

1. Type: ASTM C 90, Class 1, Type I, Standard Level of Quality with minimum compressive strength of 1,500 pounds per square inch.

2. Surface Texture: See Drawings.

3. Color: See Drawings and to be approved by DISTRICT.

4. Typical Size: 8 inches wide by 8 inches high by 16 inches long, unless otherwise indicated on the Drawings, or other sizes as needed to minimize cutting.

5. Special Sizes and Shapes: As required for window and door openings, bond beams, piers, pilasters, lintels, control joints, and other special applications to minimize cutting.

PART 3 EXECUTION

A. Preparation

1. Protect adjacent construction with appropriate means from mortar droppings and other effects of laying of concrete masonry units.

2. Thoroughly clean foundations of laitance, grease, oil, mud, dirt, mortar droppings, and other objectionable matter.

B. Concrete Masonry Units

1. Provide Standard Level of Quality.

2. Lay concrete masonry units dry.

3. Lay units in uniform and true courses, level, plumb, and without projections or offset of adjacent units.

4. Lay units to preserve unobstructed vertical continuity of cells to be filled with grout or insulation.

5. Align vertical cells to be filled with grout to maintain clear, unobstructed continuous vertical cell measuring not less than 2 by 3 inches.

6. Place mortar with full coverage of joints at webs of all cells and face shells.

7. Butter vertical head joints for thickness equal to face shell thickness of units, and shove joints tightly together so that mortar bonds to both masonry units.

8. Solidly fill joints from face of units to inside face of cells.

9. Lay units to desired height with joints of uniform thickness.

10. Bond shall be plumb throughout.

11. Lay units to avoid formation of cracks when units are placed. Keep cells of units as free of mortar as possible as masonry wall height increases.

12. Lay masonry plumb, true to line, with courses level. Keep bond pattern plumb throughout. Lay masonry within the following tolerances:

    a. Maximum variation from the plumb in the lines and surfaces of columns, walls, and in the flutes and surfaces of fluted or split faced blocks:

        1) In adjacent masonry units - 1/8 inch.

        2) In 10 feet - 1/4 inch.

        3) In any story or 20 feet maximum - 3/8 inch.

        4) In 40 feet or more - 1/2 inch.

    b. Maximum variations from the plumb for external corners, expansion joints, and other conspicuous lines:

        1) In any story or 20 feet maximum - 1/4 inch.

        2) In 40 feet or more - 1/2 inch.

    c. Maximum variations form the level or grades indicated on the Drawings for exposed lintels, sills, parapets, horizontal grooves, and other conspicuous lines:

        1) In any bay or 20 feet maximum - 1/4 inch.

        2) In 40 feet or more - 1/2 inch.

    d. Maximum variations of the linear building lines from established position in plan and related portion of columns, walls, and partitions:

        1) In any bay or 20 feet maximum - 1/2 inch.

        2) In 40 feet or more - 3/4 inch.

    e. Maximum variation in cross sectional dimensions of columns and in thickness of walls:

        1) Minus - 1/4 inch.

        2) Plus - 1/2 inch.

13. When positions of units shift after mortar has stiffened, bond is broken, or cracks are formed, relay units in new mortar.

14. Remove mortar, mortar droppings, debris, and other obstructions and materials from inside of cell walls.

15. Seal cleanouts after inspection and before grouting or placing insulation.

C. Mortar Joints

1. Make joints straight, clean, smooth, and uniform in thickness.

2. Tool exposed joints, slightly concave. Strike concealed joints flush.

3. Make vertical and horizontal joints 3/8 inch thick.

4. Where fresh masonry joins totally or partially set masonry, clean and roughen set masonry before laying new units.

D. Bond Pattern

Lay concrete masonry units in running bond pattern, unless otherwise indicated on the Drawings.

E. Grouting and Reinforcement

1. Where horizontal and vertical bars are spliced and adjacent lap splices are separated by more than 3 inches, the lap splice length shall be 72 bar diameters. Where adjacent lap splices are separated by 3 inches or less, the lap splice length shall be increased by 1.3 times or the lap splices shall be staggered at least 24 bar diameters with no increase in length.

2. Hold vertical reinforcing bars in position at intervals not exceeding 200 bar diameters. Use steel wire bar positioners to position bars and tie reinforcing bars to dowels with wire ties.

3. Obtain acceptance of reinforcement placement before grouting.

4. Fill all spaces and cells solidly with grout.

    a. Low-lift Grouting: Hollow unit masonry to be grouted by the low lift method shall be constructed and grouted in lifts not exceeding 4 feet. Slushing with mortar will not be permitted.

    b. High-lift Grouting: If grouting is accomplished by the high-lift method, hollow unit masonry shall be allowed to cure at least 24 hours before grouting. Grout shall be placed in lifts not to exceed 6 feet in depth. Each lift shall be allowed to set for 10 minutes after initial consolidation of grout before successive lift is placed. The full height of each section of wall shall be grouted in one day.

5. Grout in cells shall have full contact with surface of concrete footings.

6. When grouting stops for one hour or longer, form horizontal construction joints by stopping grout placement 1-1/2 inches below top of uppermost unit containing grout.

7. After placement, consolidate grout using mechanical immersion vibrators designed for consolidating grout. 5 minutes after initial consolidation, the grout should again be consolidated to eliminate voids created by the absorption of water in the grout.

8. Placement:

    1. Use a hand bucket, concrete hopper, or grout pump.

    2. Place grout in final position within 1-1/2 hours after mixing.

    3. Place grout to completely fill the grout spaces without segregation of the aggregates.

    4. Do not insert vibrators into lower grout placements that are in a semi-solidified state.

F. Cutting Concrete Masonry Units

1. When possible, use full units of the proper size in lieu of cut units. Cut units as required to form chases, openings, for anchorage, and for other appurtenances.

2. Cut and fit units with power-driven carborundum or diamond disc blade saw.

G. Control Joints

1. Provide in masonry walls where indicated on the Drawings or a maximum of 50 feet apart if not specifically shown.

2. Make full height and continuous in appearance.

3. Run bond beams and bond beam reinforcing bars continuously through control joints.

4. Insert control joint filler in joints as wall is constructed.

5. Apply sealant as specified in Section 07900.

H. Openings and Lintels

1. Use lintel block units where underside of lintel will be exposed.

2. Provide minimum of 8 inch bearing at each end of lintel.

3. Embed reinforcing bars minimum 24 inches or 40 bar diameters, whichever is longer, into wall past edges of openings or as indicated on the Drawings.

    a. At corners, provide 90 degree bend with equivalent total embedment length.

I. Steel Door Frames

1. Anchor and fully grout jambs and head of steel door frames connected to concrete unit masonry.

2. Fill frames with grout as each 2 feet of concrete unit masonry is laid.

J. Anchor Bolts

1. Hold anchor bolts in place with template during grouting to assure precise alignment.

2. Do not cut or ream members being anchored or use other means to accommodate misaligned anchor bolts in roof deck support angles.

3. Provide required clearance of anchor bolt from the face shell of the masonry unit as shown in the typical detail on the Drawings.

K. Enclosures

1. Where concrete masonry units enclose conduit, pipes, stacks, ducts, and similar items, construct chases, cavities, and similar spaces as required, whether or not such spaces are indicated on the Drawings.

2. Point openings around flush mounted electrical outlet boxes with mortar, including flush joints above boxes.

3. Do not cover enclosures until inspected and when appropriate, tested.

L. Other Embedded Items

Build in wall plugs, accessories, flashings, pipe sleeves, and other items required to be built-in as the masonry work progresses.

M. Patching

Patch exposed concrete masonry units at completion of the Work and in such manner that patching will be indistinguishable from similar surroundings and adjoining construction.

N. Water Curing

Protect concrete masonry units from drying too rapidly by frequently fogging or sprinkling walls with water leaving them always visibly damp for minimum of 3 days.

O. Miscellaneous

Build in required items, such as anchors, flashings, sleeves, frames, structural steel, lintels, anchor bolts, and metal fabrications, as required for complete installation.

P. Water Repellent

Apply water repellent as specified in Section 07190.

Q. Field Quality Control

1. Have minimum 3 concrete masonry units of each type proposed for Project tested in accordance with ASTM C90, C140, and C426 to verify conformance to Specifications.

2. Tests shall include compressive strength, linear shrinkage, total absorption, moisture content as percent of total absorption, and unit weight. Employ and pay acceptable independent testing laboratory to perform testing.

R. Cleaning

1. Exercise extreme care to prevent mortar splotches.

2. Do not attach construction supports to concrete masonry walls.

3. Wash off concrete scum and grout spills before scum and grout set.

4. Remove grout stains from walls.

5. Clean exposed masonry. Remove scaffolding and equipment. Dispose of debris, refuse, and surplus material offsite legally.

6. Correct efflorescence on exposed surfaces with commercially prepared cleaning solution acceptable to masonry unit manufacturer.

    a. Apply cleaning solution in accordance with cleaning solution manufacturer's printed instructions.

    b. Do not use muriatic acid as cleaning solution.

    c. Do not use high pressure cleaning equipment.

S. Forms and Shores

1. Where required, construct forms to the shapes indicated on the Drawings.

    a. Construct forms sufficiently rigid to prevent deflection which may result in cracking or other damage to supported masonry and sufficiently tight to prevent leakage of mortar and grout.

    b. Do not remove supporting forms or shores until the supported masonry has acquired sufficient strength to support safely its weight and any construction loads to which it may be subjected.

    c. Wait at least 16 hours after grouting masonry columns or walls before applying uniform loads.

    d. Wait at least 64 hours before applying concentrated loads.

T. Protection

1. Provide temporary protection for exposed masonry corners subject to damage.

2. Bracing:

   a. Adequately brace masonry walls and columns over 8 feet in height to prevent overturning and to prevent collapse, unless wall is adequately supported for lateral loads by permanent supporting elements (i.e., roof or floor diaphragm) so wall/column will not overturn or collapse.

   b. Keep bracing in place until permanent supporting elements of structure are in place.

3. Limited Access Zone:

   a. Establish limited access zone prior to start of masonry wall construction.

   b. Zone shall be immediately adjacent to wall and equal to height of wall to be constructed plus 4 feet by entire length of wall on unscaffolded side of wall.

   c. Limit access to zone to workers actively engaged in constructing wall. Do not permit other persons to enter zone.

   d. Keep zone in place until wall is adequately supported or braced by permanent supporting elements to prevent overturning and collapse.

U. Grouting Equipment

1. Grout Pumps:

   a. Do not pump grout through aluminum tubes.

   b. Operate pumps to produce a continuous stream of grout without air pockets.

   c. Upon completion of each days pumping, eject grout from pipeline without contamination or segregation of the grout.

      1) Remove waste materials and debris from the equipment.

      2) Dispose of waste materials, debris, and all flushing water outside the masonry.

2. Vibrators:

   a. Internal vibrators shall maintain a speed of not less than 5,000 impulses per minute when submerged in the grout.

   b. Maintain at least one spare vibrator, at the site at all times.

c. Apply vibrators at uniformly spaced points not further apart than the visible effectiveness of the machine.

d. Limit duration of vibration to time necessary to produce satisfactory consolidation without causing segregation.

V. Efflorescence Tests

Perform efflorescence tests on mortar, which will be exposed to weathering. Tests shall be scheduled far enough in advance of starting masonry work to permit retesting if necessary.

END OF SECTION

SECTION 05120

STRUCTURAL STEEL

PART 1 GENERAL

A. Scope of Work

The CONTRACTOR shall furnish, fabricate, and place all structural steel and make all connections necessary to provide a complete work and in accordance with the Contract Documents.

B. References

1. Codes: All codes, as referenced herein, are specified in Section 01090, "Reference Standards."

2. American Institute of Steel Construction (AISC):

   a. Specification for Structural Steel Buildings—Allowable Stress Design and Plastic Design, excluding Section A7.1

   b. Allowable Stress Design Specification for Structural Joints using ASTM A325 or A490 Bolts.

   c. Manual of Steel Construction, Allowable Stress Design

   d. Seismic Provisions for Structural Steel Buildings

   e. Code of Standard Practice for Steel Buildings and Bridges, excluding Sections 3, 4, 7.11.3.3, 7.11.4, 7.11.5, and 7.13

   f. AISC Quality Certification Program

   g. AISC Erector Certification Program

3. American Society of Mechanical Engineers (ASME):

   BPVC SEC IX Qualification Standard for Welding and Brazing Procedures, Welders, Brazers, and Welding and Brazing

4. American Society of Nondestructive Testing (ASNT):

   ASNT-TC-IA Personnel Qualification and Certification in Nondestructive Testing

5. American Welding Society (AWS):

   D1.1 Structural Welding Code-Steel

QC 1	Standard for AWS Certification of Welding Inspectors

6. ASTM International (ASTM):

A6	Standard Specification for General Requirements for Rolled Structural Steel Bars, Plates, Shapes, and Steel Piling.
A36	Standard Specification for Structural Steel
A53	Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded and Seamless
A123	Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
A143	Standard Practice for Safeguarding Against Embrittlement of Hot-Dip Galvanized Structural Steel Products and Procedures for Detecting Embrittlement
A153	Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware
A307	Standard Specification for Carbon Steel Bolts and Studs, 60,000 PSI Tensile Strength
A325	Standard Specification for High-Strength Bolts for Structural Steel Joints
A384	Standard Practice for Safeguarding Against Warpage and Distortion During Hot-Dip Galvanizing of Steel Assemblies
A385	Standard Practice for Providing High-Quality Zinc Coatings (Hot-Dip)
A490	Standard Specification for Heat-Treated Steel Structural bolts, 150 ksi Minimum Tensile Strength.
A500	Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes
A501	Standard Specification for Hot-Formed Welded and Seamless Carbon Steel Structural Tubing
A563	Standard Specification for Carbon and Alloy Steel Nuts
A572	Standard Specification for High-Strength Low Alloy Columbium-Vanadium Structural Steel
A588	Standard Specification for High-Strength Low Alloy Structural Steel with 50 ksi Minimum Yield Point to 4 in. thick
A673	Standard Specification for Sampling Procedure for Impact Testing of Structural Steel
A780	Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings
A992	Standard Specification for Steel for Structural Shapes for Use in Building Frames
B695	Standard Specification for Coatings of Zinc Mechanically Deposited on Iron and Steel.
F436	Standard Specification for Hardened Steel Washers
F959	Standard Specification for Compressible-Washer-Type Direct Tension Indicators for Use with Structural Fasteners

F1852 Standard Specification for “Twist Off” Type Tension Control Structural Bolt/Nut/Washer Assemblies, Steel, Heat Treated, 120/150 ksi Minimum Tensile Strength

C. Submittals

1. Action Submittals:

   a. Provide shop drawings showing erection plans, member size and their connections.

   b. Anchor bolt layouts.

   c. Hardened washer details (if applicable).

   d. Joint details for complete penetration welds

   e. Schedules for fabrication procedures

   f. Primer and other coatings for items in this Section

   g. Name and address of manufacturer(s)

   h. Product specifications

   i. Manufacturers' testing procedures and standards

   j. Preparation and installation or application instructions, as appropriate

2. Informational Submittals:

   a. Mill Certificates of tests made in accordance with ASTM A6.

   b. High-Strength Bolts (Plain Noncoated and Hot-Dip Galvanized):

      1) Certificates of Compliance that products meet chemical and mechanical requirements of standards specified.

      2) Manufacturer's inspection test report results for production lot(s) furnished, to include:

         a) Tensile strength

         b) Yield strength

         c) Reduction of area

         d) Elongation and hardness

   c. Certified Mill Test Reports for Bolts and Nuts:

1) Name and address of manufacturer.

2) Bolts correctly marked.

3) Marked bolts and nuts used in required mill tests and manufacturer's inspection tests.

d. Direct Tension Indicators (DTIs): Furnish manufacturer's test report meeting requirements of ASTM F959.

e. Tension Control (TC) Bolts: Furnish manufacturer's test report meeting requirements of ASTM A325 and ASTM F1852.

f. Methods proposed to resolve misalignment between anchor bolts and bolt holes in steel members.

g. Welding Procedures, Qualifications, and Inspection Report

h. AISC Quality Certification: AISC certificate showing name and address of certified firm, effective date, and category of certification.

D. Quality Assurance

1. Mill identification marks in accordance with ASTM A6.

2. AISC Quality Certification for Fabricator: Conventional Steel Structures (Sbd).

3. Welding Qualifications:

a) Welding Procedure Specifications: In accordance with AWS D1.1 (Annex E) or ASME BPVC SEC IX (Forms QW-482 and QW-483).

b) Welder/Welding Operator Performance Qualifications: In accordance with AWS D1.1 (Annex E), or ASME BPVC SEC IX (Form QW-484).

c) Certified Welding Inspector: Certified in accordance with AWS QC1, and having prior experience with the welding codes specified.

d) Testing Agency: Personnel performing tests shall be Nondestructive Testing Level II Certified in accordance with ASNT SNT-TC-1A.

E. Delivery, Storage and Handling

1. Delivery: Load structural members in such a manner that they will be transported and unloaded without damage to coatings and without being excessively stressed, deformed, or otherwise damaged.

2. Storage:

a. Protect structural steel members and packaged materials from corrosion and deterioration.

b. Store in dry area and not in direct contact with ground.

c. Protect fasteners from dirt and moisture. Do not remove lubricant from bolts and nuts.

d. Handle materials to avoid distortion or damage to members or supporting structures.

PART 2 PRODUCTS

A. Materials

1. Rolled Plates, Shapes except W-Shapes, and Bars: ASTM A36, unless indicated otherwise.

2. W-Shapes: ASTM A992, unless indicated otherwise on Drawings.

3. Plate material for frame connections shall be ASTM A572, Grade 50, where indicated on Drawings.

B. Fasteners

1. Anchor Bolts: As specified in Section 05500, METAL FABRICATIONS AND CASTINGS.

2. High-Strength Bolts: ASTM A325 or ASTM A490, bolt type 1, galvanized. Bolt length and thread length shall be as required for the connection type shown, with hardened washers as required.

3. Machine Bolts (M.B.): ASTM A307

4. Nuts: ASTM A563, type to match bolt type and finish.

5. Hardened Steel Flat and Beveled Washers: ASTM F436, type to match bolt finish.

C. Ancillary Materials

1. Surface Preparation and Primer: As specified in Section 09900, PAINTING

2. Grout: As specified in Section 03600, GROUT.

D. Fabrication

1. General:

a. Fabricate as shown and in accordance with AISC Specification for Structural Steel Buildings and AISC Code of Standard Practice for Steel Buildings and Bridges.

b. Columns shall be full length members without splices, unless shown otherwise or approved by ENGINEER.

c. Mark and match mark materials for field assembly.

d. Complete assembly, including bolting and welding of units, before start of finishing operations.

e. Fabricate to agree with field measurements.

2. Connections:

a. Shop Connections: Weld or bolt, as shown.

b. Meet requirements of AISC Manual of Steel Construction tables for bolted double-angle shear connections, unless indicated otherwise.

c. Provide oversized holes for anchor bolts in column base plates in accordance with AISC Manual of Steel Construction, unless indicated otherwise.

3. Welded Construction:

a. Conform to governing welding codes for type of weld and material for each weld.

b. Groove and Butt Joint Welds: Complete penetration, unless otherwise indicated.

c. Interface with Other Work.

4. Holes:

a. As necessary or as indicated for securing other Work to structural steel framing, and for passage of other Work through steel framing members.

b. No flame-cut holes will be permitted without prior approval of ENGINEER.

c. Weld threaded nuts to framing, and other specialty items as shown to receive other Work.

5. Shop Paint Primer:

a. Surface Preparation and painting as specified in Section 09900, PAINTING.

b. Do not shop prime the following surfaces, unless indicated otherwise:

1) Faying surfaces of slip critical bolted connections.

2) Within 2 inches of field-welded connections.

3) Steel members to be completely encased in reinforced concrete or coated with cementitious fireproofing.

6. Galvanizing:

a. Fabricate steel to be galvanized in accordance with ASTM A143, A384, and A385. Avoid fabrication techniques that could cause distortion or embrittlement of steel.

b. Remove welding slag, splatter, burrs, grease, oil, paint, lacquer, and other deleterious material prior to delivery for galvanizing.

c. Remove by blast cleaning or other methods surface contaminants and coatings not removable by normal chemical cleaning process in the galvanizing operation.

d. Hot-dip galvanize steel members, fabrications, and assemblies after fabrication in accordance with ASTM A123.

e. Hot-dip galvanize A325 bolts, nuts, washers, and hardware components in accordance with ASTM A153.

f. Oversize holes to allow for zinc alloy growth.

g. Shop assemble bolts, nuts, and washers with special lubricant and test in accordance with ASTM A325 and A563.

h. Tension-control (TC) bolts, nuts, and washers shall be mechanically zinc coated in accordance with ASTM F1852 and B695, Class 50.

i. Galvanize components of bolted assemblies separately before assembly.

7. Slip Critical Bolted Connections:

a. Mask faying surfaces of slip critical (SC) bolted connections to be shop painted as specified in Section 09900, PAINTING.

b. Roughen galvanized faying surfaces with hand wire brushing.

E. Source Quality Control

1. Welding:

   a. Visually inspect fabrication welds in accordance with AWS D1.1, Section 6 and Table 6.1, Visual Inspection Acceptance Criteria.

   b. An independent testing agency will be retained by DISTRICT to perform the following inspection and testing of fabrication welds.

      1) Groove welds:

         a) Radiographic (RT) or ultrasonic (UT) testing for 10 percent of randomly selected welds, unless otherwise indicated.

         b) Use RT only for butt joint groove welds.

      2) Fillet welds larger than 5/16-inch: Liquid penetrant (PT) or magnetic particle (MT) for 10 percent of randomly selected welds, unless otherwise indicated.

      3) All Welds: 100 percent visually inspected (VT).

   c. The Certified Welding Inspector (CWI) shall perform inspection prior and during assembly, during welding, and after welding. CWI duties include:

      1) Verifying conformance of specified job material and proper storage.

      2) Monitoring conformance with approved Welding Procedure Specification.

      3) Monitoring conformance of Welder/Welding Operator Performance Qualification.

      4) Inspecting weld joint fit-up and in-process inspection.

      5) Providing 100 percent visual inspection of all welds.

      6) Supervising nondestructive testing personnel and evaluating test results.

      7) Maintaining records and preparing report confirming results of inspection and testing comply with the Work.

   d. Repair and retest rejected weld defects until sound weld metal has been deposited in accordance with appropriate welding codes.

2. Special inspection of fabrication process and shop welding will be provided by DISTRICT as indicated on Drawings.

3. Hot-Dip Galvanizing:

a. An independent testing agency will be retained by DISTRICT to inspect and test hot-dip galvanized fabricated items in accordance with ASTM A123 and A153.

b. Visually inspect and test for thickness and adhesion of zinc coating for minimum of three test samples from each lot in accordance with ASTM A123 and A153.

c. Reject and retest nonconforming articles in accordance with ASTM A123 and A153.

PART 3 EXECUTION

A. Steel Member Erection

1. Meet requirements of AISC Specification for Structural Steel Buildings and AISC Code of Standard Practice for Steel Buildings and Bridges, with exceptions as specified.

2. CONTRACTOR is responsible for design and installation of temporary bracing to support components as erection proceeds.

3. High-Strength Bolted Connections:

   a. Tighten in accordance with AISC Specification for Structural Joints Using ASTM A325 or A490 Bolts.

   b. Hardened Washers:

      1) Provide at locations required by Washer Requirements section of AISC Specification for Structural Joints Using ASTM A325 or A490 Bolts, to include slip critical connections using slotted or oversized holes or A490 bolts.

      2) Use beveled style and extra thickness where required by AISC Specification.

      3) Use square or rectangular beveled washers at inner flange surfaces of American Standard beams and channels.

      4) Do not substitute DTIs for hardened flat washers required at slotted and oversize holes.

   c. For bearing-type connections not fully tensioned (N, X), tighten to snug tight condition. Use hardened washer over slotted or oversize holes in outer plies.

4. Fully Tensioned Bolted Connections:

a. Use DTIs or TC bolts at slip critical (SC) and fully tensioned (FT) bearing-type connections.

b. DTIs:

1) Position within bolted assembly in accordance with ASTM F959.

2) Install bolts, with DTIs plus hardened washers as required, in all holes of an assembly and tighten until plies are in firm contact and fasteners are uniformly snug tight.

c. Final tighten bolts, beginning at most rigid part of bolted connection and progressing toward free edges, until final twist-off of TC bolts or until DTIs have been compressed to an average gap equal to or less than shown in Table 2, ASTM F959.

5. Welded Connections:

a. Welding and Fabrication by Welding: Conform to AWS D1.1 Structural Welding Code based on material and type of weld.

b. Groove and Butt Joint Welds: Complete penetration, unless otherwise indicated.

B. Anchor Bolts

1. Coordinate installation of anchor bolts and other connectors required for securing structural steel to in-place work.

2. Provide templates and other devices for presetting bolts and other anchors to accurate locations.

3. Projection of anchor bolts beyond face of concrete and threaded length shall be adequate to allow for full engagement of all threads of hold-down nuts, adjustment of leveling nuts, washer thicknesses, and construction tolerances, unless indicated otherwise.

4. Placement Tolerances:

a. As required by AISC Code of Standard Practice for Steel Buildings and Bridges, unless indicated otherwise.

b. Embedded anchor bolts shall not vary from the dimensions as shown on Drawings by more than the following:

1) Center to center of any two bolts within an anchor group: 1/8 inch.

2) Center to center of adjacent anchor bolt groups: 1/4 inch.

3) Variation from perpendicular to theoretical bearing surface: 1:50.

C. Setting Bases and Bearing Plates

1. Clean concrete and masonry bearing surfaces of bond reducing materials and roughen to improve bond to bearing surfaces.

2. Clean bottom surface of base and bearing plates.

3. Set loose and attached base plates and bearing plates for structural members on wedges, shims, leveling nuts, or other adjustable devices. Use leveling plates where indicated on Drawings.

4. Tighten anchor bolts after supported members have been positioned and plumbed. Do not remove wedges or shims, but if protruding, cut off flush with edge of base or bearing plate prior to placing grout. Weld plate washers to base plates where indicated in Drawings.

5. Grout Under Base plates: As specified in Section 03600, GROUT, prior to placing loads on structure.

D. Field Assembly

1. Set structural frames accurately to lines and elevations shown.

2. Clean bearing surfaces and other surfaces that will be in permanent contact before assembly.

3. Align and adjust various members forming a part of a complete frame or structure before permanently fastening.

4. Level and plumb individual members of structure within tolerances shown in AISC Code of Standard Practice for Steel Buildings and Bridges.

5. Establish required leveling and plumbing measurements on mean operating temperature of structure. Make allowances for difference between temperature at time of erection and mean temperature at which structure will be completed and in service.

6. Perform necessary adjustments to compensate for minor discrepancies in elevations and alignment.

7. Provide additional field connection material as required by AISC Code of Standard Practice for Steel Buildings and Bridges.

8. Splice members only where indicated and accepted on shop drawings.

E. Misfits at Bolted Connections

1. Where misfits in erection bolting are encountered, immediately notify ENGINEER for approval of one of the following methods of correction:

    a. Ream holes that must be enlarged to admit bolts and use oversized bolts.

    b. Plug weld misaligned holes and redrill holes to admit standard size bolts.

    c. Drill additional holes in connection, conforming with AISC Standards for bolt spacing and end and edge distances, and add additional bolts.

    d. Reject member containing misfit, incorrect sized, or misaligned holes and fabricate new member to ensure proper fit.

2. Do not enlarge incorrectly sized or misaligned holes in members by burning or using a drift pin.

F. Misfits at Anchor Bolts

1. Resolve misalignments between anchor bolts and bolt holes in steel members in accordance with approved submittal.

2. Do not flame cut to enlarge holes without prior approval of ENGINEER.

G. Gas Cutting

1. Do not use gas cutting torches in field for correcting fabrication errors in structural framing.

2. Secondary members not under stress and concealed in finished structure may be corrected by gas cutting torches, if approved by ENGINEER.

3. Finish flame-cut sections equivalent to sheared and punched appearance.

H. Repair and Cleaning

1. Immediately after erection, clean field welds, bolted connections, and abraded areas of shop primer.

2. Remove and grind smooth tack welds, fit-up-lugs, and weld runoff tabs.

3. Remove weld back-up bars and grind smooth where indicated on Drawings.

4. Apply touchup paint primer by brush or spray of same thickness and material as that used in shop application and as specified in Section 09900, PAINTING.

I. Repair of Damaged Hot-Dip Galvanized Coating

1. Conform to ASTM A780.

2. For minor repairs at abraded areas, use sprayed zinc conforming to ASTM A780.

3. For flame cut or welded areas, use zinc-based solder, or zinc sticks, conforming to ASTM A780.

4. Use magnetic gauge to determine that thickness is equal to or greater than base galvanized coating.

J. Field Quality Control

A. High-Strength Bolted Connections:

1. An independent testing agency will be retained by DISTRICT to perform the following inspection and testing in accordance with the AISC Specification for Structural Joints Using ASTM A325 or A490 Bolts:

a. Marking identification and conformance to ASTM standards.

b. Alignment of bolt holes.

c. Placement, type, and thickness of hardened washers.

d. Tightening of bolts.

2. Bearing-Type Connections Not Fully Tensioned (N, X): Snug tight condition with plies of joint in firm contact.

3. Fully Tensioned (FT) Bearing and Slip Critical (SC) Connections:

a. Conduct preinstallation test.

b. Monitor installation and tightening of DTIs or TC bolts.

c. Monitor condition of faying surfaces for slip critical connections.

4. Preinstallation Test:

a. Conduct jobsite test prior to start of work using a bolt tension measuring device.

b. Select representative sample of not less than three bolts of each diameter, length, and grade.

c. Include DTIs and flat hardened washers as required to match actual connection assembly.

d. Conduct test in accordance with Specification for Structural Joints Using ASTM A325 or A490 Bolts.

5. Nondestructive Testing (NDT) Report: Prepare and submit a written NDT report identifying location of inspected bolted connections and summary of corrections as required to meet code acceptance criteria.

6. Defective Connections: Correct and reinspect defective and improperly tightened high-strength bolted connections. Retest fully tensioned bolts as necessary to demonstrate compliance of completed work.

B. Welded Connections:

1. Visually inspect field welds in accordance with AWS D1.1, Section 6 and Table 6.1, Visual Inspection Acceptance Criteria.

2. An independent testing agency will be retained by DISTRICT to perform the following inspection and testing of field welds.

3. Unless otherwise specified, perform nondestructive testing (NDT) of welds at a spot testing frequency as shown below in accordance with the referenced welding codes. Perform ultrasonic on complete joint penetration groove welds that cannot be readily radiographed. In case there is a conflict the higher frequency level of NDT shall apply:

a. Complete Joint Penetration (CJP) Butt Joint Welds: 10 percent random Radiographic (RT).

b. Groove Welds:

1) Radiographic (RT) or ultrasonic (UT) testing for 10 percent of randomly selected welds, unless otherwise indicated.

2) Use RT only for butt joint groove welds.

c. Fillet Welds Larger Than 5/16 Inch: Liquid penetrant (PT) or magnetic particle (MT) testing for 10 percent of randomly selected welds, unless otherwise indicated.

d. Partial Joint Penetration (PJP) Groove Welds: 10 percent random PT or MT.

e. All Welds: 100 percent visually inspected (VT).

4. Weld Acceptance:

a. Visual Testing:

1) Structural Pipe and Tubing: AWS D1.1, paragraph 6.9, Visual Inspection, Tubular Connections.

2) All Other Structural Steel: AWS D1.1, paragraph 6.9, Visual Inspection, Statically Loaded Nontubular Connections.

3) Stud Connections: AWS D1.1, paragraph 7.8.1.

b. Ultrasonic Testing: Perform UT of CJP groove welds in accordance with AWS D1.1, paragraph 6.13.3, Class R Indications.

c. Radiographic Testing: Perform RT of CJP butt joint welds in accordance with AWS D1.1, paragraph 6.12.1.

d. PT or MT:

1) Perform on fillet and PJP groove welds in accordance with AWS D1.1, paragraph 6.10.

2) Acceptance shall be in accordance with VT standards specified above.

5. The CWI shall be present whenever field welding is performed. The CWI shall perform inspections prior and during assembly, during and after welding. CWI duties include:

a. Verifying conformance of specified job material and proper storage.

b. Monitoring conformance with approved WPS.

c. Monitoring conformance of WPQ.

d. Inspecting weld joint fit-up and in-process inspection.

e. Providing 100 percent visual inspection of all welds.

f. Supervising nondestructive testing personnel and evaluating test results.

g. Maintaining records and preparing report confirming results of inspection and testing comply with the Work.

6. Repair and retest rejected weld defects until sound weld metal has been deposited in accordance with appropriate welding codes.

C. Special inspection will be provided by DISTRICT as indicated on Drawings.

D. Welded Shear Studs: Inspect and test welded shear studs as specified in Section 05500, METAL FABRICATIONS AND CASTINGS.

END OF SECTION

SECTION 05300

METAL DECKING

PART 1 GENERAL

A. Scope of Work

Contractor shall furnish and install the metal decking product and all appurtenance complete and shall coordinate all of the work hereunder with the related work specified in other Sections, in accordance with the requirements of the Contract Documents.

B. Related Sections

Section 05120 Structural Steel
Section 05500 Miscellaneous Metal Work

C. References

1. Codes: All codes, as referenced herein

AISI	Specifications for the Design of Cold-Formed Steel Structural Members: American Iron and Steel Institute
ASTM A 653	Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
ASTM A 780	Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings.
ASTM A 924	Specification for General Requirements for Steel Sheet, Metallic-Coated by the Hot-Dip Process
DOD P-21035A	Paint, High Zinc Dust Content, Galvanizing Repair (metric); US Department of Defense

2. SDI Publication No. 27: Steel Deck Institute Design Manual for Composite Decks, Form Decks, Roof Decks and Cellular Metal Floor Deck with Electrical Distribution; Steel Deck Institute, Inc.

3. Manufacturers' Standards: In addition to the standards listed above, the metal deck products and their installation shall be in accordance with the manufacturer's published recommendations, specifications and I.C.C. report.

D. Action Submittals

1. General: Submittals shall be in accordance with the requirements of Section 01330, "Submittal Procedures."

2. Decking Submittal:

a. Provide a layout plan of decking showing type and section properties of the deck panel, reinforcing channels, pans, special jointing, and accessories.

b. Location of the openings, deck laps, and deck attachment details.

E. Submittals for Information

1. General: Submittals shall be in accordance with the requirements of Section 01330, "Submittal Procedures."

2. The manufacturer's specifications, literature, published installation instructions and current I.C.C. report for metal decking product shall be submitted to the ENGINEER.

3. Operation manuals for mechanical fastener installation tools.

4. Welder Qualifications: Submit evidence that welders employed in the work are currently certified under AWS qualification procedures.

F. Quality Assurance

1. Comply with the requirements of the following, except where exceeded by the Contract Documents or requirements of governing authorities:

   a. AISI “Specifications for the Design of Cold-Formed Steel Structural Members”

   b. AWS D1.3 “Structural Welding Code – Sheet Steel”

   c. SDI “Steel Deck Institute Design Manual for Composite Decks, Form Decks, Roof Decks and Cellular Metal Floor Deck with Electrical Distribution”

2. Welding processes and welding operators shall be qualified according to procedures specified in ANSI / AWS D1.1

3. An independent testing agency selected and paid by the DISTRICT shall inspect all field welds. If testing indicates that welds do not comply with requirements, the defective work shall be removed and replaced at no additional cost to the DISTRICT.

G. Delivery, Storage and Handling

1. Delivery of Materials: Manufactured materials shall be delivered in original, unbroken packages, containers, or bundles bearing the name of the manufacturer.

2. Storage: Separate sheets and store units on dry wood sleepers, sloped to promote drainage. Cover metal decking panels with waterproof material, ventilate to avoid condensation.

PART 2 PRODUCTS

A. Materials

1. Metal deck material shall conform to ASTM A 653, Structural Quality grade 33 or higher. See drawings for gauge of deck panel.

2. Galvanizing of the metal deck shall conform to ASTM A 924, G60 coating as defined in ASTM A653.

3. Galvanized surface repair shall be in conformance with Federal Specification DOD P-21035A.

4. Acceptable Manufacturers: Roof deck design is based on the following products.

   a. Steel Roof Deck:

      1) Verco; PLB-36 Gauge 20 (1 ½" deep)

      2) Approved equal

B. Accessories

1. Provide pour stops, column closures, end closures, cover plates, girder fillers, finish strips, reinforcing channels, and other accessories required for complete installation.

2. Accessories shall comply with requirements of SDI and deck manufacturer**.**

C. Mechanical Fasteners

1. Refer to Detail 1 on Sheet S-504 for metal decking fastener requirements.

2. Powder Driven Fasteners:

   a. 1/2-inch minimum diameter steel washer with 0.190-inch minimum diameter knurled shank and corrosion resistant coating.

PART 3 EXECUTION

A. General

1. The installation shall conform to applicable codes and the manufacturer's published or written recommendations, specifications, and published installation

instructions for the type of deck being installed. Work shall be coordinated with the work of other trades.

2. The roofing work shall be performed by an installer authorized by the roofing system manufacturer.

3. Contractor shall investigate the support framing and the conditions under which decking work is to be performed. Any unsatisfactory conditions shall be addressed prior to starting this work.

B. Installation

1. Decking shall be oriented perpendicular to the framing members.

2. Side seams shall be tight fitting and secured together in accordance with the Contract Documents.

3. The deck shall be welded to each of the lines of support and boundary edge as indicated in the Contract Documents.

4. No damaged pieces of decking shall be installed.

END OF SECTION

SECTION 05500

METAL FABRICATIONS AND CASTINGS

PART 1: GENERAL

A. Scope of Work

The CONTRACTOR shall furnish, fabricate, and install miscellaneous metalwork, such as connection plates, floor plates, appurtenances, complete, in accordance with the requirements of the Contract Documents.

B. References

1. The Aluminum Association, Inc. (AA):

    a. The Aluminum Design Manual

2. American Association of Highway Transportation Officials (AASHTO):

    a. HS-20 Truck Loading

3. American Galvanizers Association (AGA):

    a. Inspection of Products Hot-Dip Galvanized After Fabrication.

4. American Institute of Steel Construction (AISC):

    a. S329, Allowable Stress Design

    b. Specification for Structural Joints using ASTM A325 or A490 Bolts.

5. American Iron and Steel Institute (AISI):

    a. Stainless Steel Types

6. American Welding Society (AWS):

    D1.1 Structural Welding Code - Steel
    D1.2 Structural Welding Code - Aluminum
    D1.6 Structural Welding Code - Stainless Steel

7. ASTM International (ASTM):

A36/A36M	Specification for Carbon Structural Steel
A48	Specification for Gray Iron Castings
A53/A53M	Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless

A108	Specification for Steel Bars, Carbon, Cold-Finished, Standard Quality
A123/A123M	Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
A143	Practice for Safeguarding Against Embrittlement of Hot-Dip Galvanized Structural Steel Products and Procedure for Detecting Embrittlement
A153/A153M	Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware
A193/A193M	Specification for Alloy-Steel and Stainless Steel Bolting Materials for High-Temperature Service
A194/A194M	Specification for Carbon and Alloy Steel Nuts for Bolts for High-Pressure or High-Temperature Service, or Both
A240/A240M	Specification for Heat-Resisting Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels
A276	Specification for Stainless Steel Bars and Shapes
A278	Specification for Gray Iron Castings for Pressure-Containing Parts for Temperatures Up to 650 Degree
A283/A283M	Specification for Low and Intermediate Tensile Strength Carbon Steel Plates
A307	Specification for Carbon Steel Bolts and Studs, 60,000 PSI Tensile
A325	Specification for Structural Bolts, Steel, Heat Treated 120/105 ksi Minimum Tensile Strength
A380	Practice for Cleaning, Descaling, and Passivation of Stainless Steel Parts, Equipment, and Systems
A384	Practice for Safeguarding Against Warpage and Distortion during Hot-Dip Galvanizing of Steel Assemblies
A385	Practice for Providing High-Quality Zinc Coatings (Hot-Dip)
A489	Specification for Carbon Steel Lifting Eyes
A500	Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes
A501	Specification for Hot-Formed Welded and Seamless Carbon Steel Structural Tubing
A563	Specification for Carbon and Alloy Steel Nuts
A653	Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
A780	Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings
A786/A786M	Specification for Hot-Rolled Carbon, Low-Alloy, High-Strength Low-Alloy, and Alloy Steel Floor Plates

A793	Specification for Rolled Floor Plate, Stainless Steel
A967	Specification for Chemical Passivation Treatments for Stainless Steel Parts
A992/A992M	Specification for Steel for Structural Shapes for Use in Building Framing
B209	Specification for Aluminum and Aluminum-Alloy Sheet and Plate
B308/B308M	Specification for Aluminum-Alloy 6061-T6 Standard Structural Profiles
B429	Specification for Aluminum-Alloy Extruded Structural Pipe and Tube
B632/B632M	Specification for Aluminum-Alloy Rolled Tread Plate
D1056	Specification for Flexible Cellular Materials - Sponge or Expanded Rubber
F436	Specification for Hardened Steel Washers
F468	Specification for Nonferrous Bolts, Hex Cap Screws, and Studs for General Use
F593	Specification for Stainless Steel Bolts, Hex Cap Screws, and Studs
F594	Specification for Stainless Steel Nuts
F844	Specification for Washers, Steel, Plain (Flat), Unhardened for General Use
F1554	Specification for Anchor Bolts, Steel, 36, 55, and 105-ksi Yield Strength

8. International Code Council (ICC):

   a. Evaluation Reports for Concrete and Masonry Anchors.

9. NSF International (NSF):

10. Occupational Safety and Health Administration (OSHA):

29 CFR 1910.27	Fixed Ladders
29 CFR 1926.105	Safety Nets
29 CFR 1926.502	Fall Protection Systems Criteria and Practices

11. Specialty Steel Industry of North America (SSINA):

   a. Specifications for Stainless Steel

   b. Design Guidelines for the Selection and Use of Stainless Steel

   c. Stainless Steel Fabrication

   d. Stainless Steel Fasteners

C. Definitions

1. Submerged: Location at or below top of wall of open water-holding structure, such as a basin or channel, or surface inside a covered water-holding structure, or exterior face of below grade wall.

2. Interior Wet Area: Location inside building or structure where floor is sloped to floor drains or gutters and is subject to liquid spills or washdown, or where wall, floor, or roof slab is common to a water-holding or earth-retaining structure.

3. Interior Dry Area: Location inside building or structure where floor is not subject to liquid spills or washdown, nor where wall or roof slab is common to a water-holding or earth-retaining structure.

4. Corrosive Area: Containment area or area exposed to delivery, storage, transfer, or use of chemicals.

D. Submittals

1. Action Submittals:

   a. Shop Drawings:

      1) Metal fabrications such as pipe supports, ladders, fabricated supports or connection plates and floor plates. Show dimensions, indicate profile, size count and reference materials of construction by ASTM designation and grade, including welding and fastener information.

      2) Specific instructions for concrete anchor installation, including drilled hole size, preparation, placement procedures, and instructions for safe handling of anchoring systems.

   b. Design Calculations: Design calculations shall be prepared by a California licensed professional civil or structural engineer hired by the CONTRACTOR. The calculations shall be submitted for review and approved by the ENGINEER prior to fabrication.

      1) Calculations shall include, but not be limited to, ladders, pipe brackets, floor plates or support flanges, and fasteners.

      2) Calculations shall be stamped and signed by a California civil or structural professional engineer.

2. Informational Submittals:

   a. Concrete and Masonry Drilled Anchors:

1) Manufacturer's product description and installation procedures.

2) Current ICC evaluation report.

3) Adhesive Anchor Installer Certification.

E. Quality Assurance

1. Qualifications:

   a. All fabrication shall be performed in a County approved fabrication shop subject to special inspection in accordance with the CBC.

   b. Adhesive Anchor Installers: Trained and certified by manufacturer.

   c. Galvanized Coating Applicator: Company specializing in hot-dip galvanizing after fabrication and following procedures of Quality Assurance Manual of the American Galvanizers Association.

2. Special Inspection: The following portions of the work require continuous special inspection by a deputy inspector.

   a. Shop fabrication and field welding

   b. Installation of epoxy adhesive anchors in drilled holes

F. Delivery, Storage and Handling

1. Insofar as practical, factory assemble items specified herein. Assemblies that due to necessity have to be shipped unassembled shall be packaged and tagged in manner that will protect materials from damage and will facilitate identification and field assembly.

2. Package stainless steel items in a manner to provide protection from carbon impregnation.

3. Protect painted coatings and hot-dip galvanized finishes from damage due to metal banding and rough handling. Use padded slings and straps.

PART 2: PRODUCTS

A. General Requirements

1. Unless otherwise indicated, meet the following requirements:

Item	ASTM Reference
Steel Shapes and Plates	A36/A36M

Item	ASTM Reference
Steel Pipe	A501 or A53/A53M, Type E or S, Grade B
Structural Steel Tubing	A500, Grade B
Stainless Steel:	
Bars and Angles	A276, AISI Type 316
Shapes	A276, AISI Type 304
Steel Plate, Sheet, and Strip	A240/A240M, AISI Type 316
Bolts, Threaded Rods, Anchor Bolts, and Anchor Studs	F593, AISI Type 316, Condition CW
Nuts	F594, AISI Type 316, Condition CW
Steel Bolts and Nuts:	
Carbon Steel	A307 bolts, with A563 nuts
High-Strength	A325, Type 1 bolts, with A563 nuts
Anchor Bolts and Rods	F1554, Grade 55, with weldability supplement S1.
Eyebolts	A489
Threaded Rods	A36/A36M
Flat Washers (Unhardened)	F844
Flat and Beveled Washers (Hardened)	F436
Thrust Ties for Steel Pipe:	
Threaded Rods	A193/A193M, Grade B7
Nuts	A194/A194M, Grade 2H
Plate	A283/A283M, Grade D
Welded Anchor Studs	A108, Grades C-1010 thru C-1020
Aluminum Plates and Structural Shapes	B209 and B308/B308M, Alloy 6061-T6
Aluminum Bolts and Nuts	F468, Alloy 2024-T4
Cast Iron	A48, Class 50B or better

2. Bolts, Washers, and Nuts: Use stainless steel, hot-dip galvanized steel, zinc-plated steel, and aluminum material types as indicated in FASTENER SCHEDULE at end of this section.

3. Corrosion Protection: Unless otherwise indicated, miscellaneous metalwork of fabricated steel, which will be used in a corrosive environment and/or will be submerged shall be stainless steel unless noted otherwise.

B. Anchor Bolts and Anchor Bolt Sleeves

1. Cast-In-Place Anchor Bolts:

   a. Headed type, unless otherwise shown on Drawings.

   b. Material type and protective coating as shown in FASTENER SCHEDULE at end of this section.

2. Anchor Bolt Sleeves:

   a. Plastic:

      1) Single unit construction with corrugated sleeve.

      2) Top of sleeve shall be self-threading to provide adjustment of threaded anchor bolt projection.

      3) Material: High density polyethylene.

      4) Manufacturer: Sinco Products, Inc., Middletown, CT. (800-243-6753).

   b. Fabricated Steel: ASTM A36/A36M.

C. Concrete and Masonry Drilled Anchors

1. General:

   a. Use AISI Type 316 stainless, hot-dip galvanized, or zinc-plated steel, as shown in FASTENER SCHEDULE at end of this section.

   b. Product shall have a current evaluation reports by ICC.

2. Expansion Anchors:

   a. Manufacturers and Products:

      1) Simpson Strong-Tie.; Strong Bolt 2 Anchor.

      2) Approved Equal.

3. Epoxy Adhesive Anchors:

a. Threaded Rod:

1) ASTM F593 stainless steel threaded rod, diameter as shown on Drawings.

2) Length as required, to provide minimum depth of embedment.

3) Clean and free of grease, oil, or other deleterious material.

4) For hollow-unit masonry, provide stainless steel wire cloth screen tube to fit threaded rod.

b. Adhesive:

1) Two-component, designed to be used in adverse freeze/thaw environments, with gray color after mixing.

2) Cure Temperature, Pot Life, and Workability: Compatible for intended use and environmental conditions.

3) Nonsag, with selected viscosity base on installation temperature and overhead application where applicable.

c. Packaging and Storage:

1) Disposable, self-contained cartridge system capable of dispensing both components in the proper mixing ratio and fitting into a manually or pneumatically operated caulking gun.

2) Store adhesive cartridges on pallets or shelving in covered storage area, in accordance with manufacturer's written instructions.

3) Cartridge Markings: Include manufacturer's name, product name, material type, batch or serial number, and adhesive expiration date.

4) Dispose of cartridges if shelf life has expired.

d. Manufacturers and Products:

1) Simpson Strong-Tie Co., Inc., Pleasanton, CA; Structural Epoxy-Tie Adhesive SET-3G

2) Approved Equal.

D. Embedded Steel Support Frames for Floor Plate and Grating

1. Steel angle support frames to be embedded in concrete shall be stainless steel, ASTM A276, AISI Type 316, unless indicated otherwise.

2. Welded stainless steel anchors to stainless steel support frames.

E. Fabrication

1. General:

    a. Finish exposed surfaces smooth, sharp, and to well-defined lines.

    b. Furnish necessary rabbets, lugs, and brackets so work can be assembled in neat, substantial manner.

    c. Conceal fastenings where practical; where exposed, flush countersink.

    d. Drill metalwork and countersink holes as required for attaching hardware or other materials.

    e. Grind cut edges smooth and straight. Round sharp edges to small uniform radius. Grind burrs, jagged edges, and surface defects smooth.

    f. Fit and assemble in largest practical sections for delivery to site.

2. Materials:

    a. Use steel shapes, unless otherwise noted.

    b. Steel to be hot-dip galvanized: Limit silicon content to less than 0.04 percent or to between 0.15 and 0.25 percent.

    c. Fabricate aluminum in accordance with AA Specifications for Aluminum Structures – Allowable Stress Design.

3. Welding:

    a. Weld connections and grind exposed welds smooth. When required to be watertight, make welds continuous.

    b. Welded fabrications shall be free from twisting or distortion caused by improper welding techniques.

    c. Steel: Meet fabrication requirements of AWS D1.1, Section 5.

    d. Aluminum: By Gas Metal Arc (MIG) or Gas Tungsten Arc (TIG) process in accordance with AWS D1.2. Discoloration of exposed aluminum surfaces, whether or not due to welding, shall constitute a basis for rejection of the entire assembly.

    e. Stainless Steel: Meet requirements of AWS D1.6.

    f. Welded Anchor Studs: Prepare surface to be welded and weld with stud welding gun in accordance with AWS D1.1, Section 7, and manufacturer's instructions.

g. Complete welding before applying finish.

4. Painting:

a. Shop prime with rust-inhibitive primer as specified in Section 09900, PAINTING, unless otherwise indicated.

b. Coat surfaces of galvanized steel and aluminum fabricated items to be in direct contact with concrete, grout, masonry, or dissimilar metals, with electrolysis protective coating.

c. Do not apply protective coating to galvanized steel anchor bolts, unless indicated otherwise.

5. Electrolysis Protection:

a. Electrolysis protective material shall be alkali-resistant asphaltum base paint.

b. Manufacturers and product:

1) Koppers “Bitumastic 50”

2) Texaco “Cement 1401”

3) Approved equal

6. Galvanizing:

a. Fabricate steel to be galvanized in accordance with ASTM A143, ASTM A384, and ASTM A385. Avoid fabrication techniques that could cause distortion or embrittlement of the steel.

b. Provide venting and drain holes for tubular members and fabricated assemblies in accordance with ASTM A385.

c. Remove welding slag, splatter, burrs, grease, oil, paint, lacquer, and other deleterious material prior to delivery for galvanizing.

d. Remove by blast cleaning or other methods surface contaminants and coatings not removable by normal chemical cleaning process in the galvanizing operation.

e. Galvanize steel members, fabrications, and assemblies after fabrication by hot-dip method in accordance with ASTM A123/A123M.

f. Hot-dip galvanize bolts, nuts, washers, and hardware components in accordance with ASTM A153/A153M. Oversize holes to allow for zinc alloy growth. Shop-assemble bolts and nuts.

g. Galvanize steel sheets in accordance with ASTM A653.

h. Galvanize components of bolted assemblies separately before assembling. Galvanizing of tapped holes is not required.

7. Accessories: Furnish as required for a complete installation. Fasten by welding or with stainless steel bolts or screws.

F. Source Quality Control

1. Visually inspect all fabrication welds and correct any deficiencies.

a. Steel: AWS D1.1, Section 6 and Table 6.1, Visual Inspection Acceptance Criteria.

b. Aluminum: AWS D1.2.

c. Stainless Steel: AWS D1.6.

PART 3: EXECUTION

A. Installation of Metal Fabrications

1. General:

a. Install metal fabrications plumb or level, accurately fitted, free from distortion or defects.

b. Install rigid, substantial, and neat in appearance.

c. Install manufactured products in accordance with manufacturer's recommendations.

d. Obtain ENGINEER approval prior to field cutting steel members or making adjustments not scheduled.

2. Aluminum:

a. Do not remove mill markings from concealed surfaces.

b. Remove inked or painted identification marks on exposed surfaces not otherwise coated after installed material has been inspected and approved.

c. Fabrication, mechanical connections, and welded construction shall be in accordance with the AA Aluminum Design Manual.

3. Pipe Sleeves:

a. Provide sleeve where pipes pass through concrete or masonry.

b. Holes drilled with a rotary drill may be provided in lieu of sleeves in existing walls.

c. Provide a center seep ring flange for water stoppage on sleeves in exterior or water-bearing walls.

d. Provide a rubber caulking sealant or a modular mechanical unit to form a watertight seal in the annular space between pipes and sleeves.

B. Cast-in-Place Anchor Bolts

1. Accurately locate and hold anchor bolts in place with templates at the time concrete is placed.

2. Use anchor bolt sleeves for location adjustment and provide two nuts and one washer per bolt of same material as bolt.

3. Minimum Bolt Size: 1/2-inch diameter by 12 inches long, unless otherwise shown.

C. Concrete and Masonry Drilled Anchors

1. Begin installation only after concrete or masonry to receive anchors has attained design compressive strength.

2. Install in accordance with manufacturer's instructions.

3. Provide minimum embedment, edge distance, and spacing as shown on Drawings.

4. Use only type of drill, type of drill bit and diameter recommended by anchor manufacturer. Clean hole of debris and dust with brush and compressed air as recommended.

5. Using a non-destructive method, to locate reinforcing in substrate prior to drilling. If drilled hole is required to be abandoned, the hole shall be filled with cement grout, see Section 03600.

6. Epoxy Adhesive Anchors:

a. Do not install adhesive anchors when temperature of concrete is below 40 degrees F or above 100 degrees F.

b. Remove any standing water from hole with oil-free compressed air. Inside surface of hole shall be dry where required by manufacturer's instructions.

c. Do not disturb anchor during recommended curing time.

d. Do not exceed maximum torque as specified in manufacturer's instructions.

D. Common Machine Bolts and Nuts

1. General: Bolts shall be inserted accurately into the bolt holes without damaging the thread. Bolt heads shall be protected from damage during installation. Bolt heads and nuts shall rest squarely against the base metal. Where bolts are to be used on beveled surfaces having slopes greater than 1 in 20 with a plane normal to the bolt axis, beveled washers shall be provided to give full bearing to the head or nut. Where self-locking nuts are not furnished, bolt threads shall be upset to prevent the nuts from backing off.

2. Bolt Insertion: Bolts shall be of the length that will extend entirely through but not more than 1/4-inch beyond the nuts. Bolt heads and nuts shall be drawn tight against the work. Bolt heads shall be tapped with a hammer while the nut is being tightened. After having been finally tightened, the nuts shall be locked.

E. Electrolytic Protection

1. Aluminum and Galvanized Steel:

   a. Coat surfaces of galvanized steel and aluminum fabricated items to be in direct contact with concrete, grout, masonry, or dissimilar metals with electrolytic protection coating specified in this Section.

   b. Do not apply protective coating to galvanized steel anchor bolts or galvanized steel welded anchor studs, unless indicated otherwise.

   c. Allow coating to dry before installation of the material.

   d. Protect coated surfaces during installation.

   e. Should coating become marred, prepare and touch up in accordance with paint manufacturer's written instructions.

2. Titanium: Where titanium equipment is in contact with concrete or dissimilar metal, provide full-face neoprene insulation gasket, 3/32-inch minimum thickness and 70-durometer hardness.

3. Stainless Steel:

   a. During handling and installation, take necessary precautions to prevent carbon impregnation of stainless steel members.

b. After installation, visually inspect stainless steel surfaces for evidence of iron rust, oil, paint, and other forms of contamination.

c. Remove contamination in accordance with requirements of ASTM A380 and A967.

d. Brushes used to remove foreign substances shall utilize only stainless steel or nonmetallic bristles.

e. After treatment, visually inspect surfaces for compliance.

F. Painting and Repair of Galvanized Steel

1. Painted Galvanized Surfaces: Prepare and paint as specified in Section 09900, PAINTING.

2. Repair of Damaged Hot-Dip Galvanized Coating:

a. To prepare surface, remove all oil, grease, soil, and soluble material by cleaning with water and detergent (SSPC, SP1) followed by brush off blast cleaning (SSPC, SP 7), over an area extending at least 4 inches into the undamaged area.

b. For minor repairs at abraded areas, apply Galvinox, Galvo-Weld, Drygalv or equal zinc conforming to ASTM A780.

c. For flame cut or welded areas, use zinc-based solder, or zinc sticks, conforming to ASTM A780.

d. Use magnetic gauge to determine that thickness is equal to or greater than the base galvanized coating.

G. Fastener Schedule

1. Anchor Bolts Cast Into Concrete for Structural Steel Column Base Plates

a. Interior Dry Areas: Plain uncoated

b. Exterior and Interior Wet or Humid Areas: Stainless steel headed anchor bolts.

2. Anchor Bolts Cast Into Concrete for Equipment Bases

a. All Locations: Stainless steel headed anchor bolts, unless otherwise specified with equipment

3. Anchor Bolts Cast Into Concrete for Metal Fabrications and Structural Components

a. Interior Dry Areas: Hot-dip galvanized steel headed anchor bolts

b. Submerged, Exterior, Interior Wet, and Corrosive Areas: Stainless steel headed anchor bolts with fusion bonded coating – See Section 09900

4. Drilled Anchors for Metal Components to Cast-in-Place Concrete (e.g., Ladders, Handrail Posts, Electrical Panels, and Equipment)

a. Interior Dry Areas: Zinc-plated or stainless steel wedge or expansion anchors.

b. Submerged, Exterior, Interior Wet, and Corrosive Areas: Adhesive stainless steel anchors

5. Anchors in Grout-Filled Concrete Masonry Units

a. Exterior and Interior Wet and Dry Areas: Hot-dip galvanized steel headed anchor bolts.

6. Connections for Structural Steel Framing

a. Exterior and Interior Wet and Dry Areas: Galvanized headed bolts, unless noted otherwise

7. Connections for Steel Fabrications and Wood Components

a. Exterior and Interior Wet and Dry Areas: Hot-dip galvanized carbon steel bolted connections

8. Connections for Aluminum Components

a. All locations: Stainless steel bolted connections, unless otherwise specified with equipment.

9. All Others

a. All locations: Stainless steel fasteners

10. Antiseizing Lubricant: Use on all stainless steel threads.

11. Do not use adhesive anchors to support fire-resistive construction or where ambient temperature will exceed 120 degrees F.

END OF SECTION

SECTION 07182

WET WELL DAMP PROOFING

PART 1 GENERAL

A. Scope of Work

This section covers furnishing and applying coatings to the buried portion of the exterior of the new wet well and the exposed exterior walls of the existing wet well.

B. Reference

ASTM D412	Test Methods for Rubber Properties in Tension
ASTM D822	Recommended Practice for Operating Light- and Water-Exposure Apparatus (Carbon-Arc Type) for Testing Paint, Varnish, Lacquer, and Related Products
ASTM D903	Test Method for Peel and Stripping Strength of Adhesive Bonds
ASTM E96	Test Methods for Water Vapor Transmission of Materials

C. Submittals for Review

1. Section 01300 – Contractor Submittal: Procedures for submittals.

2. Manufacturer's data sheets showing the following information:

    a. Percent solids by volume.

    b. Minimum recommended dry-film thickness per coat for prime, intermediate and finish coats.

    c. Recommended surface preparation.

    d. Physical properties.

    e. Moisture vapor transmission.

    f. Application instructions including recommended equipment and temperature limitations.

D. Material, Delivery and Handling

1. All materials shall be delivered to the jobsite in its original unopened containers bearing the manufacturer's name, product name and batch number.

2. All coatings shall be stored in enclosed structures to protect them from weather and excessive heat and cold. Flammable coatings must be stored to conform with city, county and state safety codes for flammable coating or paint materials.

PART 2 MATERIALS

A. Damp Proofing Materials

1. Buried wet well exterior walls and exposed exterior walls of the existing wet well structure shall be coated with SELECT SHIELD 300A (phone no. 714/429-0808), CARBOLINE BITUMASTIC, or an approved equal in conformance with these specifications.

2. The material shall be an approved waterproofing/damproofing composition for use on exterior concrete and shotcrete surfaces.

3. Approved materials shall conform to the following physical properties:

   a. Percent solids: 50 minimum.

   b. Tack force time: 30 minutes approximate (initial set).

   c. Tensile stress: 150 psi minimum at 21 day (ASTM D412).

   d. Ultimate elongation: 150% minimum at 21 day (ASTM D412).

   e. Moisture vapor transmission: 0.03 perms at 21 day (ASTM E96).

   f. Ultra-violet resistance: No degradation (ASTM D822).

   g. Adhesion in peel (ASTM D903): 20 lbs. peel strength with 0% adhesion loss.

PART 3 EXECUTION

A. Equipment

The Contractor's coating equipment shall be designed for application of materials specified and shall be maintained in first class working condition. Compressors shall have suitable traps and filters to remove water and oils from the air. Contractor's equipment shall be subject to approval of the Engineer.

B. Surface Preparation

1. All concrete surfaces shall be prepared in accordance with the recommendations of the coating manufacturer.

2. The surfaces shall be thoroughly cleaned, if they are not free of grease, curing compounds or other deleterious matter, as recommended by the coating manufacturer.

C. Application

1. Two coats of SELECT SHIELD 300A, CARBOLINE BITUMASTIC, or an approved equal, shall be applied by brush, spray or roller to completely cover the buried wall at a maximum coverage of 80 square feet per gallon per coat, or, if smaller, at the manufacturers recommended usage rate.

2. Each coat shall be free of runs, skips, or “holidays”.

3. All work shall be done in accordance with the manufacturer’s recommendations, except as modified herein.

END OF SECTION

SECTION 07190

WATER REPELLENTS

PART 1 GENERAL

A. Scope of Work

Section Includes: Water repellent for masonry.

B. Definitions

Water Repellent: Resistance to penetration of water from rainfall.

C. System Description

Performance Requirements: Surfaces with water repellent shall be uniform in color with unaltered texture.

D. Submittals

1. Product Data

2. Samples: Water repellent applied on 8 inch by 8 inch substrates to receive water repellent, marked with application date and application rate.

3. Manufacturer's Application Instructions

E. Quality Assurance

1. Manufacturer Qualifications: Manufacturer of water repellents for minimum 5 years with satisfactory performance record.

2. Applicator Qualifications: Trained, approved, and accepted by water repellent manufacturer.

3. Spray Personnel Qualifications: Minimum 2 years of experience spraying exotic coatings.

4. Regulatory Requirements: Comply with volatile organic compound regulations.

5. Mock-ups:

    a. Apply water repellent on 8 by 8 foot mock-up walls. Use same equipment and procedures that will be used in applying material on walls.

    b. Test mock-up for water penetration 30 days after applying water repellent in accordance with field quality control.

c. When accepted by the Engineer, mock-up walls will be standard for walls.

F. Delivery, Storage and Handling

1. Deliver materials to site in manufacturer's original containers with seals unbroken and labeled with manufacturer's batch number.

2. Store materials in original, unopened containers in compliance with manufacturer's printed instructions.

G. Project Conditions

1. Environmental Requirements: Apply water repellent under temperature and relative humidity conditions before, during, and after application in accordance with manufacturer's instructions. Allow surfaces to dry for minimum 5 days after rains.

2. Make proper material allowance based upon substrate material and surface configuration when determining quantities of material.

H. Warranty

Contractor to warrant to furnish and apply water repellent on walls that experience water penetration because of failure of water repellent for minimum 5 years.

I. Maintenance

Extra Materials: Deliver water repellent in manufacturer's original unopened containers to District that equals minimum 1 percent of material supplied.

PART 2 PRODUCTS

A. Manufacturers

1. Water Repellent Sealer: Manufacturers; one of the following or equal:

   a. Rainguard Products, Inglewood, CA.

   b. PROSOCO, Inc., Kansas City, KS.

   c. Tnemec, Kansas City, MO.

   d. Degussa Building Systems, Shakopee, MN

B. Materials

1. Water Repellent Sealer for Concrete and Slump Block: Silane/Siloxane; Volatile

Organic Compound compliant; free of silicone oils, paraffin wax, or urethanes; one of the following or equal:

a. Rainguard, BLOK-LOK.

b. Chemprobe, Tnemec

c. Sure Klean Custom Masonry Sealer, PROSOCO

d. Hydrozo 40 VOC, Degussa Building Systems

C. Equipment

1. Spray Equipment: High-volume, low-pressure, airless, with maximum 60 pounds per square inch pressure.

   a. Pump: Non-atomizing, able to flow material on walls at minimum 1 to 1-1/2 gallons per minute.

   b. Orifice Size for Concrete, Slump Block, Exposed Concrete Aggregate, and Cement Plaster: 0.060 to 0.110 inches.

   c. Orifice Size for Brick, Clay Brick Tile, Brick Veneer, Stone, and Wood: 0.060 inches.

PART 3 EXECUTION

A. Examination

1. Carefully inspect installed construction. Verify that construction is ready for repellent application.

2. Require manufacturer's representative to verify that water repellent may be installed.

B. Preparation

1. Allow concrete or masonry walls to cure at least 30 days before applying water repellent.

2. Clean wall surfaces of soil, mud, efflorescence, or other detrimental materials.

3. Tuck-point or caulk cracks, other than hairline cracks.

4. Route out defective mortar joints, point with mortar and tool.

5. Moisture Content: Apply water repellent sealer when moisture content of substrate is 15 percent or less.

6. Test substrate surfaces for moisture content with "Electronic Moisture Register - Model B." Take 1 reading for each 200 square feet of wall area and tabulate results.

C. Application on Concrete, Concrete Block, and Exposed Concrete Aggregate

1. Apply water repellent in accordance with manufacturer's printed instructions.

2. Apply flood coat using low pressure spray equipment.

3. Start at top of wall and work down using overlapping horizontal passes.

4. Hold spray head 8 to 10 inches from surface so saturation coat runs freely down wall 6 to 10 inches below point of application on most substrates.

5. Spray by traveling horizontally to ensure uniform coverage.

6. Overlap each following pass by centering spray head on bottom line of the previous pass.

7. Trigger gun off at end of each pass to avoid applying excessive amount of material. Do not over apply.

8. Avoid application in hot windy weather as premature drying can cause whitish residue on walls.

D. Field Quality Control

1. Test water repellent with running water 20 days after application.

2. Notify the Engineer and manufacturer at least 72 hours in advance of test. Conduct test in the Engineer's and manufacturer's presence.

3. Use 3/4 inch garden hose with garden type spray nozzle, and outrigger or similar acceptable equipment. Place 8 to 10 feet from wall where designated by the Engineer. Aim nozzle so water strikes wall at 45 degree downward angle.

4. Run water onto wall at full available force for minimum 4 hours. Make provisions to collect run off water into containers for possible reuse.

5. Inspect interior surface of wall for evidence of moisture penetration.

6. Where evidence of moisture penetration is discovered, apply additional coat of water repellent on entire wall from corner to corner.

7. Test other locations where directed by the Engineer.

E. Cleaning

1. Concrete, Concrete Block, and Exposed Concrete Aggregate: Clean drips, runs, and overspray residue while still wet, using detergent and water. Clean application and spray equipment with detergent and water immediately following use.

2. Clean application and spray equipment according to the manufacturer's recommendations.

3. Remove excess materials, equipment, and debris incidental to water repellent application upon completion.

F. Protection

1. During application, protect water repellent treated and adjacent surfaces from damage.

2. Protect glass, aluminum, and other surfaces from overspray.

3. Protect concrete sidewalks from runoff. Soak with water immediately prior to application on adjacent walls.

4. Repair damaged areas promptly.

END OF SECTION

SECTION 07210

THERMAL INSULATION

PART 1 GENERAL

A. Description

1. Rigid insulation at roof.

B. Submittals

1. Product Data: Provide data on product characteristics, performance criteria,and product limitations.

2. Manufacturer's Installation Instructions: Include information on special environmental conditions required for installation and installation techniques.

3. Manufacturer's Certificate: Certify that products meet or exceed specifiedrequirements.

C. Field Conditions

1. Do not install insulation adhesives when temperature or weather conditions aredetrimental to successful installation.

D. Code Requirement

1. System shall be designed to meet the minimum wind design requirements of the applicable version of ASCE 7.

PART 2 - MATERIALS

A. Foam Board Insulation

1. Polyisocyanurate Board Insulation: Rigid cellular foam, complying with ASTM C1289; Type II, glass fiber mat facer one face.

    a. Flame Spread Index: 25 or less, when tested in accordance with ASTM E84.

    b. Smoke Developed Index: 450 or less, when tested in accordance with ASTME84.

    c. Compressive Strength: 16 psi (172 kPa)

d. Board Size: 48 x 96 inch (1220 x 2440 mm).

e. Insulation Board Thickness: 3 inches (26 mm) Minimum.

B. Accessories

1. Sheet Vapor Retarder: White polypropylene film reinforced with glass fiber square mesh, 20 mil (0.5 mm) thick.

2. Tape: Reinforced polyethylene film with acrylic pressure sensitive adhesive.

    a. Application: Sealing of interior circular penetrations, such as pipes or cables.

    b. Width: Are required for application.

3. Flashing Tape: Special polyolefin film with high performance adhesive.

    a. Application: Interior window and door sill flashing tape.

    b. Width: Are required for application.

4. Tape joints of rigid insulation in accordance with roofing and insulation manufacturers' instructions.

5. Adhesive/Fastener: Type recommended by insulation manufacturer for application.

PART 3 - EXECUTION

A. Examination

1. Verify that substrate, adjacent materials, and insulation materials are dry and thatsubstrates are ready to receive insulation.

2. Verify substrate surfaces are flat, free of fins or irregularities.

B. Foam Board Insulation Installation

1. Install insulation in accordance with manufacturer's instructions.

C. Protection

1. Do not permit installed insulation to be damaged prior to its concealment

END OF SECTION

SECTION 07600

FLASHING AND SHEET METAL

PART 1: GENERAL

A. Description

This section includes materials and installation of flashing and sheet metal.

B. Design Criteria

1. Obtain overall dimensions from drawings.

2. Conform to the recommendations of Architectural Sheet Metal Manual, Sheet Metal and Air Conditioning Contractor's National Association, Inc.

C. Submittals

1. Submit shop drawings in accordance with the General Conditions and in sufficient detail to show fabrication, installation, anchorage, and interface of the work of this section with the work of adjacent trades.

2. Submit manufacturer's catalog data and descriptive literature needed to show compliance with the specified requirements.

PART 2: MATERIALS

A. Galvanized Steel

Comply with ASTM A 525, 24 gauge minimum.

B. Aluminum

Comply with ASTM B 209, Alloy 3003, Temper H14, 0.032 inch minimum.

C. Nails

Use flathead, wire, barbed, slating type, galvanized steel nails, conforming to U.S. Federal Specification FF-N-105B, with steel components and sheet.

D. Screws

Use self-tapping sheet-metal type, conforming to U.S. Federal Specification FF-S-107C. Screw material shall be aluminum or steel matching the material to be fastened.

E. Solder for Galvanized Steel

Comply with ASTM B 32, Alloy Grade Sn50.

F. Sealant

Comply with U.S. Federal Specification TT-S-00230C, Type II, Class A.

G. Fabrication

Fabricate sheet metal with lines, breaks, and angles sharp and true surfaces free from objectionable wave, warp, or buckle. Fold exposed edges of sheet metal back to form 1/2-inch-wide hem on side concealed from view. Finish work free from water leakage under all weather conditions.

H. Product

1. McElroy Mater LOK-90

2. Or Approved Equal

PART 3: EXECUTION

A. Preparation for Installation

Verify that substrates are smooth and clean to extent needed for sheet metalwork. Verify that nails, cants, and blocking to receive sheet metal are installed and free of concrete and soil. Verify shapes and dimensions of surface to be covered.

B. Installation

1. Install work watertight, without waves, warps, buckles, fastening stresses, or distortion, allowing for expansion and contraction. Hem exposed edges. Angle bottom edges of exposed vertical surfaces to form drips. Clean and flux metals prior to soldering.

2. Common Lock Seams: 5/8-inch finished width. Four-ply loose lock.

3. Flat-Lock Seams: 3/4-inch finished width. Four-ply flat lock, malleted tight. Sweat full with solder.

4. Single-Corner Seams: 5/8-inch finished width. Three-ply loose lock. Corners lapped and soldered.

5. Lap Seams: 7/8-inch finished width.

6. Roof Penetration Flashing: Extend base flashing flange onto roof 6 inches minimum away from penetration. Extend flange upward around penetration to at least 8 inches above roofing felts. Solder lap joints.

C. Cleaning

As work progresses, neutralize excess flux with 5% to 10% washing soda solution and thoroughly rinse. Leave work clean and free of stains, scrap, and debris.

END OF SECTION

SECTION 07631

GUTTERS AND DOWNSPOUTS

PART 1 GENERAL

A. Section Includes

Gutters and downspouts.

B. Related Sections

Section 09900 Field painting of metal surfaces

C. References

ASTM B32	Solder Metal
ASTM B486	Paste Solder
FS O-F-506	Flux, Soldering, Paste and Liquid
FS TT-C-494	Coating Compound, Bituminous, Solvent Type, Acid Resistant
SMACNA	Architectural Sheet Metal Manual

D. Submittals

Product Data: Provide data on prefabricated components and general appearance of product.

E. Delivery, Storage, and Handling

1. Deliver, store, protect and handle products to site under provisions of Section 01650.

2. Stack preformed and prefinished material to prevent twisting, bending, or abrasion, and to provide ventilation. Slope to drain.

3. Prevent contact with materials during storage which may cause discoloration, staining, or damage.

PART 2 PRODUCTS

A. Materials

Aluminum: 0.032" thick minimum.

B. Components

1. Gutters: SMACNA Rectangular style profile.

2. Downspouts: SMACNA Square cross-section profile.

3. Accessories: Profiled to suit gutters and downspouts.

C. Accessories

1. Anchorage Devices: Type recommended by fabricator.

2. Gutter Supports: Brackets at 5’-0” o.c. maximum.

3. Downspout Supports: Straps at 6’-0” o.c. maximum.

4. Fasteners: Stainless steel.

D. Fabrication

1. Form gutters and downspouts of profiles and size indicated.

2. Fabricate with required connection pieces.

3. Form sections square, true, and accurate in size, in maximum possible lengths, free of distortion or defects detrimental to appearance or performance.

4. Hem exposed edges of metal.

5. Fabricate gutter and downspout accessories; seal watertight.

PART 3 EXECUTION

A. Examination

Verify that surfaces are ready to receive work.

B. Installation

1. Install gutters, downspouts, and accessories in accordance with manufacturer's instructions.

2. Join lengths with seams sealed watertight. Flash and seal gutters to downspouts and accessories.

3. Slope gutters 1/16 inch per foot.

4. Seal metal joints watertight.

END OF SECTION

SECTION 07900

JOINT SEALERS

PART 1 GENERAL

A. Scope of Work

This section covers the work necessary for sealed joints not specifically covered by other Sections of these Specifications, including sealant, sealant backup, and associated materials.

B. References

1. Commercial Standards:

ASTM D412	Test Methods for Vulcanized Rubber and Thermoplastic Rubbers and Thermoplastic Elastomers - Tension.
ASTM D624	Test Method for Tear Strength of Conventional Vulcanized Rubber and Thermoplastic Elastomer
ASTM C920	Specification for Elastomeric Joint Sealants

2. Federal Specifications:

TT-S-00227e	Sealing Compound: Elastomeric type, multi-component (for calking, sealing, and glazing in buildings and other structures)

C. Submittals

1. Submit in accordance with Section 01300, "CONTRACTOR SUBMITTALS", of the quantity, location and details for the ENGINEER's approval before materials are delivered to the project site.

2. Product Data demonstrating conformance with these specifications.

3. Samples, include color selections.

4. Manufacturer's Installation Instructions.

5. Warranty as required by this Section.

D. Environmental Conditions

Environmental Requirements: Do not apply sealant on wet or frosty surfaces or when surface temperature is higher than 120 degrees Fahrenheit or lower than recommended by the manufacturer.

PART 2 PRODUCTS

A. Synthetic Rubber Sealing Compound (Polyurethane)

1. Sealant shall be in conformance with FS TT-S-00227e, Type I for pourable grade, and Type II for nonsag, Class A; multi-part polyurethane. The sealant shall be able to cure at room temperature to firm, highly resilient rubber and able to perform satisfactory when continuously submerged in water or sewage and exposed to direct sunlight in dry condition. The sealant shall have the following properties determined at 75 degrees Fahrenheit and 50 percent relative humidity:

    a. Base: Polyurethane rubber.

    b. Solids: Minimum 97 percent.

    c. Application Time: Minimum 2 hours.

    d. Cure Time: Maximum 3 days.

    e. Tack Free Time: 24 hours.

    f. Ultimate Hardness: 35, within 5 Shore A.

    g. Tensile Strength: Minimum 300 pounds per square inch when tested in accordance with ASTM D 412.

    h. Ultimate Elongation: Minimum 550 percent when tested in accordance with ASTM D 412.

    i. Tear Resistance: Minimum 85 pounds per inch when tested in accordance with ASTM D 624 Die C.

    j. Temperature Service Range: 50 degrees to 200 degrees Fahrenheit.

2. Color: Gray to match concrete, unless indicated on the Drawings.

3. Manufacturers:

    a. Polymeric Systems, Inc., PSI 270 or PSI 270 SL.

    b. Pacific Polymers, Garden Grove, CA, Elastothane 227R.

    c. Approved equal

B. Silicone Sealant

1. The single component silicone sealant shall be in conformance with ASTM C 920, Type S, Grade NS, Class 25.

2. Manufacturers:

    a. Tremco, Proglaze.

b. Pecora Corp., Number 864.

c. Dow Corning, Number 795

d. General Electric, Number 1200 Series

e. Approved equal

C. Acrylic-Latex Sealant

1. Permanently flexible, nonstaining, and nonbleeding latex modified acrylic sealant compound, colors as selected by Engineer from manufacturer's standard options.

2. Manufacturers; one of the following or equal:

a. Tremco, Proglaze.

b. Pecora Corp., Number 864.

c. Sonneborn, Sonolac.

d. Approved equal

D. Synthetic Sponge Rubber Filler

1. Closed-cell expanded sponge rubber manufactured from synthetic polymer neoprene base, or resilient polyethylene foam backer rod.

2. Characteristics:

a. Suitable for application intended.

b. Strength: As necessary for supporting sealing compound during application.

c. Resiliency: Sufficient resiliency to prevent significant load transfer across joint.

d. Resistance to environmental conditions of installation.

e. Bonding: No bonding to the sealing compound.

f. Structure: Cellular, prevents wicking or absorption of water.

g. Compatibility with other materials in joint and acceptance by manufacturer of sealing compound.

h. Size: Minimum 25 percent greater than nominal joint width.

3. Manufacturers:

a. Presstite, Number 750.3 Ropax Rod Stock.

b. Rubatex Corp., Rubatex-Cord.

c. Approved equal

E. Related Materials

1. Primer: Nonstaining type, recommended by sealant manufacturer to suit application.

2. Joint Cleaner: Noncorrosive, nonstaining, compatible with joint forming materials and as recommended by sealant manufacturer.

3. Bond Breaker Tape: Pressure-sensitive tape recommended by sealant manufacturer to suit application.

PART 3 EXECUTION

A. Examination

1. Verify acceptability of joint dimensions, physical, and environmental conditions.

2. Verify that surfaces are dry, clean, and free of dirt, grease, curing compound, and other residue which might interfere with adhesion of sealants.

B. Preparation

1. Allow concrete to cure thoroughly before caulking.

2. Synthetic Sponge Rubber Filler:

   a. Prepare surfaces designated to receive filler in accordance with manufacturer's installation instructions.

   b. Do not stretch filler beyond its normal length during installation.

3. Caulking:

   a. Verify that surfaces are dry, clean, and free of dirt, grease, curing compounds, and other residue that might interfere with adhesion of caulking compound.

   b. Concrete, Masonry, Wood, And Steel Surfaces: Clean and prime in accordance with manufacturer's instructions prior to caulking.

4. Synthetic Rubber Sealing Compound:

   a. Ensure surfaces to which synthetic rubber must bond are dry and free of dust, dirt, and other foreign residue.

b. Heavy sandblasted caulking groove to sound surface, and prime with manufacturer's recommended primer for particular surface.

5. For sidewalks, pavements, and similar joints sealed with elastomeric sealants and subject to traffic and other abrasion and indentation exposures, fill joints to depth equal to 75 percent of joint width, but neither more than 5/8 inches deep nor less then 3/8 inches deep.

6. For normal moving building joints sealed with elastomeric sealants not subject to traffic, fill joints to depth equal to 50 percent of joint width, but neither more than 2 inch deep nor less than 1/4 inch deep.

7. For joints sealed with acrylic-latex sealants, fill joints to depth in range of 75 percent to 125 percent of joint width.

8. Use joint filler to achieve required joint depths, to allow sealants to perform properly.

9. Prepare surfaces and install synthetic sponge rubber filler in accordance with manufacturer's recommendations.

10. Do not stretch filler beyond normal length during installation.

11. Apply bond breaker when recommended by joint sealer manufacturer.

C. Installation

1. Synthetic Sponge Rubber Filler: Install filler in accordance with manufacturer's installation instructions.

2. Caulking, Joints, and Sealing:

   a. Construct expansion, contraction, and construction joints as indicated on the Drawings.

   b. Install pipe and conduit in structures as indicated on the Drawings.

   c. Caulk doors, windows, louvers, and other items installed in or over concrete openings inside and out.

   d. Use synthetic rubber sealing compound for caulking where indicated on the Drawings or as specified, except for masonry construction and where specified otherwise.

   e. Complete caulking prior to painting

   f. Verify that concrete is thoroughly cured prior to caulking.

   g. When filler compressible material is used, use untreated type

h. Apply caulking with pneumatic caulking gun.

i. Use nozzles of proper shape and size for application intended.

j. Maintain continuous bond between caulking and sides of joint to eliminate gaps, bubbles, or voids and fill joint in continuous operation without layering of compound.

k. Employ experienced applicators to caulk joints and seams in neat workmanlike manner.

l. To hasten curing of compound when used on wide joints subject to movement, apply heat with infra-red lamps or other convenient means.

m. Apply synthetic rubber sealing compound with pneumatic caulking tool or other acceptable method.

D. Cleaning

1. Clean surfaces adjacent to sealant as work progresses.

2. Remove excess uncured sealant by soaking and scrubbing with sealant cleaning solvent.

3. Remove excess cured sealant by sanding with Number 80 grit sandpaper.

4. Leave finished work in neat, clean condition.

E. Schedule

1. Synthetic Rubber Sealing Compound (Polyurethane), Non-sag Type II:

a. Use where indicated on the Drawings.

b. Water-bearing and earth-bearing concrete structures.

c. Joints in masonry, concrete vertical surfaces, and metal faced panels in vertical surfaces.

d. Joints between sheet metal flashing and trim.

e. Joints between sheet metal flashing and trim, and vertical wall surfaces.

f. Small voids between materials requiring filling for weathertight performance in vertical surfaces.

g. Surfaces in contact with bituminous materials in vertical surfaces.

h. Perimeters of frames of doors, windows, louvers, and other openings where

bonding is critical to airtight performance.

i. Expansion and control joints in masonry vertical surfaces.

2. Synthetic Rubber Sealing Compound (Polyurethane), Self-leveling Type I:

a. Use where indicated on the Drawings.

b. Expansion and control joints in masonry, concrete horizontal surfaces, and metal panels in horizontal surfaces.

c. Small voids between materials requiring filling for weathertight performance in horizontal surfaces.

d. Surfaces in contact with bituminous materials.

e. Pavement joints.

f. Perimeters of frames of doors, windows, louvers, and other openings in horizontal surfaces where bonding is critical to airtight performance.

3. Silicone:

a. Use where indicated on the Drawings.

b. Joints and recesses formed where window, door, louver and vent frames, and sill adjoin masonry, concrete, stucco, or metal surfaces.

c. Door threshold bedding.

d. Moist or wet locations, including joints around plumbing fixtures.

e. Stainless steel doors and frames, including joints between applied stops and frames, and around anchor bolts.

f. Plenum joints.

4. Acrylic Latex

a. Use where indicated on the Drawings.

b. Interior joints with movement less than 7.5 percent and not subject to wet conditions.

END OF SECTION

SECTION 08110

STEEL DOORS AND FRAMES

PART 1 GENERAL

A. Description

1. Section Includes:

   a. Steel doors

   b. Steel door frames

B. Related Work Specified Elsewhere

Section 04220	Concrete Masonry Units
Section 08710	Finish Hardware
Section 09900	Painting and Coating

C. Reference Specifications, Codes and Standards

1. Codes: All codes, as referenced herein.

2. Commercial Standards:

ASTM A 366	Standard Specification for Steel, Sheet, Carbon, Cold-Rolled Commercial Quality
ASTM A 525	Standard Specification for General Requirements for Steel Sheet, Zinc Coated (Galvanized) by the Hot-Dip Process.
ASTM A 526	Standard Specification for Steel Sheet, Zinc Coated (Galvanized) by the Hot-Dip Process Commercial Quality.
ASTM A 569	Standard Specification for Steel, Carbon (0.5 Maximum Percent), Hot-Rolled Sheet and Strip, Commercial Quality
ASTM E 152	Standard Methods of Fire Tests of Door Assemblies

3. National Association of Architectural Metal Manufacturers (NAAMM):

HMMA 810	Hollow Metal Doors
HMMA 861	Guide Specifications for Commercial Hollow Metal Doors and Frames

4. National Fire Protection Association (NFPA):

NFPA 80	Fire Doors and Windows
NFPA 252	Standard Methods of Fire Tests of Door Assemblies

5. Steel Door Institute (SDI):

SDI 100	Standard Steel Doors and Frames
SDI 117	Manufacturing Tolerances Standard Steel Doors and Frames

6. Underwriters Laboratories Inc. (UL):

UL 10B	Fire Tests of Door Assemblies

D. Submittals

1. Product Data.

2. Shop Drawings: Show the following with references to the Engineer's door marks and hardware groups:

   a. Location of door and frame types.

   b. Details of fabrication, including core construction, glass lights, louvers, weatherstripping, and factory finish for each door.

   c. Cut-outs and reinforcements for hardware.

   d. Methods of installation and anchorage to adjacent construction.

3. Certificates of Compliance: Submit certificates certifying compliance with designated standards, governing codes, and applicable labeling agencies.

4. Manufacturer's Instructions: Submit manufacturer's installation instructions.

5. Certifications: Manufacturer's certification that oversize fire-resistive doors conform to Specifications.

E. Quality Assurance

Testing Agency Qualifications: Approved by ultimate enforcing authority for the Project; regularly engaged in inspection of materials and workmanship at factory.

F. Delivery, Storage and Handling

1. Before delivery, identify type and size of each door and frame in such a way that markings will not damage finish.

2. Preassemble door frames in shop and deliver to Project site with spreader bar at sill or tie them in pairs to form box.

3. Protect doors and frames with resilient packaging sealed with heat shrunk plastic. Break seal on-site to permit ventilation.

4. Protect doors and frames during shipment and storage to prevent warping, bending, and corrosion.

G. Sequencing and Scheduling

Ensure timely delivery of reviewed hardware schedule and hardware templates such that no delay occurs in the work of the Contract.

PART 2 MATERIALS

A. Materials

1. Sheet Steel: ASTM A 366, commercial quality, level, cold rolled steel, or ASTM A 569, hot rolled, pickled and oil rolled steel. Galvanize by hot-dip process with zinc-coating conforming to ASTM A 525 and A 526 A 60, with a coating weight of not less than 0.60 ounces per square foot (0.30 ounces per square foot per side).

2. Clips, Bolts, Screws, and Rivets: Sized as recommended by manufacturer.

3. Primer: Rust-inhibitive metal primer capable of being baked and compatible with finish painting system specified in Section 09900.

4. Touch-up Materials: Primer as recommended by manufacturer.

5. Finished Hardware: As specified in Section 08710.

6. Grout: As specified in Section 03600.

B. Door and Frame Types

1. Exterior Doors: SDI-100, Level 3, Model 3, or NAAMM HMMA 810 Type A, flush steel rib-stiffened, minimum 16 gauge face sheets.

2. Exterior Frames: SDI-100 or NAAMM HMMA 861, fully welded frames HMMA 861, except minimum 14 gauge sizes and shapes as indicated on the Drawings.

C. Components

1. Door Cores:

   a. Stiffeners: Vertical steel ribs formed from minimum 22-gauge plain sheet steel, spaced at maximum 6 inches apart and securely attached to face sheets by spot welds at maximum 5 inches on center.

   b. Core Fillers: Insulation, minimum 0.60 pound density noncombustible type, installed in spaced between stiffeners for full height of door; labeled door

core material shall conform to requirements of labeling authority.

D. Fabrication of Frames

1. Frames: Sheet steel, integral type, welded continuous to full depth of frames with minimum 5/8 inch deep stops, unless otherwise indicated on the Drawings.

2. Hardware Reinforcement: Minimum 7 gauge at hinges; 12 gauge at strikes, bolts, closers, and other applied hardware.

3. Jamb Anchors: As required for adjacent wall construction, minimum 3 per jamb, unless otherwise indicated on the Drawings;

4. Floor Anchors: Fixed type, except where adjustable anchors are indicated on the Drawings, 1 per jamb, with minimum 2 holes for anchorage. Where floor fill occurs, terminate bottom of frames at indicated finished floor level and support by adjustable extension clips resting on and anchored to structural slabs.

5. Anchors at Masonry: Adjustable strap and stirrup, minimum 16 gauge corrugated or perforated steel at maximum of 30 inches on center and extending minimum 8 inches into masonry.

6. Anchors for Fire Resistive Frames: Conform to requirements of labeling authority having jurisdiction.

7. Masonry Angle Stiffeners: Factory welded into heads of frames for installation in openings more than 48 inches wide.

8. Mullions, Muntins, and Transom Bars: Minimum 18 gauge, tubular sheet steel matching, and butt-welded to, head and jamb members.

9. Removable Stops: Fasten and approximately 12 to 16 inches on center.

E. Fabrication of Doors

1. Reinforce face sheets with steel rib stiffeners, spaced at maximum 6 inches apart, and securely attached to face sheets by spot welds at maximum 5 inches on center.

2. Coat inner surfaces of face sheets with layer of synthetic resin based sound deadener and fill voids between face sheets and stiffeners with core filler material.

3. Edges: Bevel striking edge 1/8 inch in 2 inches.

4. Tops and Bottoms of Doors: Close with continuous recess steel channel of minimum 16 gauge, extending full width of door and spot welded to both faces.

5. Tops and Bottoms of Exterior Doors: Flush closing channels welded to make tops and bottoms waterproof with weep holes for escape of moisture.

6. Hinge Reinforcement: 7 gauge.

7. Lock, Closer, and Flush Bolt Reinforcement: 12 gauge.

8. Astragals: Do not provide astragal cutouts for hardware operations.

9. Astragal Clearances for Fire Resistive Rated Doors:

   a. Door bottoms at doors designated to receive non-combustible threshold: Not to exceed 3/8 inch between threshold and door bottom.

   b. Door bottoms where there is no threshold: Maximum clearance between door and floor not to exceed 1/2 inch.

   c. Door bottoms at doors designated to receive combustible floor coverings: Not to exceed 1/2 inch between floor covering and door bottom.

   d. Clearance between door and frame and between meeting edges of pairs of doors: Not to exceed 1/8 inch.

10. Astragal Clearances for Non-Fire Resistive Rated Doors: Same as fire resistive rated doors, unless otherwise indicated on the Drawings.

F. Fabrication of Fire Rates Doors and Frames

1. Fabricate to meet requirements of NFPA 252, UL 10B, and ASTM E 152, except hose stream test shall not be required for opposite swing double egress exit doors and for doors of fire endurance rating of less than 45 minutes with or without approved glass lites.

2. Temperature Rise Requirements at Doors at Exit Enclosures: Maximum transmitted temperature end point of less than 450 degrees Fahrenheit above ambient at end of 30 seconds when tested in accordance with NFPA 252.

3. Apply approved testing agency labels on fire rated doors and frames.

4. Fabricate oversized fire rated doors in accordance with requirements for ratings indicated on the Drawings.

G. Hardware Preparation

1. Cut-out, drill, and reinforce frames and doors for hardware in accordance with hardware templates.

2. Install plaster guards or mortar boxes in back of hardware cut-outs in and welded to frames.

3. Prepare fire resistive rated doors for hardware in accordance with requirements of labeling authority.

4. Do not weld hinges to door frames.

5. Silencers:

   a. Drill single leaf door frame jamb stops for minimum 3 silencers.

   b. Drill double-leaf door frame Head stops for minimum 2 silencers.

   c. Do not door frames with weatherstripping for silencers.

H. Finishing

1. Thoroughly clean surfaces of oil, grease, and other impurities; touch-up abraded galvanizing; and chemically etch.

2. Fill irregularities and sand smooth finish surface.

3. Apply 1 coat of manufacturer's standard rust inhibitive baked-on primer.

4. Finish Painting: As specified in Section 09900.

PART 3 EXECUTION

A. Examination

1. Examine reviewed hardware schedules and verify proper coordination of hardware and doors and frames.

2. Examine Opening Locations and Verify Following:

3. Correctness of dimensions, backing or support conditions.

4. Absence of defects that would adversely affect frame or door installation.

B. Installation

1. Install doors and frames in accordance with approved shop drawings and manufacturer's written instructions.

2. Frames:

   a. Set accurately in position, plumb, align, and attach securely to structure.

   b. Set in place before construction of adjacent masonry or framed walls.

   c. Anchor frames to previously placed concrete.

   d. Set frames before removing spreader bars.

e. Fully grout frames in masonry as the Work progresses.

f. Grout frames at concrete through keyways provided at head and jambs.

3. Doors: Install at correct openings, ensure smooth swing and proper closure with frame.

4. Fire Resistive Frames and Doors: Install to conform to NFPA 80 for fire resistive rated class as indicated on the Drawings.

5. Door Hardware: Install in accordance with Section 08710.

6. Separate or isolate dissimilar metals with neoprene gaskets, sleeves, and washers, or with coatings acceptable to the Engineer.

C. Tolerances

Manufacturing and Installation Tolerances: As indicated on the Drawings or in conformance to SDI 117 as minimum.

D. Adjusting and Cleaning

1. Prime Coat Touch-up: Immediately after installation, sand smooth and touch-up rust areas and other areas where primer has been damaged, with prime touch-up paint.

2. Make adjustments as required for correct, proper, and free function and smooth operation without binding of hardware or doors and frames.

3. Protect doors and frames from damage to surface or profile.

END OF SECTION

SECTION 08710

FINISH HARDWARE

PART 1 GENERAL

A. Summary

1. Provide finish hardware throughout the Work as specified herein and as needed for a complete and proper installation.

2. Related work:

   a. Documents affecting work of this Section include, but are not necessarily limited to, General Conditions, Supplementary Conditions, and Sections in Division l of these Specifications.

   b. Installation of finish hardware is described in other Sections of these Specifications.

B. Submittals

1. Comply with pertinent provisions of Section 01300.

2. Product Data: Within 45 calendar days after the Contractor has received the DISTRICT's Notice to Proceed, submit:

   a. A "Door Schedule" listing all doors in the Work, and all other locations requiring finish hardware (a copy of the Door Schedule included in the Drawings may be used for this purpose), and assigning a "Hardware Group" to each such door and other location.

   b. A "Finish Hardware Schedule" listing each of the proposed "Hardware Groups," and defining in detail the proposed contents of each Hardware Group.

      1) Show the quantity of each type of item proposed to be supplied within each Hardware Group;

      2) Show the dimensions, when pertinent, and the manufacturer's catalog number;

      3) Show the finish of each item;

      4) Show the manufacturer's name by a suitable legend.

3. Samples:

   a. Within 15 calendar days after being so requested by the Construction Manager, deliver to the Construction Manager Samples of each finish

hardware item.

b. All Samples will be returned to the Contractor, provided those Samples which are approved by the Construction Manager are positively identified and are installed in the Work at locations agreed to by the Construction Manager.

4. In a timely manner to assure orderly progress of the Work, deliver templates or physical samples of the approved finish hardware items to pertinent manufacturers of interfacing items such as doors and frames.

C. Quality Assurance

1. Provide the services of an AHC or DAHC member of the Door Hardware Institute to:

   a. Be available for consultation with the Construction Manager at no additional cost to the DISTRICT during progress of construction;

   b. Be present at completion of construction, and:

      1) Inspect installation of all finish hardware items;

      2) Make minor adjustments as required; and

2. Report to the Construction Manager on completeness of the installation.

3. The hardware consultant may be an employee of the supplier.

D. DELIVERY, STORAGE, AND HANDLING

Individually package each unit of finish hardware, complete with proper fastenings and appurtenances, clearly marked on the outside to indicate contents and specific locations in the Work.

PART 2 PRODUCTS

A. General

1. Fasteners:

   a. Furnish necessary screws, bolts, and other fasteners of suitable size and type to anchor the hardware in position for long life under hard use.

   b. Where necessary, furnish fasteners with expansion shields, toggle bolts, sex bolts, and other anchors approved by the Construction Manager, according to the material to which the hardware is to be applied and according to the recommendations of the hardware manufacturer.

2. Where butts are required to swing 180 degrees, furnish butts of sufficient throw to clear the trim.

3. Furnish silencers for door frames at the rate of three for each single door and two for each door of pairs of doors; except weatherstripped doors and doors with light seals or sound seals.

B. Keys and Keying

1. Contractor shall provide CyberLock cylinders (no exceptions)

2. DISTRICT to facilitate programming of all CyberLock cylinders BEFORE installation in the doors or door hardware.

3. Construction keying:

   a. No keys to be provided by the Engineer. All keys to be issued by the DISTRICT.

   b. Construction keys, issued by the DISTRICT, to be returned upon completion. DISTRICT will provide two (2) keys total.

C. Tools and Manuals

With the delivery of permanent keys, deliver to the DISTRICT one complete set of adjustment tools and one set of maintenance manuals for locksets, latchsets, closers, and panic devices.

D. Acceptable Products

1. Single source for items:

   a. Except as specifically otherwise approved by the Construction Manager, furnish for each item (such as "door butt type 1") only the product of a single manufacturer (such as "Hager BB-800").

   b. To the maximum extent practicable, furnish similar items (such as "door butts") only as the product of a single manufacturer (such as "Hager").

2. For each of the required items of finish hardware, provide from the following list of acceptable products, or equals approved in advance by the Construction Manager.

   a. Door Butts / Hinges:

      1) Stanley;
      2) Hager;
      3) McKinney.

b. Locksets:

1) Locksets and Latchsets

a) All locksets and latchsets shall be mortise type with anti-friction 2-piece latchbolts with a minimum 3/4-inch-throw and 1-inch-throw dead bolts with hardened roller inserts.

b) Locksets and latchsets at fire rated doors shall meet Uniform Building Code and Uniform Fire Code requirements and shall be modified as necessary. All locksets, latchsets, privacy sets, and passage sets shall be provided with lever handles conforming to handicapped person requirements unless specified elsewhere. All locksets and latchsets shall be provided with satin stainless steel finish 630 (US 32D) unless otherwise specified.

c) ets shall be provided with satin stainless steel finish 630 (US 32D) unless otherwise specified.

d) Function of locksets or latchsets shall be appropriate for the use of the door to which it is attached.

e) Mortise deadlocks shall be of weight and quality comparable to locksets and latchsets specified.

f) Lock strikes shall be boxed type of sufficient length and having curved lips to protect the trim and jambs and be so shaped as to avoid the possibility of tearing clothing. All strikes shall be provided with metal strike boxes.

g) All locks shall be provided with the CyberLock cylinders. The Contractor shall swap out standard cylinders for CyberLock cylinders. DISTRICT to facilitate programming of all CyberLock cylinders.

h) The CyberLock cores compatible with the rim cylinder housings.

i) Padlocks shall be heavy-duty type, keyed as directed and shall be of same manufacturer as locksets.

j) Locksets and latchsets shall be manufactured by the following or equal:

i. Allegion Schlage

ii. Corbin Russwin

iii. Sargent

iv. Schlage

v. Yale

c. Latchsets:

1) Sargent;
2) Schlage;
3) Assa Abloy

d. Door closers:

1) Sargent;
2) Norton;
3) LCN.

e. Exit (Panic) devices:

1) Von Duprin;
2) Yale.
   a) Single Door: 7100(F)
   b) Double Doors: 7130(F) Mortise

f. Door stops (Wall, Floor, etc.):

1) Quality;
2) Builders Brass Works.
3) Rockwood

g. Kick Plates:

1) Construction Specialties Inc;
2) Pawling Corporation.
3) Rockwood

3. Finishes: Provide finish hardware with finish selected by the Construction Manager from standard finishes of the approved manufacturers in the actual items selected.

E. Other Materials

Provide other materials, not specifically described but required for a complete and proper installation, as selected by the Contractor subject to the approval of the Construction Manager.

PART 3 EXECUTION

A. Deliveries

Stockpile items sufficiently in advance to assure their availability and make necessary deliveries to the job site in a timely manner to assure orderly progress of the total Work.

B. Coordination

Coordinate as necessary with other trades to assure proper and adequate provision in the work of those trades for interface with the work of this Section.

END OF SECTION

ATTACHMENT

HARDWARE LIST

Hardware Sets are as follows: "X"-1 for exterior single doors; "X"-2 for exterior double doors; where "X" = Hardware Designation (H, L, C, T, etc.).

HINGES:

H-1 and H-2:Stanley, PBB 4B51, 4 1/2 x 4 1/2, NRP, US32D

LOCKSETS:

L-1 and L-2:Sargent, 8200, function 45, mortise type, US32D

CLOSERS:

C-1 and C-2:Sargent, 351-H

THRESHOLDS:

T-1 and T-2: Pemko, 170A

SILENCERS:

SI-1 and SI-2:

WEATHERSTRIPPING:

W-1 and W-2:Pemko, 303 AS

FLUSH BOLTS:

B-1 and B-2: Quality, 1358, US26D with dustproof strikes

DOOR BOTTOMS:

D-1 and D-2: Pemko, 222AV for steel doors, clear anodized

KICK PLATES

K-1 and K-2: Construction Specialties, Inc. or Pawling Corporation

EXIT DEVICES:

E-1 and E-2:Von Duprin, 9875/9975, mortise type, US32D

STOPS:

S-1 and S-2: Quality, 302 wall bumper (concave), US26D

SECTION 09809

POLYURETHANE COATING

PART 1 GENERAL

1.01 SECTION INCLUDES

A. The Work of this Section includes requirements for surface preparation, concrete repairs and polyurethane coating application to the interior of existing wet well, the interior of the new twelve (12) foot diameter manhole, and the interior of the modified pump room.

B. A brief description of the rehabilitation work on the existing dry pit is provided in Appendix X

1.02 REFERENCES

A. ASTM D4414 – Standard Practice for Measurement of Wet Film Thickness of Organic Coatings by Notched Gages

B. ASTM D4541 – Pull-off Strength of Coatings Using a Portable Adhesion Tester.

C. ASTM – The published standards of the American Society for Testing and Materials, West Conshohocken, PA.

D. NACE – The published standards of National Association of Corrosion Engineers (NACE International), Houston, TX.

E. SSPC – The published standards of the Society of Protective Coatings, Pittsburgh, PA.

F. ASTM D4263 – Standard Method for Indicating Moisture in Concrete by the Plastic Sheet Method.

1.03 SUBMITTALS

A. The following items shall be submitted in accordance with the Section 01330:

1. Technical data sheet on each product used, including ASTM test results indicating the product conforms to and is suitable for its intended use per these specifications.
2. Material Safety Data Sheets (MSDS) for each product used.
3. Four project references for each type of application with contact names and phone numbers that used the submitted coating material for coating sewer manholes and wet wells (a total of eight project references). The total number of manholes shall be at least 100. All projects shall be at least three years old with no coating failures.
4. Applicator Qualifications:
    a. Manufacturer certification that Applicator has been trained and approved in the handling, mixing and application of the products to be used.

b. Certification by the protective coating manufacturer that the equipment to be used for applying the products has been approved and Applicator personnel have been trained and certified for proper use of the equipment.

c. Five recent references for the Applicator of projects of similar size and scope indicating successful application on underground concrete substrates of the specified coating.

d. Three recent references for the project foreman of similar size and scope indicating successful surface preparation and coating application on underground concrete substrates of the specified coating.

e. Proof of any necessary federal, state or local permits or licenses necessary for the project.

5. Design details and descriptions for the systems, processes, and equipment to be used in site and surface preparation, application and testing.

6. The Contractor shall submit a detailed plan for the removal of loose material from the interior sides of the wet well and the new manhole. The plan shall include the tool and equipment to be used in the removal and cleaning process; the method to use to prevent the material from entering the sewer; the method for removal and disposal; and the final disposal location.

7. Cementitious patching and repair materials: Project specific submittals and procedures shall be provided including application, cure time and surface preparation procedures which permit optimum bond strength with the epoxy coating.

8. Method statements and design procedures are to be provided by the Contractor when confined space entry, flow diversion, debris removal or bypass is necessary to perform the specified work.

1.04 QUALITY ASSURANCE

A. Applicator shall initiate and enforce quality control procedures consistent with applicable ASTM, NACE and SSPC standards and the protective coating manufacturer's recommendations.

B. Once the coating formulation has been accepted and approved by the Engineer, it shall not be changed except by authority of the Engineer.

C. A Coating Inspector shall be provided by ETWD. The Coating Inspector will observe daily operations, procedures and final product testing to ensure adherence to the specifications by Applicator. All work shall be done in the presence of ETWD’s Coating Inspector. The Contractor shall provide access for Engineer and ETWD’s Representative to perform inspections. Work shall include but not limited to confined space entry support, access system and safety training.

D. Applicator shall conform to all local, state and federal regulations including those set forth by OSHA, RCRA and the EPA and any other applicable authorities.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Materials are to be kept dry, protected from weather and stored under cover.

B. Protective coating materials are to be stored between 50 deg F and 90 deg F. Do not store near flame, heat or strong oxidants.

C. Protective coating materials are to be handled according to their material safety data sheets.

1.06 WARRANTY

A. Contractor shall warrant all work against defects in materials and workmanship for a period of not less than five (5) years, unless otherwise noted, from the date of Final Acceptance of the Project. Contractor shall, within a reasonable time after receipt of written notice thereof, repair defects in materials and workmanship which may develop during the warranty period, and any damage to other work caused by such defects or the repairing of same, at his/her own expense and without any additional cost to the District.

B. Manufacturer's 5-Year Full System Warranty: Upon successful completion of the Work to the Polyurethane Manufacturer's and the Engineer's satisfaction, and receipt of final payment, the five (5) Year Full System Warranty shall be issued. The System Warranty shall provide for the polyurethane coating, and Contractor labor.

C. Applicator/Polyurethane Contractor 5 Year Guarantee: The Applicator shall supply the District with a five (5) year Workmanship Guarantee. In the event any Work related to the polyurethane is found to be within the Applicator warranty term, defective or otherwise not in accordance with the Contract Documents, the Applicator shall repair that defect at no cost to ETWD. The Applicator's warranty obligation shall run directly to ETWD.

D. District Responsibility: The Engineer shall notify both the Manufacturer and the Applicator of any defects as they occur during the time period when both warranties are in effect.

E. A Coating Inspector provided by ETWD shall conduct the testing as specified in these specifications. The Coating Inspector shall observe and document warranty repairs to ensure adherence to the specifications. All work shall be done to the satisfaction of the Coating Inspector.

PART 2 PRODUCTS

2.01 REPAIR MATERIALS

A. Repair material shall be hand-troweled high strength mortar mix as recommended by the manufacturer of the protective coating system.

B. All repair materials used shall be approved by the manufacturer of the protective coating system.

C. For exposed reinforcement, primer shall be Sika Armetic 110 EPOCEM, Tnemec Hi-Build Epoxoline II N69, Sherwin Williams Co-Poxy Shop Primer or approved equal. The primer shall be compatible with the polyurethane coating system.

2.02 PROTECTIVE COATING MATERIALS

A. The lining shall be high build, corrosion and abrasion resistant, 100 percent polyurethane coating. The lining shall be capable of application to 250 mils thickness in one continuous coat. The lining system shall employ a 100 percent solids epoxy primer capable of bonding to damp concrete.

B. The coating material shall be recommended by the manufacturer for use with the following solutions and substances:

Substance	Concentration
Sulfuric acid	20%
Sodium Hydroxide	5%
Ammonium Hydroxide	5%
Nitric Acid	1%
Ferric chloride	1c/0
Soap	0.1%
Detergent (linear alkyl benzyl	0.1%
Sodium hypochloride	1%
Bacteriological (BOD) Petroleum Oils and Greases Vegetable and Animal Oils	700 PPM

C. The lining shall be colored white or cream. The complete coating shall be impermeable to sewer gases and liquids, and shall be nonconducive to bacteria or fungus growth. The lining shall be capable of being repaired at any time during its life with high-build, 100 percent solids, hand patching kits.

D. The protective coating shall be Sancon 100; Endurflex; Utilithane or equal. The coating shall be applied to a minimum thickness of 150 mils, or as recommended by the manufacturer, whichever is greater.

PART 3 EXECUTION

3.01 EXISTING PRODUCTS

A. Remove existing coatings prior to application of the new protective coating. Applicator is to maintain strict adherence to applicable NACE and SSPC recommendations with regard to proper surface preparation and compatibility with existing coatings.

3.02 ACCEPTABLE APPLICATORS

A. Repair mortar applicators shall be trained to properly apply the repair mortar according to manufacturer's recommendations.

B. Protective coating must be applied by a Certified Applicator of the protective coating manufacturer and according to manufacturer specifications.

3.03 EXAMINATION

A. Appropriate actions shall be taken to comply with local, state and federal regulatory and other applicable agencies with regard to environment, health and safety.

B. Installation of the protective coating shall not commence until the concrete substrate has properly cured and been prepared in accordance with these specifications.

3.04 SURFACE PREPARATION

A. Coordinate with the District and bypass subcontractor to verify when the sewage bypass pumping will start, when the removal of sewage from the wet well and cleaning will be completed and the wet well or pump room will be available for entry to perform the work.

B. Applicator shall inspect all surfaces specified to receive a protective coating prior to surface preparation. Applicator shall notify Engineer of any noticeable disparity in the surfaces which may interfere with the proper preparation or application of the repair mortar and protective coating.

C. All contaminants including: oils, grease, unsound or incompatible existing coatings, waxes, form release, curing compounds, efflorescence, sealers, salts, or other contaminants shall be removed.

D. It is the responsibility of the Contractor to include sufficient resources to remove the existing coating. After removal of existing coating, the exposed concrete surfaces shall be pressure washed to clean any remaining contaminants from the concrete surface prior to abrasive blasting or grouting activities.

E. During surface preparation, care must be taken so that no loose material enters the sewer. If chemicals are used for surface preparation, provisions must be taken and approved by the Engineer to prevent chemicals from entering the sewer system. Waste disposal shall be the sole responsibility of the Contractor.

F. All concrete that is not sound or has been damaged by chemical exposure, including carbonation, shall be removed up to sound concrete and replaced. Sound concrete is defined as concrete prepared to a level of and in accordance with National Association of Corrosion Engineers Surface Preparation Number 13 (NACE SP No. 13) and International Concrete Restoration Institute Concrete 310.1R.2008 (formerly No. 03730) Surface Preparation Level CSP 5. Sound concrete is non-delaminated concrete whose components remain bound to each other under the impact of the edge on the flat face of a mason's hammer and has uniform grey appearance. Final determination of acceptable sound concrete will be made by the Engineer. The pH shall be a minimum of 8.

G. Removal of loose and unsound concrete per ICRI 310.1R "Guide to Surface Preparation". Chip out all unsound concrete and remove all loose material. Unsound concrete surface areas shall have perimeter boundaries saw-cut to minimum depth of ½ inch. Saw cuts shall be perpendicular to the concrete surface. All concrete shall be removed from within the repair boundary to a minimum of ½ inch.

H. Wherever preparation of concrete surfaces is required for the application of SIKA PLUS 123; QUIKRETE FASTSET REPAIR MORTAR, CTS rapid set mortar or equal, the Contractor shall inspect the wet well, pump room, and manhole surfaces to determine the amount and area of surface preparation required.

I. The wet well and pump room surfaces to be prepared shall then be high pressure or ultra high pressure water blasted to sound concrete. The bid item shall include up to 2-inches of concrete removed by high pressure water blast or other means necessary to accomplish the concrete removal. For the purposes of this project, sound concrete will be determined by ETWD's inspection and is generally defined in NACE and ICRI standards by use of a hammer or chain drag test.

J. Remove protrusions that might interfere with installing the coating system.

K. Surface preparation method(s) should be as necessary based upon the conditions of the substrate and the requirements of the protective coating to be applied.

L. To determine the depth of concrete removal within the wet well and/or pump room, the Contractor shall install stainless steel pins. The pins shall consist of ¼-inch by 3-inch long 316 stainless steel concrete wedge anchors installed flush with the existing concrete surface. Prior to commencement with concrete removal work, the Contractor shall determine locations for pin placement in the field at locations acceptable to Engineer. At a minimum, a pin shall be installed every five (5) feet of vertical wall. If present, remove and recycle nut and bolt supplied with wedge anchor. Install ¼-inch by 3-inch long 316 stainless steel wedge anchor flush with existing surface.

M. Using a depth gage, the Contractor shall measure the distance from tip of wedge anchor to base of cement matrix adjacent to wedge anchor. Alternatively, the Contractor may use a small probe such as a nail and place side by side with wedge anchor so that tip of probe contacts base of cement matrix adjacent to wedge anchor and mark where top of wedge anchor meets side of probe with permanent marking pen and then use a measuring tape to measure distance from probe tip to the marking point. The Contractor shall record the location of wedge anchor, time stamp, and depth measurement.

N. Surfaces to receive protective coating shall be cleaned and abraded to produce a surface with adequate profile and porosity to provide a strong bond between the protective coating and the substrate. High pressure water jetting (refer to NACE Standard No. 5/SSPC-SP12), abrasive blasting, shotblasting, grinding, scarifying or acid etching are methods that may be used. Detergent water cleaning and hot water blasting may be necessary to remove oils, grease or other hydrocarbon residues from the concrete. Whichever method(s) are used, they shall be performed in a manner that provides a uniform, sound, clean neutralized surface that has no indication of damage.

O. Active infiltration shall be stopped in accordance to with SSPWC Section 500-2.3.4. Infiltration migration within wet well to be rehabilitated shall utilize injection grouting. The Contractor shall notify the Engineer if infiltration is observed during the WORK. Injection grouting will be paid for as a change order for injection grouting. Infiltration caused by surface preparation shall be repaired by the Contractor at no additional cost to the District.

P. Applicator shall test prepared surface for moisture prior to application of protective coating in accordance with ASTM D4263. Electronic handheld moisture detectors may be used if approved by the Engineer. Additional drying of concrete shall be done by removal of the moisture sources and ventilation or dehumidification. The surface moisture level immediately prior to coating shall not exceed manufacturer's recommended moisture level for application of the protective coating.

Q. All surfaces shall be inspected during surface preparation and before the repair mortar is applied.

R. Areas where structural steel has been exposed the Contractor shall notify the Engineer immediately for further inspections. Exposed reinforcing steel shall be prepared per ICRI 310.1R "Guide for Surface Preparation". Where ½ inch or more of diameter of reinforcing steel is exposed either by existing conditions or concrete removal, the concrete shall be removed to provide a minimum ¾ inch clearance around either perimeter of steel and along the exposed length of the reinforcement. Clean the reinforcement per SSPC SP-10 (near white metal blast cleaning). Prime the reinforcement with the specified primer. Provide sufficient cure time for the primer prior to embedment in the repair mortar.

S. Applicator shall test prepared surfaces for pH and other manufacturer recommended physical properties immediately prior to application. These properties shall be as recommended by the manufacturer. The pH shall be 8 or greater as measured by ASTM D4262.

3.05 APPLICATION OF REPAIR MATERIALS

A. The Contractor shall repair all surfaces with the approved cementious repair material to a minimum of ¼-inch or the thickness removed during surface preparation, and in accordance with the manufacturer's printed recommendations. Repair material shall restore the surface to the original profile of the existing wet well and/or pump room.

B. Repair materials shall meet the specifications contained herein. The materials shall be trowel or spray applied utilizing proper equipment on to damaged surfaces. The material thickness shall be according to manufacturer's recommendations.

C. Cementitious repair materials shall be applied to provide a smooth surface with an average profile equivalent to coarse sandpaper to optimally receive the protective coating. No bugholes or honeycomb surfaces shall remain after the final trowel procedure of the repair mortar. Use a brush finish after troweling to provide a coarse sandpaper-type finish. Contractor shall provide surface profile of ICRI CSP-5. The Contractor shall test for surface undulations in the presence of the Engineer by placing a 2-foot straight edge vertically on wet well and/or pump room surfaces. The Contractor shall correct any irregularities greater than ¼-inch by placement of additional material and refinishing. Curved surfaces and surfaces where the 2-inch straight edge does not fit shall visually appear the same as those tested with the straight edge. All repairs shall be made to squared slopes.

D. The repair materials shall be permitted to cure according to the manufacturer's recommendations.

E. Application of the repair materials, if not performed by the coating certified applicator, shall be inspected by the protective coating manufacturer's representative or certified applicator to ensure proper finishing for suitability to receive the specified coating.

F. After abrasive blast and leak repairs have been performed, all surfaces shall be inspected for remaining laitance prior to protective coating application. Any evidence of remaining contamination or laitance shall be removed by additional abrasive blast, shotblast or other approved method. Areas to be coated must also be prepared in accordance with these specifications after receiving a cementitious repair mortar and prior to application of the coating.

G. All surfaces shall be inspected during and after preparation and before the protective coating is applied.

3.06 APPLICATION OF COATING

A. All interior surfaces of polyurethane-lined wet well, pump room, and manhole, including floor, walls and interior of roof slab, shall be coated unless indicated otherwise. The coating shall be applied to a minimum thickness of 150 mils, or as recommended by the manufacturer, whichever is greater. Application of the lining shall be as specified by the lining manufacturer.

B. The coating shall be continuous, seamless, and free from any holes or defects.

C. Prior to application, the Contractor shall verify that the moisture level, using the ASTM D4263 (plastic sheet method), is within the manufacturer’s recommendation.

D. If using approved cementitious materials as a basecoat, such shall be troweled to provide a smooth surface with an average profile equivalent to coarse sandpaper to optimally receive the coating. No bugholes or honeycomb surfaces shall remain after the final trowel procedure of the repair mortar.

E. After cleaning and leak repair is performed, all surfaces shall be inspected for remaining laitance prior to coating application. Any evidence of remaining contamination or laitance shall be removed. Areas to be coated must also be prepared in accordance with these specifications after receiving a cementitious repair mortar and prior to application of the coating.

F. The spray equipment shall be specifically designed to accurately ratio and apply the specified protective coating materials and shall be regularly maintained and in proper working order.

G. The protective coating material must be spray applied by a Certified Applicator of the protective coating manufacturer.

H. Only those workers trained by and licensed as installers by the manufacturer shall be used.

I. The Contractor shall take all necessary precautions to prevent the installed coating from being damaged by equipment used in or taken through the work.

J. Upon completion of the work, all tools and excess material shall be removed and the structure shall be left in a clean and presentable condition.

K. Contractor shall meet minimum requirements as established in the manufacturer's written requirements for installation and application

L. All personnel working in the area shall wear personal protective air support equipment as recommended by the coating manufacturer.

3.07 TESTING AND INSPECTION

Testing and inspection shall be conducted by ETWD'S Coating Inspector. Any portion of the coating that does not satisfactorily pass the inspection and testing requirements shall be repaired or replaced by the Contractor at no additional cost to the District. Additional testing and/or inspection may be done at the discretion of the Engineer/District.

A. Preparation Inspection: The Contractor shall notify the Engineer and the Coating Inspector of the time and date for inspection and approval two working days prior to completing the surface preparation of the wet well, pump room, and manhole and prior to application of the coating.

B. The moisture content in the concrete prior to application shall be less than that recommended by the manufacturer. The Inspector may use a "blotter test", or other test method to determine the moisture content. Contractor shall provide ASTM D4263 plastic sheet method per manufacturer's recommended moisture level.

C. Thickness Testing: During application a wet film thickness gage, such as those available through Paul N. Gardner Company, Inc., or equal, meeting ASTM D4414 - Standard Practice for Measurement of Wet Film Thickness of Organic Coatings by Notched Gages, or equal, may be used to ensure a monolithic coating and uniform thickness during application.

D. Holiday Testing (Spark Testing): After the protective coating has set hard to the touch it shall be inspected with high-voltage holiday detection equipment. Surfaces shall first be dried; an induced holiday shall then be made on to the coated concrete surface and shall serve to determine the minimum/maximum voltage to be used to test the coating for holidays at that particular area. The spark tester shall be initially set at 100 volts per 1 mil (25 microns) of film thickness applied but shall be adjusted as necessary to detect the induced holiday (refer to NACE RPO188-99). All detected holidays shall be marked and repaired by abrading the coating surface with grit disk paper or other hand tooling method. After abrading and cleaning, additional protective coating material can be hand applied to the repair area. All touch-up/repair procedures shall follow the protective coating manufacturer's recommendations.

E. Bond Strength Test: Measurement of bond strength of the protective coating to the substrate shall be made in accordance with ASTM D4541. The number and locations inside the wet well and pump room to be tested shall be determined by the Engineer after application of coating. The Contractor shall apply the dollies, perform the test in the presence of the Engineer and submit a report of testing that includes the failed dollies which shall be marked to indicate when the test was taken. The wet well, pump room, and manhole shall each have two or more 20mm dollies fixed and pulled in accordance with ASTM D4541, using an Elcometer 106 instrument. The Contractor shall provide the Elcometer and shall provide written certification of calibration for this project. Prior to testing, the coating shall be scored around the dollies down to the cementious substrate. The adhesion pulls shall exceed 200 psi or concrete failure of 50% of the subsurface adhered to the coating. For each test that fails, two additional tests shall be performed at locations chosen by the Engineer. Further bond tests shall be performed by the Contractor to determine the extent of potentially deficient bonded areas. The Contractor shall repair all bond strength test sites in accordance with manufacturer's recommendations. If two consecutive dollies fail, the coating shall be removed and replaced at no additional cost to ETWD.

F. The Engineer shall determine whether or not a sample shall be scored prior to initiating the Bond Strength Test.

G. Visual Inspection: A visual inspection shall be made by the Inspector and manufacturer's representative using the latest NASSCO standard inspection form (if available) or ETWD's Representatives inspection form. Any deficiencies in the finished coating shall be marked and repaired according to the procedures set forth herein by Applicator.

3.08 MANUFACTURER'S SERVICES

A. Coating manufacturer's representative shall be present as follows:

1. Pre-construction meeting.
2. A minimum of two site inspection visits (two each for manhole, wet well, and pump room), each a minimum of one hour, in order to provide Manufacturer's Certificate of Proper Cure.
3. As required to resolve field problems or concerns attributable to or associated with manufacturer's product.

END SECTION

SECTION 11215

SUBMERSIBLE PUMPS

PART 1 - GENERAL

A. Description

This section includes materials, testing, and installation of heavy-duty submersible non-clog pumps with submersible electric motors, discharge elbows, guide bars, brackets, slide rail assembly and accessories.

Pump shall be of the heavy-duty, submersible, vertical shaft, centrifugal type, suitable for pumping fluids containing sewage from the gravity collection system serving Laguna Woods Village. Pumps shall be designed for continuous operation under submerged, partially submerged condition without damage to the pump and motor.

The pump shall be mounted on a guide rail system to allow the pump to be easily removed for this purpose and no need for personnel to enter the wet well. The pump shall be fitted with a stainless steel lifting chain or cable of adequate strength and length to permit raising the pump for inspection and removal.

Contractor to supply three (3) submersible pumps and motors.

B. Related Work Specified Elsewhere

1. Painting and Coating: 09900.
2. Electric Motors: 16150.

C. Manufacturer's Services

A manufacturer's representative for the equipment specified herein shall be present at the jobsite for installation assistance, inspection and certification of the installation, functional testing, and training of District's personnel. The individual services may not occur on same day. The Contractor should be prepared to have a manufacturer's representative available for the individual services for a minimum of one day and one additional day for training, for a minimum total of two (2) days.

D. Submittals

1. Performance data curves showing head, capacity, horsepower demand, and pump efficiency over the entire operating range of the pump from shutoff to maximum capacity. The equipment manufacturer shall indicate separately the head, capacity, horsepower demand, and pump efficiency at the rated capacity.

2. Submit dimensional drawings, showing materials of construction by ASTM

reference and grade. Show linings and coatings. Construction details and materials of pump, pump base and slide rail system. Outline dimensions and weights.

3. Complete motor rating and data on all special motor features being provided.

4. Submit manufacturer's sample form for reporting performance test results at least 30 days before the tests. The test should contain the data presented in the sample form in Section 6 of the ASME Performance Test Code, PTC 8.2.

5. Submit manufacturer's certified performance curves from the factory performance testing for review at least two weeks prior to shipping the units from the factory. Show pump total head, brake horsepower, pump efficiency, required submergence, and required NPSH.

E. Guarantee

The pumps shall be new and of current manufacture. No pump shall be purchased for use in the work prior to return of acceptable shop drawings submitted by the Contractor in accordance with the District's requirements.

The Contractor shall be responsible for the satisfactory operation of the pumping units under the specified operating conditions, and all necessary baffles, vanes, and appurtenances, in addition to those shown, shall be furnished with the pumping units. Any unit which develops excessive noise, vibration, or operating malfunctions within the warrant period shall be repaired or modified as necessary at no additional cost to the District and all such repairs and/or modifications shall be approved by the District. The District reserves the right to operate unsatisfactory equipment until it may be conveniently taken out of service.

The pump manufacturer shall be responsible for all components and for the satisfactory installation and operation for a completely assembled unit, including the motor and pump.

The pump manufacturer shall provide a two (2) year warranty for the pump and motor, in writing, against defects in materials and workmanship.

F. Experience Requirement

Pumping equipment shall be the product of a manufacturer or manufacturers having at least 10 years experience in the manufacture and installation of such equipment.

G. Pump Efficiency Test

1. The minimum pump efficiency specified is the minimum laboratory efficiencies for a completely staged and assembled unit.

2. It is required that the pump manufacturer list the guaranteed efficiency for his pump at the specified design heads and submit curves showing the performance characteristics of the pump.

   In the event of failure of pump to meet the guaranteed efficiency or to operate to the District's satisfaction, the Contractor shall make such modifications and repairs as are necessary to make the unit conform to specification requirements and shall receive no additional compensation therefore.

3. Each pump shall be tested for performance at the factory to determine head versus capacity, efficiencies, and kilowatt draw required for the operating points indicated. All tests shall be run in accordance with the American Hydraulic Institute Standards. Testing shall also include the following:

   a. Impeller, motor rating, and electrical connections shall first be checked for compliance with the Contract Documents.

   b. A motor and cable insulation test for moisture content or insulation defects shall be made.

   c. Prior to submergence, the pump shall be run dry to establish correct rotation and mechanical integrity.

   d. The pump shall be run for 30 minutes submerged, a minimum of 6 feet under water, at ¼, ½, ¾, and full flow, without cavitation or overheating.

   e. After operational test described in Item d, the insulation test described in Item b shall be performed again.

4. The District will accept the pump when the field test satisfies the pump design criteria.

PART 2 - MATERIALS

A. General

1. The pumps shall be controlled by variable frequency drives with programmable pump ramp up and ramp down timing, back-up manual starters, level sensors with the addition of a high low water cut-off float switch.

2. Each pump shall be capable of continuous operation at full load with a full wet well water level without cavitation or overheating of the motor. The maximum expected ambient temperature inside the sump is 65 degrees F.

3. Each pump, with its cable and appurtenances, shall be able to withstand continuous submergence to a minimum depth of 65 feet, when running or off, without leakage.

4. Each pump shall be able to operate for short periods at low water levels without causing any damage to any part of the unit.

5. All pumps shall be Fairbanks, Cornell, ESSCO, Grundfos, Flygt, or approved equal.

B. Performance Requirements

1. Aliso Creek Lift Station (3 pumps)

Design Operating Point: 2,000 gpm at 230 feet TDH with minimum pump efficiency of 65%.

Design Assumptions: Centerline elevation of discharge: X. For the below data, 0 bgs is elevation X±.

Pump characteristics (at 1750 rpm):

Flow (gpm)	TDH (ft)	Min. pump Eff. (%)
0	287	--
500	272	--
1000	258	--
1500	244	--
2000	230	65 % (Design Point)
2500	213	--
3000	197	--

Flygt NP3231/745, Cornell 6NHTB or approved equal.

Sump Classification: Class 1, Division 1, Groups C and D

Pump Removal Method: Slide rail quick disconnect system with 2-inch stainless steel guide pipes

Min. Size of Spheres Capable of Passing Through the Pump: 3-inch

Type of Drive: direct drive submersible explosion proof electric motor

Submersible Motor: Electric, 480 volt, 3 phase, 60 Hz.

Motor Horsepower (minimum): 200 HP

Nominal Operating Speed: 1780 RPM

Pump setting (bottom of pump assembly): Elevation x± or (x± bgs)

Discharge pipe size (inches);	8-inches (provide reducer if required)

C. Construction Details

1. Pump Design: Single stage, centrifugal submersible type, close-coupled to sealed electric motor, for continuous operation in a wet pit. The non-clog volute shall be a centerline design. The non-clog volute shall be fitted with a High Chrome Iron 550 wear ring and a hand hole cleanout cover or a replaceable double wear ring system (AISI 420 Heat Treated Stainless Steel, 400-500BHN) of the peripheral design.

2. Impeller: AISI 316 stainless steel,215 HB two-port enclosed non-clog type dynamically balanced, to handle sewage with grit and organic material or a two-port design with backvanes, with High Chrome Iron 550 wear ring or a replaceable double wear ring system of the peripheral design.

3. Wear Plate: The pump-end shall be furnished with a separate replaceable wear plate positioned between the motor mounting flange and volute just above the impeller to protect the motor flange and lower mechanical seal from wear. A wear plate is not required for pumps with motor adapter/back plate along with an impeller backvane.

4. Pump Shaft: One piece 416 stainless steel shaft extending through both bearings with machined shoulders for the bearings and impeller to press against. Minimum surface finish: 12 micro-inches.

5. Bearings: Permanently lubricated, heavy-duty axial and radial ball or roller bearings, top and bottom, double shielded with a minimum L-10 life of 50,000 hours, at continuous, maximum load speed.

6. Seals: Dual independent single mechanical shaft seals, easily replaceable, oil lubricated, with moisture detector probes, alarm and test circuits. The seals shall not require any maintenance or adjustment, nor any differential pressure to effectively seal.

7. Oil Chamber: To supply oil for lubrication and cooling of the shaft seals.

8. Slide Rail Assy.: Ductile iron, non-spark, straight-through base with a bolt-on Ductile Iron 90 degree 4”x4” flanged footed discharge elbow with machined flanged faces, anchored to sump floor. Provide with concentric or eccentric ductile iron reducer, as required. Connections: Machined quick disconnect type with an “O” ring seal, for withdrawal of unit from above, without disconnecting pipe. When lowered into place, the pump shall automatically connect and lock into the discharge elbow without touching the floor. The rail guides, slide face insert and attaching claws shall be cast bronze, all other parts

shall be Cast 316 Stainless Steel. Lifting Devices: Each pump shall be furnished with Type 316 stainless steel 2" diameter guide pipes with top and intermediate guide brackets and a 316 stainless steel lifting cable with stainless steel lift rings every 4 feet intervals and of sufficient operating length.

9. Motor Cables: Each pump shall be furnished with the necessary "SO" type cables for power connection, moisture detection and overload protection, sheathed, coded and suitable for submersible pumps, and of sufficient length for direct connection to the terminal boxes indicated. All cables shall be connected to the pumps and tested at the factory. It is the contractor's responsibility to verify the cable lengths before ordering.

10. 0.375" x 0.4375" 316 Stainless Steel nylon coated lift cable with 316 SS lift rings every 4' intervals.

11. The motor skin shall be shop primed and painted as specified in Part 3, Section D.

D. Materials

1. Pump, volute, motor mounting flange	Cast Iron (ASTM A48, 30)
2. Impeller	Cast Iron (ASTM A48, 30)
3. Wear Plate (if required)	Cast Iron (ASTM A48, 30)
4. Motor Shaft	Type 416 stainless steel
5. Exposed bolts, nuts washers	Type 316 stainless steel
6. Mechanical seals	Independently operating carbon ceramic upper mechanical seal and silicon carbide lower seal with stainless steel springs
7. Case & Impeller wear rings	High Chrome Iron 550 material (non-clog pumps only) or replaceable double wear ring system (AISI 420 Heat Treated Stainless Steel, 400 – 500 BHN (with minimum of 50 BHN difference between the two rings).
8. Slide rail quick disconnect Assembly and Elbow	Ductile Iron or Cast Iron ASTM A48, Class 30 Elbow with Bronze Slide face insert, claws and pipe guides.

9. Slide rail guide pipes: (Cast ASTM A351-CF8M)
Type 316 stainless steel

E. Nameplates

A stainless steel nameplate shall be permanently attached to the pump, to the motor, and to the surface plate, and contain the following information using specified units:

1. Manufacturer's name.

2. Equipment tag number.

3. Serial number of pump and motor.

4. Size and type of pump.

5. Pumping head (feet) (design point).

6. Rated capacity (gpm) (design point).

7. Motor rating, service factor, volts, phase, hertz.

8. Revolutions per minute.

F. Submersible Motor

1. Approval: The pumping system, including the motor and wiring, shall be approved by a nationally approved testing agency for explosion-proof service. The system shall be rated Class 1, Division 1, Group C and D service as determined by the National Electric Code and approved by a nationally recognized testing agency, U.L., at the time of bidding of the project. The Contractor shall include in his bid a copy of certificate of approval.

2. Insulation: Pump motors shall be designed for continuous duty and rated for inverter duty in hazardous locations. The stator and stator leads shall be moisture-resistant, triple varnished and insulated according to Class H, capable of withstanding temperatures of up to 155 deg C. The allowable temperature rise of the motor at full load condition shall not exceed 80 deg C. The motor shall be capable of sustaining a minimum of 10 starts per hour and of operating continuously.

3. Stator: The motor stator shall be mounted in an air-filled, watertight casing, and shall not be fixed in place by externally-mounted screws which may cause leakage in the motor.

4. Rating: The motor shall be non-overloading all throughout the pump curve and shall have a combined service factor of 1.00 or greater.

5. Cable Entry: The SO type power and control cables shall be joined to high temperature wires with butt splices inside the motor pot-head and sealed water tight with an epoxy sealant preventing water and gasses from entering the motor.

6. Cooling: The motor shall be air filled and able to operate continuously at varied speeds in water and to operate short periods of time in air without damage to the windings.

7. Motor Protection: Integral thermal sensors in the motors, one for each phase, shall be provided to monitor stator temperatures. These sensors shall be used in conjunction with and supplemented by external motor over-current protection fitted at the control panel.

8. Motor Mounting Flange: The mounting flange of the motor shall be constructed of Cast Iron ASTM A48, Class 30.

G. Spare Parts

The following spare parts shall be provided. Spare parts shall be packed and boxed.

1. 2 Side rail slide face "O" ring (if required by the slide rail system)

PART 3 - EXECUTION

A. General

1. Care during storage and procedures for installation, lubrication, and startup of the pumps and motors shall be in strict conformance with the manufacturer's instructions. In addition, the instructions for installation, operation, and maintenance from the Hydraulic Institute Standards shall be adhered to where applicable.

2. A complete set of manufacturer's instructions covering storage, installation, operation, lubrication, and maintenance shall be available at the jobsite no later than the date other pumps are received. This requirement is in addition to Equipment Manuals as specified herein before.

B. Pump Installation

1. Install submersible pump, motor, and appurtenances per manufacturer's instructions, plans and specifications. Installation shall include furnishing the required oil and grease for initial operation in accordance with the manufacturer's recommendations.

2. Adjust pump assemblies for proper alignment. Flexible couplings shall not be considered to compensate for misalignment.

3. Anchor bolts shall be set only after the discharge piping has been properly installed to ensure exact fit with embedded piping components.

4. All strain from attached piping and appurtenances shall be eliminated from the pumps. Any evidence of pump misalignment, noisy operation, or other signs of improper setting shall be corrected.

C. Field Tests

1. Check to ensure that motor has been connected for proper rotation.

2. Operate each pump for seven consecutive days, during which time no repairs or adjustments shall be made. Assure that all pumps operate as designed and specified in response to run/stop signals. Assure that all pumps operate without evidence of cavitation of damage to impellers and shafts. Repairs, replace, or realign motors, shafts, and impellers and retest.

D. Painting and Coating

1. The motor surface shall be coated per Section 09900, System No. B-1 suitable for use in a wet well condition.

2. The pump wet end, which includes the backplate, the impeller, the volute, and the suction plate, shall be coated inside and outside with fusion bonded epoxy per Section 09900, System No. G-1.

3. The pump discharge stationary base assembly including the slide rail quick disconnect assembly and elbow, shall be coated inside and outside with fusion bonded epoxy per Section 09900, System No. G-1.

END OF SECTION

SECTION 15000

PIPING SCHEDULE & GENERAL PIPING REQUIREMENTS

PART 1 - GENERAL

A. Description

This section describes the general requirements for selecting piping materials; selecting the associated bolts, nuts, and gaskets for flanges for the various piping services in the project.

B. Related Work Specified Elsewhere

1. Installation of Pipe: 15051.

2. Ductile-Iron Pipe and Fittings: 15056

C. Submittals

Refer to the applicable pipe installation sections.

D. Definitions of Buried and Exposed Piping

1. Buried piping is piping buried in the soil, or encased in concrete, commencing at the inside face of the wall or top of the slab of a structure. Where a coating is specified, provide the coating up to the inside of the structure.

2. Exposed piping is piping in any of the following conditions or locations:

   a. Above ground.
   b. Inside buildings, vaults, or other structures.
   c. In underground concrete trenches or galleries.

E. Default Piping Materials

If no material is shown in the drawings, use the following piping materials:

Service	Size Range (inches)	Material	Specification Section
Sewer Force Main Buried and Exposed	2” and smaller	Stainless Steel	15065
	3” and larger	DIP	15056
Sewer Gravity	4” and larger	PVC	02715
Buried	4” and larger	AWWA C-900 PVC	15064
Service	Size Range (inches)	Material	Specification Section

Exposed Potable Water	2” and smaller 3” and larger	Copper or Brass DIP	15057 15056
Buried Irrigation	1 1/2" and smaller 2” and larger	PVC Sch 40 PVC Class 315	---- ----
Exposed Irrigation	2 1/2" and smaller 3” and larger	Brass DIP	15057 15056

PART 2 - MATERIALS

A. Materials Selection

The acceptable piping materials for the pipelines are shown on the Plans.

B. Thread Forming for Stainless-Steel Bolts

Form threads by means of rolling, not cutting or grinding.

C. Bolts and Nuts for Flanges for Ductile Iron Piping

1. Bolts and nuts for buried flanges, submerged flanges, flanges located outdoors above ground, located indoors or in vaults shall be Type 316 stainless steel conforming to ASTM A 193, Grade B8M, for bolts and ASTM A 194, Grade 8 M, for nuts. Fit shall be Classes 2A and 2B per ANSI B1.1 when connecting to cast-iron valves having body bolt holes.

2. Bolts used in flange insulation kits shall conform to ASTM A 193 (Grade B7). Nuts shall conform to ASTM A 194 (Grade 2H).

3. Provide washers for each nut. Washers shall be of the same material as the nuts.

D. Lubricant for Stainless-Steel Bolts and Nuts

Lubricant shall be TRX-Synlub by Ramco, Anti-Seize by Ramco, Husk-It Husky Lube O'Seal.

E. Gaskets for Flanges for Ductile Iron Piping

1. Gaskets shall be full face, 1/8-inch thick, cloth-inserted rubber. Gaskets shall be suitable for a water pressure of 350 psi at a temperature of 180°F.

PART 3 - EXECUTION

A. Raised Face and Flat Face Flanges

Where a raised face flange connects to a flat faced flanged, provide a ring gasket filler between the two flanges. The ring gasket filler shall be of the same material as specified for the gasket between the flanges.

B. Installing Flanged Piping

1. Set pipe with the flange bolt holes straddling the pipe horizontal and vertical centerline. Install pipe without springing, forcing, or stressing the pipe or any adjacent connecting valves or equipment.

2. Clean flanges by wire brushing before installing flanged fittings. Clean flange bolts and nuts by wire brushing, lubricate carbon steel bolts with oil and graphite, and tighten nuts uniformly and progressively. If flanges leak under pressure testing, loosen or remove the nuts and bolts, reset or replace the gasket, reinstall or retighten the bolts and nuts, and retest the joints. Joints shall be watertight.

3. Assemble insulating flanges in the shop, not in the field. Hydrostatically test at 200/300 psi and then electrically test.

C. Installation of Stainless-Steel Bolts and Nuts

Prior to assembly, coat threaded portions of stainless-steel bolts and nuts with lubricant.

END OF SECTION

SECTION 15042

HYDROSTATIC TESTING OF PRESSURE PIPELINES

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Hydrostatic leakage testing of new or rehabilitated pressure pipelines

1.02 RELATED REQUIREMENTS

A. Section 02223, Trenching, Backfilling, and Compacting

1.03 DEFINITIONS

A. Working Pressure: Maximum anticipated sustained operating pressure

1.04 REFERENCE STANDARDS

A. American Water Works Association (AWWA)

1. AWWA C600: Installation of Ductile Iron Water Mains and Their Appurtenances
2. AWWA C604: Installation of Buried Steel Water Pipe - 4 In. (100 mm) and Larger
3. AWWA C605: Underground Installation of Polyvinyl Chloride (PVC) and Molecularly Oriented Polyvinyl Chloride (PVCO) Pressure Pipe and Fittings

1.05 SEQUENCING

A. Requirements Prior to Testing:

1. Before testing, the pipe trench shall be backfilled and compacted to the ground surface per Section 02223.
2. All concrete anchor blocks shall be allowed to cure a sufficient time to develop a minimum strength of 2,000 psi, but not less than five (5) days, before testing, unless otherwise directed by the District.
3. Steel pipelines shall not be tested before the mortar lining and coating on all of the pipe lengths in the line have attained an age of 14 days. Cement-mortar lined pipe shall not be filled with water until a minimum period of eight hours has elapsed after the last joint in any section has been made.
4. All surrounding utilities shall be installed prior to testing.

B. Connection to Existing Mains: Complete hydrostatic testing before connecting new pipelines with existing pipelines.

C. Final Pavement: All pipeline shall be satisfactorily pressure tested prior to the placement of final pavement.

D. Disinfection: Disinfecting of pipelines may occur concurrently with hydrostatic testing. Sewage force mains will not be required to be disinfected.

1.06 SUBMITTALS

A. Action Submittals:

1. Testing plan and schedule
2. Testing equipment, pumps, gauges, and meters
3. Meter and gauge calibration certification

B. Certified testing results

1.07 QUALITY ASSURANCE

A. Conform to requirements of the following standards depending on the pipeline material. Where discrepancies exist between the current AWWA standards and this specification, the more stringent requirements shall govern.

1. Ductile iron pipe: AWWA C600
2. Steel pipe: AWWA C604
3. PVC pipe: AWWA C605

B. Testing Company

1. All testing shall be performed by a District-approved testing company.
2. Tester will have a gauge and meter, calibrated annually.

PART 2 PRODUCTS

2.01 WATER

A. The same water used for chlorination of the pipeline may be used to fill the line for pressure testing.

B. Make up water for testing shall be potable water.

PART 3 EXECUTION

3.01 TEST PROCEDURES

A. Fill pipeline test section with water while purging all air.

B. For cement mortar lined pipe, allow water to stand for at least 24 hours to permit maximum absorption of water by the lining. Additional makeup water shall be added to replace water absorbed by the lining.

C. Apply test pressure by approved pumping assembly connected to pipe with temporary test bulkheads.

D. Monitor leakage rate for duration of test by measuring the required makeup water flow rate to maintain test pressure within allowable variance.

3.02 TEST PRESSURES

A. Test pressures for force mains shall be 120 psi.

B. Hydrostatic test pressures at any point in the section tested shall not exceed the following:

1. Design pressure capacity of pipe and appurtenances
2. Design capacity of thrust restraints

C. Ensure the test pressure variance is less than +/- 5 psi for duration of test.

3.03 TEST DURATION

A. Perform hydrostatic leakage test for a minimum duration of four hours.

3.04 PIPELINE FILLING

A. Filling velocity: The pipeline should be filled at a rate such that the average velocity of flow is less than 1-foot per second. At no time shall the maximum velocity of flow exceed 2-feet per second. For convenience, the following table has been provided to relate the velocity of 1-foot per second to an equivalent volume flow rate.

Normal Pipe Diameter (inches)	Flow Rate (gallons per minute)
4	38
6	88
8	158
12	353
16	624

B. Air Removal:

1. All air should be purged from the pipeline before checking for leaks or performing pressure or acceptance tests on the system.
2. To accomplish this, if air valves or hydrants or other outlets are not available, corporation cocks shall be installed at the high points to expel the air, and these cocks shall be tightly closed afterwards. If allowed by the District, air may be purged using temporary blow-offs at the end of the lines at the test bulkhead.

3.05 ALLOWABLE LEAKAGE RATES

A. Ductile Iron Pipe:

$L = (S \times D \times P^{1/2}) / (133{,}200)$

Where:

L = Allowable leakage rate (makeup water flow rate), in gallons per hour

S = Length of pipe tested, in feet

D = Nominal diameter of pipe, in inches

P = Average test pressure during hydrostatic test, in gauge pound per square inch (psig)

B. Steel and PVC Pipe:

$L = (N \times D \times P^{1/2}) / (7{,}400)$

Where:

L = Allowable leakage rate (makeup water flow rate), in gallons per hour

N = Number of joints (not including welded joints) in pipeline tested, in feet

D = Nominal diameter of pipe, in inches

P = Average test pressure during hydrostatic test, in gauge pound per square inch (psig)

C. Flanged, grooved, and welded joints shall have zero leakage.

3.06 REPAIR

A. Any noticeable leak shall be stopped and all defective pipe, fittings, valves, and other accessories discovered in consequence of the test shall be removed and replaced by the Contractor with sound material.

B. Repeat test until the pipeline meets the testing requirements.

END OF SECTION

SECTION 15043

TESTING OF NON-PRESSURE SEWER PIPELINES AND MANHOLES

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Low-pressure air test of sewer pipelines

B. Infiltration testing of sewer pipelines

C. Deflection testing of sewer pipelines

D. Leakage testing of manholes

1.02 RELATED REQUIREMENTS

A. Section 03461, Precast Reinforced Concrete Manholes

B. Section 15066, Gravity Sewer Pipelines

1.03 REFERENCED STANDARDS

A. ASTM International:

1. ASTM C828: Standard Test Method for Low-Pressure Air Test of Vitrified Clay Pipe Lines
2. ASTM C1244: Standard Test Method for Concrete Sewer Manholes by the Negative Air Pressure (Vacuum) Test Prior to Backfill
3. ASTM F1417: Standard Practice for Installation Acceptance of Plastic Non-pressure Sewer Lines Using Low-Pressure Air

1.04 QUALITY ASSURANCE

A. Conform to requirements of the following standards depending on the pipeline material. Where discrepancies exist between the current standards and this specification, the more stringent requirements shall govern.

1. Vitrified Clay Pipe: ASTM C828
2. PVC Pipe: ASTM F1417

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.01 GENERAL

A. General:

1. The Contractor shall furnish all equipment and materials required for testing.
2. All tests shall be made in the presence of the District. No one shall be allowed in the manholes during testing because of the hazards present.

B. Leakage: Each section of sewer between two successive manholes shall be tested for leakage and the leakage test shall be made on all sections of sewer.

C. Infiltration: The infiltration test shall be made where excessive groundwater is encountered.

D. Retesting: Even though a section may have previously passed the leakage or infiltration test, each section of sewer shall be tested subsequent to the last backfill compacting operation if, in the opinion of the District, heavy compaction equipment or any of the operations of the Contractor or others may have damaged or affected the structural integrity or water tightness of the pipe, structure, and appurtenances.

E. Other Utilities: Official District tests will not be made until after all the other utilities have been installed and their trench compaction verified.

F. Excessive Leakage or Infiltration: If the leakage or infiltration rate is greater than the amount specified, the pipe joints shall be repaired or, if necessary, the pipe shall be removed and relaid by the Contractor.

G. Acceptance: The sewer will not be accepted until the leakage or infiltration rate, as determined by testing, is less than the maximum allowable.

H. House Laterals: House laterals are not to be connected until after the sewer main has been successfully tested.

3.02 LOW-PRESSURE AIR TEST

A. Test Section: Each section of sewer between two successive manholes shall be tested by plugging all pipe outlets.

B. Addition of Air: Air shall be slowly added until the internal pressure is raised to 4.0 pounds per square inch gage (psig). The compressor used to add air to the pipe shall have a blowoff valve set at 5 psig to ensure that at no time the internal pressure in the pipe exceeds 5 psig.

C. Internal Pressure: The internal pressure of 4 psig shall be maintained for at least two minutes to allow the air temperature to stabilize, after which the air supply shall be disconnected and the pressure allowed to decrease to 3.5 psig.

D. Pressure Drop: The time in seconds that is required for the internal air pressure to drop from 3.5 psig to 2.5 psig shall be measured and the results compared with the minimum permissible pressure holding times indicated in the following table.

E. Minimum Pressure Holding Times

1. Vitrified Clay Pipe:

Pipe Diameter (inch)	Time (minutes) per 100 feet of length
6	0.7
8	1.2
10	1.5
12	1.8
15	2.1

2. PVC Pipe:

Pipe Diameter (inch)	Time (minutes) per 100 feet of length
6	5.7
8	7.6
10	9.4
12	11.3
15	14.2

F. Retest: If the pressure drop from 3.5 psig to 2.5 psig occurs in less time than specified, the pipe shall be repaired and, if necessary, replaced and relaid until the joints and pipe shall hold satisfactorily under this test.

3.03 INFILTRATION TEST

A. Preparation of Test Section: The end of the sewer at the upper structure shall be closed to prevent the entrance of water, and pumping of groundwater shall be discontinued for at least three days, after which the section shall be tested for infiltration.

B. Allowable Infiltration Rate: The infiltration shall not exceed 0.025 gpm per inch of diameter per 1,000 feet of main line sewer being tested, not including the length of laterals entering that section.

C. Excessive Infiltration: Where infiltration in excess of the allowable amount is discovered before completion and acceptance of the sewer, the sewer shall be immediately uncovered and the amount of the infiltration reduced to a quantity within the specified amount of infiltration, before the sewer is accepted.

D. Individual Leaks: Even if the infiltration is less than the allowable amount, any individual leaks that may be observed shall be stopped as directed by the District.

E. Completion of Tests: All tests must be completed before the street or trench is resurfaced, unless otherwise directed by the District.

3.04 DEFLECTION TEST

A. All PVC main line pipe shall be tested for deflection, joint displacement, or other obstruction by passing a rigid mandrel through the pipe by hand.

B. Conduct deflection test not less than 30 days after completion of the trench backfill, but prior to permanent resurfacing.

C. The mandrel shall be a full circle cylinder, accepted by the District as to design and manufacture. The circular cross section of the mandrel shall have a diameter as indicated in the following table:

Pipe Diameter (inch)	Minimum Mandrel Diameter (inches)
6	5.31
8	7.09
10	8.84
12	10.51

3.05 NEGATIVE AIR PRESSURE (VACUUM) MANHOLE TEST

A. Perform test per ASTM C1244 immediately after assembly and prior to backfilling.

1. Draw 10 inches mercury of vacuum on the manhole, close vacuum line valve, and shutoff vacuum pump.

2. Measure time for the vacuum to drop to 9 inches mercury.

3. Minimum test times for the vacuum reading to drop from 10 inches to 9 inches mercury are as follows:

Depth (feet)	48-inch Diameter Manhole	60-inch Diameter Manhole	72-inch Diameter Manhole
	Minimum Test Times (seconds)		
<4	10	13	16
6	15	20	25
8	20	26	33
10	25	33	41
12	30	39	49
14	35	46	57
16	40	52	67
18	45	59	73
20	50	65	81
22	55	72	89
24	59	78	97
26	64	85	105
28	69	91	113
30	74	98	121

B. All manhole inlets and outlets shall be plugged with approved stoppers or plugs.

C. If the manhole fails the initial test, necessary repairs shall be made with a non-shrink grout while the vacuum is still being drawn. Cracks longer than two-inches shall be cause for rejection of the casting and no patching shall be allowed. Retesting shall proceed until a satisfactory test is obtained.

END OF SECTION

SECTION 15051

INSTALLATION OF PRESSURE PIPELINES

PART 1 - GENERAL

A. Description

This section describes the installation of pressure pipelines fabricated of ductile iron including pipeline closures, connections and encasement.

B. Related Work Described Elsewhere

1. Trenching, Backfilling, and Compacting: 02223.
2. Concrete: 03300.
3. Painting and Coating: 09900.
4. Piping Schedule and General Piping Requirements: 15000.
5. Ductile-Iron Pipe and Fittings: 15056.
6. Stainless Steel Pipe: 15065
7. Copper Pipe and Fittings: 15057
8. Manual Valves: 15100.
9. Domestic and Recycled Water Facilities Identification: 15151.

PART 2 - MATERIALS

A. Installation Material

Refer to the various referenced sections on pipe by type for material requirements.

B. Piping Schedule

Unless noted otherwise on the plans or in the specifications, pipe shall be furnished in accordance with the following materials schedule.

Diameter	Sewer Force Main
2-inch and smaller	Stainless Steel
2-inch and smaller	Copper with purple tape wrap
4-inch through 12-inch	Epoxy lined & coated (above ground) DIP and epoxy lined with PE encasement (buried).

Notes: Stainless Steel Pipe per Section 15065;
DIP – Ductile-Iron Pipe per Section 15056

PART 3 - EXECUTION

A. Delivery and Temporary Storage of Pipe at Site

1. Onsite Storage Limitation: Onsite pipe storage shall be limited to a maximum of one week, unless exception is approved by the District.

B. Handling of Pipe

1. Moving Pipe: Pipes shall be lifted with handling beams or wide belt slings as recommended by the pipe manufacturer. Cable slings shall not be used. Pipe shall be handled in a manner to avoid damage to the pipe. Pipe shall not be dropped or dumped from trucks or into trenches under any circumstances.

2. Inspection of Pipe: The pipe and accessories shall be inspected for defects prior to lowering into the trench. Any defective, damaged or unsound pipe shall be repaired or replaced. All foreign matter or dirt shall be removed from the interior of the pipe before lowering into position in the trench.

C. Placement of Pipe in Trench

1. General: Dewatering, excavation, shoring, sheeting, bracing, backfilling material placement, material compaction, compaction testing, and pipe laying requirements and limitations shall be in accordance with Section 02223: Trenching, Backfilling and Compacting.

2. Sanitation of Pipe Interior: During laying operations, tools, clothing, or other materials shall not be placed in the pipe.

3. Prevention of Entry into Pipe: When pipe laying is not in progress, including lunch-hour, the ends of the pipe shall be closed using vermin-proof plugs constructed in a manner to also prevent entry by any debris, animal or vermin.

4. Laying Pipe on Grades over 5 Percent: Pipes shall be laid uphill with the bell or collared joints on the uphill end of each pipe length, whenever the grade exceeds five (5) percent.

5. Pipe Base Thickness: Pipe base thickness shall be as specified in Section 02223, Trenching, Backfilling, and Compacting.

6. Depressions at Joints and Pipe Sling Points: Depressions shall be dug into pipe base material to accommodate the pipe bell and to permit removal of the pipe handling slings.

7. Placement of Pipe on Pipe Base: Pipe shall be lowered onto the bedding and installed to line and grade its full length on firm bearing except at the bell and at sling depressions. Unless specified otherwise, the tolerance on grade shall be ¼-inch; the tolerance on line shall be 1-inch. Grade shall be measured along the pipe invert.

8. Pipe Installation: Pipe shall be installed without springing, forcing, or stressing the pipe or any adjacent connecting valves or equipment. Precautions shall be taken to prevent pipe from being displaced by water entering trench. Damaged or displaced pipe shall be replaced or returned to specified condition and grade.

9. Trench Curvature and Pipe Deflection: The radius of curvature of the trench shall be determined by the maximum length of pipe section that can be used without exceeding the allowable deflection at a each pipe joint and without casuing deviation from the trench width requirements shown on the Drawings. Refer to the various referenced sections on pipe by type for allowable deflection. The deflection at any flexible joint shall not exceed that prescribed by the manufacturer of the pipe. The manufacturer's printed installation guide outlining the radius of curvature that can be negotiated with pipe sections of various lengths shall be followed.

10. Equipment for Installation of Pipe: Proper implements, tools, and facilities as recommended by the pipe manufacturer's standard printed installation instructions shall be provided and used by the Contractor for safe and efficient execution of the work. All pipe, fittings, valves, and accessories shall be carefully lowered into the trench using suitable equipment in such a manner as to prevent damage to pipe and fittings. Under no circumstances shall pipe or accessories be dropped or dumped into the trench.

11. Cutting and Machining Pipe: Cutting and machining of the pipe shall be accomplished in accordance with the pipe manufacturer's standard procedures for this operation. Pipe shall not be cut with a cold chisel, standard iron pipe cutter, nor any other method that may fracture the pipe or produce ragged, uneven edges.

D. Assembling Rubber Ring Joints

1. Cleaning Ends of Pipe: The ends of the pipe to be joined shall be cleaned of foreign material.

2. Lubrication: After placing pipe in trench, a nontoxic water soluble vegetable soap solution shall be applied to the inside of the bell of the pipe in the trench and to the rubber gasket and spigot groove of the pipe to be installed. The rubber gasket shall be stretched into the groove of the spigot end of the pipe and distributed uniformly around the circumference.

3. Joint Assembly: Without tilting the pipe to be installed, the spigot shall be inserted into the bell of the pipe. Come-a-longs or pipe jacks shall be used to drive spigot end into the bell until properly seated. The joint recess recommended by pipe manufacturer for made-up joints shall be maintained. Where deflections at joints are required for curved alignment, the manufacturer's recommended allowable joint opening on one side shall not be exceeded. A feeler gauge shall be used to verify proper placement of each gasket.

E. Flanged Connections

1. Bolthole Alignment: Pipe shall be set with flange boltholes straddling the pipe horizontal and vertical centerlines.

2. Nuts and Bolts: Nuts and bolts shall be lubricated with anti-seize prior to installation. Assemble all bolts in flange, then tighten bolts in the sequence and to the torque as recommended by the manufacturer. Retighten the bolts after 24 hours. Replace galled, cracked or distorted bolts and nuts.

3. Flange Wrapping: Flanges which connect with buried valves or other equipment shall be wrapped with sheet polyethylene film as specified for the valves and

equipment. The wrap shall be extended over the flanges and bolts and secured around the adjacent pipe circumference with tape.

4. Coating: Flanges and non-stainless steel bolts shall be completely coated as specified in Section 09900, Painting and Coating.

F. Installation of Bends, Tees, and Reducers

Fittings shall be installed utilizing standard installation procedures. Fittings shall be lowered into trench by means of rope, cable, chain, or other acceptable means without damage to the fittings. Cable, rope, or other devices used for lowering fitting into trench, shall be attached around exterior of fitting for handling. Under no circumstances shall the cable, rope or other device be attached through the fittings interior for handling. Fittings shall be carefully connected to pipe or other facility, and joint shall be checked to insure a sound and proper joint.

G. Installing Threaded Piping

Threaded piping shall be reamed, deburred, and cleaned before making up joints. Thread lubricant shall be applied to threaded pipe ends before installing fittings, couplings, unions, or joints.

H. Pipeline Closure

General: Pipeline closure assemblies shall be employed to unite sections of pipeline laid from opposite directions; to adjust the field length of the pipeline to meet structures, other pipelines, and points established by design stations; and to close areas left open to accommodate temporary test bulkheads for hydrostatic testing. Minimum length of pipe closure sections shall be four feet.

I. Thrust Restraint and Anchor Blocks

1. Location: Thrust restraint and anchor blocks shall be provided on all pressure pipelines, and shall be installed as shown on the plans and at all rubber gasketed fittings that are not otherwise restrained. Thrust restraint blocks or anchor blocks shall be installed at all valves, tees, crosses, ends of pipelines, and at all changes of direction of the pipeline greater than 5 degrees deflection either vertically or horizontally when joints are not otherwise restrained.

2. General Requirements: Thrust restraint and anchor blocks shall be of not less than 3,250 psi concrete (Class A); and shall provide a thrust bearing area to resist horizontal or downward thrust; and shall be of sufficient gross weight and area to give bearing against undisturbed vertical earth banks sufficient to absorb the thrust, allowing an earth bearing of 1500 pounds per square foot maximum.

3. Thrust Restraint not Called for on the Plans: Thrust restraint elements, where not called for on the plans, shall be sized for 150 percent of operating pipeline pressure. Prior to construction, thrust and anchor block sizing shall be submitted to the District for approval. Pipe clamps, tie-rods, and their assembly shall meet the requirements of the National Fire Protection Association Bulletin No. 24, latest edition.

4. Concrete Placement: Concrete shall be placed against wetted and undisturbed soil, and the exterior of the fitting shall be cleaned and wetted to provide a good bond with the concrete. The concrete interface with the fitting shall be an area of not less than the projected area of the fitting normal to the thrust resultant and centered on the resultant.

5. Accessibility to Joints and Fittings: Unless otherwise directed by the District, thrust restraint and anchor blocks shall be placed so that the pipe and fitting joints are accessible for repair. Placement shall include isolation of adjacent utilities and shall ensure that bearing is against undisturbed soil.

6. Harness and Tie-Rods: Metal harness or tie-rods and pipe clamps shall be used to prevent movement if shown on the plans or directed by the District. The rods and clamp harnessing arrangement shall be installed utilizing flanged harness hold-downs or lugged fittings and pipe with saddle clamps placed to bear against the pipe bells. Saddle clamps around the barrel of the pipe, which depend on friction or setscrews to prevent sliding of the clamp, are not acceptable. The pipe clamps, tie rods and their assembly shall meet the requirements of the National Fire Protection Association Bulletin No. 24, 1981 Edition. All surfaces of exposed and buried steel rods, reinforcing steel, bolts, clamps, and other metal work shall be coated before installation and touched up after assembly as specified in Section 09900, Painting and Coating, System D-1, “Buried Metal Coating System”.

7. In-line Valves: Reinforcing steel tiedown rods shall be used on all in-line valves.

J. Blowoff Assemblies

1. General: In-line type or end-of-line type blowoff assemblies shall be installed in accordance with the plans at locations noted, and at such additional locations as required by the District for removing water or sediment from the pipeline.

2. Location: The assembly shall be installed in a level section of pipe. The tap for blowoff in the line shall be no closer than 18 inches to a valve, coupling, joint, or fitting unless it is at the end of the main.

K. Combination Air and Vacuum Release Valves

1. General: Air release valve assemblies and combination air and vacuum valves shall be installed at each point in the pipeline as shown on the drawings or as

specified by the District, and in accordance with Section 15089: Combination Air and Vacuum-Release Valves.

2. Location: The tap for the air valves shall be made in a level section of pipe no closer than 18 inches to a bell, coupling, joint, or fitting.

L. Aboveground Piping Installation/Support

1. General: Installation of aboveground pipeline materials and appurtenances include requirements for buried pipeline materials and appurtenances as applicable.

2. Supports: All exposed pipe shall be adequately supported with devices of appropriate design. Where details are shown, the supports shall conform thereto and shall be placed as indicated; provided, that the support for all piping shall be complete and adequate as herein specified, whether or not supporting devices are specifically called for. Pipe hangers and supports shall conform to the requirements of the latest editions of the MSS-SP58 and SP69 and ANSI/ASME B31.1.

3. Grooved-End Pipe and Fittings: Grooved-end pipe and fittings shall be installed in accordance with coupling manufacturer's recommendations and the following: Loose scale, rust, oil, grease, and dirt shall be cleaned from the pipe or fitting groove. The coupling manufacturer's gasket lubricant shall be applied to the gasket exterior including lips, pipe ends, and housing interiors. Coupling shall be fastened alternately and evenly until coupling halves are seated properly.

M. Warning and Locator Tape

The pipe identification shall be in accordance with Section 15151, Domestic and Recycled Water Facilities Identification.

END OF SECTION

SECTION 15056

DUCTILE-IRON PIPE AND FITTINGS

PART 1 – GENERAL

A. Description

This section describes materials, installation, and testing of ductile-iron pipe and fittings.

B. Related Work Specified Elsewhere

1. Trenching, Backfilling, and Compacting: 02223.

2. Manual Valves: 15100.

C. Submittals

1. Shop drawings shall be submitted in accordance with Section 01300 and the following.

2. Affidavits of compliance with standards referenced in this specification, e.g., AWWA C151, shall be provided.

3. Layout drawings showing the locations and dimensions of pipe and fittings shall be submitted where the proposed pipeline is to be placed along streets or alignments with a radius of curvature which dictates the use of shorter-than-standard pipe lengths. In cases where restrained joint pipe is specified, lay drawings shall clearly identify the joints, lengths, fittings, and deviations from the curved centerline of the pipe trench. Consideration for adjacent parallel utility conflicts is important in developing the lay diagrams to avoid conflicts and encroaching into adjacent trench areas.

4. Lining, coating and wall thickness for all piping shall be provided.

5. Joint details for all types of joints used, e.g., push-on joints shall be submitted.

6. Calculations and/or test data proving that each proposed restrained joint arrangement can transmit the required forces shall be submitted.

PART 2 - MATERIALS

A. Ductile-Iron Pipe

1. AWWA Reference Standard: Ductile-iron pipe shall be manufactured in accordance with ANSI/AWWA C151/A21.51.

2. Minimum Wall Thickness: The minimum wall thickness for ductile-iron pipe shall be as specified in AWWA C150 for the design pressure class for bell and spigot pipe, thickness Class 53 for flanged spools, and pressure class 350 for plain end pipe, unless indicated otherwise on the plans.

3. Joints: Unless otherwise called out on the plans, push-on type joints shall be used. The joint dimension and gasket shall be as specified in ANSI/AWWA C111/ A21.11.

4. Flanges: Flanges for ductile-iron pipe, when required, shall be "screwed-on" type in accordance with ANSI/AWWA C115/A21.15.

5. Restrained Joints: Where called for on the plans, pipe and fittings shall be restrained.

   Where restrained joints are called for on 8-inches in diameter and smaller pipe, push-on joints shall be restrained with locking gasket rated for 250 psi operating pressure. Joint restraint shall be push-on joint with "Field-Lok" gaskets as manufactured by U.S. Pipe, Perma-Lock Joint as manufactured by Pacific States Cast Iron Pipe Company or approved equal. "TR-Flex" restrained joint pipe as manufactured by U.S. Pipe or approved equal is also an acceptable option for restraint of push-on joints.

   Where restrained joints are called for on 10-inches in diameter and larger pipe, use a manufactured locking restraint pipe: “TR-Flex” restrained joint pipe as manufactured by U.S. Pipe; “Flex-Ring (only) as manufactured by American Cast Iron Pipe Company; “Thrust-Lock” manufactured by Pacific States Cast Iron Pipe Company; “F-128 Super-lock” pipe as manufactured by Clow Water Systems Company, or approved equal. The restrained joint shall be a boltless restrained push-on joint design and shall contain a positive axial locking restrained system and be capable of deflection after assembly. Restraint of field cut pipe by using U.S. Pipe’s “TR Flex Gripper Ring” or approved equal will be permitted as long as the “TR Flex” pipe field weldments are not required. Any restrained joint fitting which will require a pipe field weldment will **not** be permitted under any circumstances. Restraint of field cut pipe shall be kept to a minimum.

6. Outlets for DIP shall be as follows:

2” or smaller: brass saddle with stainless steel bands

2-1/2”: brass saddle with stainless steel bands or tapped tee

4” and larger: D.I. tee fitting

7. Manufacturers: Ductile-iron pipe shall be as manufactured by American Cast Iron Pipe Company, Pacific States Cast Iron Pipe Company, U.S. Pipe and Foundry Company, Griffin Pipe Products Company, McWane Cast Iron Pipe Company, Clow Water Systems Company or approved equal.

B. Ductile-Iron Fittings

1. AWWA Reference Standard: Ductile-iron fittings shall be manufactured in accordance with ANSI/AWWA C110/A21.10. Ductile iron compact body fittings may be used for fitting sizes 4-inches through 12-inches in diameter and shall be manufactured in accordance with ANSI/AWWA C153/A21.53.

2. Push-on Joints: All fittings shall be made with push-on joints designed for use with the type of pipe to be joined unless noted otherwise on the plans.

3. Restrained Joints: Restrained fittings shall be used only as shown on the plans.

   For pipe sizes 8-inches in diameter and smaller, push-on joint fittings shall be restrained with locking gasket rated for 250 psi operating pressure. Joint restraint shall be push-on joint with "Field-Lok" gaskets as manufactured by U.S. Pipe, Perma-Lock Joint as manufactured by Pacific States Cast Iron Pipe Company or approved equal. "TR-Flex" restrained joint fitting as manufactured by U.S. Pipe or approved equal is also an acceptable option for restraint of push-on joint fittings in this size.

   For pipe sizes 10-inches in diameter and larger, restrained joint fittings shall either be “TR-Flex” restrained joint fitting as manufactured by U.S. Pipe or approved equal, or mechanical joint ductile iron fittings fitted with joint restraints. Mechanical joint restraint shall be incorporated with the design of the follower gland and shall include a restraining mechanism which, when activated, imparts multiple wedging action against the pipe, increasing its resistance as the pressure increases. The joint shall maintain flexibility after burial. Follower glands shall be manufactured of ductile iron conforming to ASTM A536-80. The mechanical joint restraint shall be EBBA IRON, Inc., MEGALUG, UNIFLANGE Series 1400, The Ford Meter Box Co., Inc. or approved equal. Any restrained joint fitting which will require a pipe field weldment will not be permitted.

Ductile iron mechanical joint fittings shall comply with AWWA C-111/A-21.11, with a pressure rating of 250 psi and ANSI Class 125 and Class 150 bolt pattern. Tee bolts for mechanical joint fittings shall be Type 316 stainless steel.

4. Hydrostatic Pressure Test: Each fitting shall be tested before lining to one and one-half times the operating pressure for a duration of 10 seconds. Suitable controls and recording devices shall be provided so that the test pressure and duration may be adequately ascertained. Any fitting that does not withstand the test pressure shall be rejected.

5. Bell Ends: Bell ends shall be compatible with the pipe ends so as to provide confinement of the rubber rings and prevent damage to the ends of the pipe. Ring grooves and interior surfaces of the bell shall be smooth and free from ridges, notches, or uneven surfaces.

6. Flanged Fittings: All fittings with flanged ends shall comply with AWWA C110/A21.10, with a pressure rating of 250 psi and a Class 125 ASME/ANSI B-16.1 flange or AWWA C-115/A-21.15 Class 125 flange. The Contractor shall be careful to confirm the mating flange, especially of valves, to make sure the compatibility of the two flanges. Butterfly valves will be Class 250 and will have 250 lb. flanges. Resilient gate valves shall be rated for 250 psi working pressure but will have 150 lb. flanges.

   The gasket surface shall have a serrated finish of approximately 16 serrations per inch, approximately 1/32-inch deep, with serrations in either a concentric or spiral pattern. In addition, all flanges shall meet the following tolerances:

Bolt circle drilling	+1/16 inch
Bolthole spacing	+1/32 inch
Eccentricity of both circle and facing with respect to bore	1/32 inch maximum

9. Manufacturers: Fittings shall be manufactured by American Pipe, Pacific States, Sigma, Star Pipe Produces, U.S. Pipe, Tyler, or approved equal.

C. Gaskets

1. Gaskets for Flanged Joints: Gaskets for flanged joints shall be 1/8-inch thick, cloth-inserted rubber. Gaskets shall be suitable for a water pressure of 350 psi at a temperature of 180°F.

2. Full Face Type Gaskets for Flanged Joints: Full face type gaskets with pre-punched holes shall be used where both flanges are flat face. Ring gaskets extending to the inner edge of the bolts may be used where a raised face flange is present.

3. Gaskets for Push-on, Mechanical, and Restrained Joints: Gaskets for push-on, mechanical, and restrained joints shall be synthetic or natural rubber in accordance with AWWA C111.

4. Manufacturers: Gasket shall be John Crane Company Style 777, Johns Manville No. 109, or approved equal.

D. Bolts, Nuts, and Washers

1. General: Bolts and nuts for buried flanges, flanges located outdoors above ground, flanges located in open vaults and structures, and submerged flanges shall be Type 316 stainless steel conforming to ASTM A 193, Grade B8M for bolts, and ASTM A 194, Grade 8M for nuts.

2. Washers: A washer shall be provided for each nut. Washers shall be Type 316 stainless steel.

3. Bolt Projection: The length of each bolt or stud shall be such that between 1/4 inch and ½ inch will project through the nut when drawn tight.

E. Ceramic Epoxy Lining

1. Lining material for ductile iron pipe and fittings (sewer applications) shall be ceramic epoxy lining. The material shall be a high build multi-component ceramic quartz filled amine cured novalac epoxy lining. The lining shall be applied at a nominal 40 mils thickness. Upon completion of the lining process, each pipe shall pass a 2500 volt holiday detection test. In addition, a thickness test shall be performed to insure a sound chemically resistant protective lining for the ductile iron pipe and fittings.

2. All ductile iron pipe and fittings shall have a bituminous coating on the exterior except for 6-inches of the exterior of the spigot ends. The bituminous coating shall not be applied to the first 6 inches of the exterior of the spigot ends. All ductile iron pipe and fittings shall be delivered to the application facility without asphalt, cement lining, or any other lining on the interior surface. Because removal of old linings may not be possible, the intent of this specification is that the entire interior of the ductile iron pipe and fittings shall not have been lined with any substance prior to the application of the specified lining.

3. The material used for lining the pipe and fittings shall be Protecto 401 Ceramic Epoxy, a high build multi-component amine cured novalac epoxy lining, or approved equal.

4. The lining shall be applied by a competent firm with a successful history of applying linings to the interior of ductile iron pipe and fittings.

5. Surface Preparation: Prior to abrasive blasting, the entire area which will receive the protective compound shall be inspected for oil, grease, etc. Any areas where oil, grease, or any substance which can be removed by solvent is present shall be solvent cleaned using the guidelines outlined in SSPC-1 Solvent Cleaning. After the surface has been made free of grease, oil or other substances, all areas to receive the protective compounds shall be abrasive blasted using compressed air nozzles with sand or grit abrasive media. The entire surface to be lined shall be struck with the blast media so that all rust, loose oxides, etc., are removed from the surface. Only slight stains and tightly adhering annealing oxide may be left on the surface. Any area where rust appears before coating must be re-blasted to remove all rust.

6. Lining: After the surface preparation and within 8 hours of surface preparation, the interior pipe shall receive 40 mils dry film thickness of the protective lining. No lining shall take place when the substrate or ambient temperature is below 40 degrees Fahrenheit. The surface also must be dry and dust free. If flange fittings of pipe are included in the project, the linings must not be used on the face of the flange; however, full face gaskets must be used to protect the ends of the pipe. All fittings shall be lined with 40 mils of the protective lining. The 40 mils system shall not be applied in the gasket grooves.

7. Coating of Gasket and Spigot Ends: Due to the tolerances involved, the gasket area and spigot end up to 6 inches back from the end of the spigot end must be coated with 6 mils nominal, 10 mils maximum of Protecto Joint Compound. This coating shall be applied by brush to ensure coverage. Care should be taken that the coating is smooth without excess buildup in the gasket groove or on the spigot end. All materials for the gasket groove and spigot end shall be applied after the application of the lining.

8. Number of Coats: The number of coats of lining material applied shall be as recommended by the lining manufacturer. However, in no case shall this material be applied above the dry thickness per coat recommended by the lining manufacturer in printed literature. The time between coats shall never exceed that time recommended by the lining material manufacturer. No material shall be used for lining which is not indefinitely recoatable with itself without roughening of the surface.

9. Touch-up & Repair: Protecto Joint Compound shall be used for touch-up or repair. Procedures shall be in accordance with manufacturer's recommendations.

10. Inspection: All ductile iron pipe and fitting linings shall be checked for thickness using a magnetic film thickness gauge. The thickness testing shall be done using the method outlined in SSPC-PA-2 Film Thickness Rating. The interior lining of all pipe and fittings shall be tested for pinholes with a nondestructive 2,500 volt test. Each pipe joint and fitting shall be marked with

the date of application of the lining system and with its numerical sequence of application on that date.

11. Certification: The pipe or fitting manufacturer shall supply a certificate to the fact that the applicator met the requirements of this specification, and that the material used was as specified, and that the material was applied as required by this specification.

12. Procedures for sealing cut ends and repairing field damaged areas: Remove burrs caused by field cutting of ends or handling damage and smooth out the edge of the lining if rough. Remove all traces of oil, grease, asphalt, dust, dirt, etc. Remove any damaged lining caused by field cutting operations or handling and clean any exposed metal by sanding or scraping. Sandblasting or power tool cleaning roughening is also acceptable. It is recommended that any loose lining be removed by chiseling, cutting, or scraping into well adhered lined area before patching. Be sure to overlap at least 1-inch over the lining in the area to be repaired.

    With the area to be sealed or repaired, absolutely clean and suitably roughened, apply a coat of Protecto Joint Compound using the following procedure: Mixing Procedure-Protecto Joint Compound is a 7 to 1 (7:1) mix ratio. When mixed, it should contain 7 parts of the black activator and one part of the translucent blending resin. This can be accomplished by simply using the same container to dip out seven containers full from the large can and pouring one container full from the small can which contains the blending resin. This is the simplest and most accurate means for field mixing less than the kit provided. After the blending resin is added to the activator, the mixture should be thoroughly agitated. All activated material must be used within 45 minutes of mixing.

    Application of Material – After the material has been thoroughly mixed in a seven-to-one (7:1) ratio, it can be applied to the prepared surface by brush. Brushing is usually best, due to the fact that the areas are usually small. Practices conducive to a good coating are contained in the technical data sheet for Protecto Joint Compound. It is important to coat the entire freshly cut exposed metal surface of the cut pipe end. To ensure proper sealing, overlap at least, one inch of the lining with this repair material.

F. Fusion Bonded Epoxy

1. As an alternative to Ceramic Epoxy Lining, the lining and coating for ductile iron pipe and fittings can be fusion bonded epoxy per AWWA C-116.

2. After installation, any area damaged during installation shall be repaired using a liquid epoxy coating applied by spray or brush in accordance with the manufacturer's recommendation. Coating to be repaired shall be roughened and feathered into a sound coating to the satisfaction of the District to assume a durable mechanical bond. Field repairs shall be limited to localized

imperfections and joints. Extensive repairs shall be returned to the manufacturer for a fusion process.

G. Coating for Pipe and Fittings

1. Exterior Surfaces: Exterior surfaces of pipe and fittings shall be coated with an asphaltic material in conformance with ANSI/AWWA C110/A21.10, and ANSI/AWWA C151/A21.51. The coating shall be free from blisters and holes; shall adhere to the metal surface at ambient temperatures encountered in the field.

2. Interior Surfaces: Interior surfaces of pipe and fittings installed within wet well and valve vault shall be epoxy lined and epoxy coated.

3. Coating for Bolts, Nuts, and Glands: Buried mechanical joint bolts, nuts and glands, and restrained joint bolts for field-cut closure pipe shall be coated per Section 09900, Painting and Coating. Stainless steel parts shall not be coated except for the threaded portion, which shall be assembled with a liberal coat of anti-seize compound.

H. Polyethylene Encasement

Pipe and fittings shall be polyethylene encased in accordance with ANSI/AWWA C105/A21.5. Contractor shall encase the pipe and fittings in **two layers** of polyethylene.

I. Grooved-End Couplings

Grooved-end couplings shall conform to AWWA C-606, rigid radius-cut groove. Grooved end couplings shall be ductile iron, ASTM A-536, Grade 65-45-12. Bolts shall be Type 316 stainless steel and conform to ASTM A-183, minimum tensile strength of 110,000 psi. Coupling shall be Victaulic, Style 31, Gustin-Bacon or approved equal. All of threaded parts shall be type 316 stainless steel and shall be lubricated with anti-seize component.

PART 3 - EXECUTION

A. General

Ductile-iron pipe and ductile iron fittings shall be installed in accordance with the applicable sections of AWWA C600 and as specified in Section 15051, Installation of Pressure Pipelines.

B. Installation

1. Allowable Joint Deflection for Restrained Joint Pipe and Fittings: For restrained joints, deflection of the joint shall not exceed 80% of the manufacturer's recommended maximum deflection.

2. Acceptable Line and Grade for Piping: The pipe shall be laid true to the line and grade shown on the plans within acceptable tolerances. The tolerance on grade is 1-inch. The tolerance on line is 2-inches.

3. Touch-Up Coating: All exposed flanges and other metal surfaces and all damaged coatings shall be coated after assembly per Section 09900, Painting and Coating. Stainless steel bolts shall not be coated.

C. Wrapping pipe with Polyethylene Encasement

All ductile-iron pipe and ductile iron fittings buried underground shall be protected with a double layer of polyethylene encasement wrap in accordance with the latest revision of AWWA C105. Each layer of polyethylene encasement shall be a loose 8-mil-thick minimum LLD polyethylene tube or loose 4-mil thick minimum HDCL polyethylene tube. All joints between plastic tubes shall be wrapped with 2-inch-wide, 10-mil thick, polyethylene adhesive tape, Polyken 900, Scotchwrap 50, or approved equal. Installation of plastic film shall conform to the following procedure, and wrapping shall be applied to the pipe in the field in the following manner:

1. Placement of Polyethylene Encasement: Using a sling, the pipe shall be picked up with a crane at the side of the trench and raised about 3 feet off the ground. The polyethylene tube, cut approximately 2 feet longer than the length of pipe, shall be slipped over the spigot end of the pipe and bunched up, accordion fashion, between end of the pipe and the sling. The Contractor shall place two layers (double bag) of polyethylene tube over the pipe.

2. Placement of Pipe into Trench: The pipe shall be lowered into the trench. The spigot shall be seated into the bell of the adjacent installed pipe, and the pipe lowered into the trench bottom. A shallow bell hole shall be provided in the trench bottom to facilitate the wrapping of the joint.

3. Joint Assembly: The pipe joint shall then be made up as described herein.

4. Adjustment of Polyethylene Encasement: The sling shall be removed from the center of the pipe and hooked into the bell cavity. The bell shall be raised approximately 12 inches and the tube of polyethylene film slipped along the full length of the pipe barrel. Enough of the film shall be left bunched up, accordion fashion, at each end of the pipe to overlap the adjoining pipe about 1 foot. Care shall be taken to ensure that soil that adheres to the pipe is removed as the polyethylene film is placed around the pipe.

5. Overlapped Joints: To make the overlapped joint wrap, the film shall be pulled over the bell of the pipe, folded around the adjacent spigot, and wrapped with about three circumferential turns of the plastic adhesive tape in order to seal the tube of film to the pipe. The tube on the adjacent pipe shall be then pulled over the first wrap on the pipe bell and sealed in place behind the bell, using about three circumferential turns of the polyethylene adhesive tape.

6. Attachment of Encasement: The resulting loose wrap on the barrel of the pipe shall be pulled snugly around the barrel of pipe, the excess material folded over the top and the fold held in place by means of short strips of 2-inch wide, 10-mil thick polythlene adhesive tape at intervals 3 feet apart along the pipe barrel.

D. Flanged Connections

Flanged pipe and fittings shall be shop fabricated, not field fabricated. Threaded flanges shall comply with AWWA C115 and shall be individually fitted and machine tightened in the shop.

E. Mechanical Joint Connections with Retainer Gland Restraints

Mechanical joint connections with retainer glands shall be assembled in accord with the manufacturer's recommendations for the specific fitting and retainer gland being used. Torquing of break-off gland bolts shall be done in the presence of the District's field representative. Each fitting shall be observed by the District's field representative prior to bagging and backfill. Any such fittings not observed by the District's field representative shall be excavated and exposed for detailed re-inspection of the fitting and bolt torque.

END OF SECTION

SECTION 15057

COPPER PIPE AND FITTINGS

PART 1 - GENERAL

A. Description

This section describes materials, installation, and testing of copper and brass pipe, and copper, brass and bronze fittings and appurtenances.

B. Related Work Specified Elsewhere

1. Trenching, Backfilling, and Compacting: 02223.

2. Painting and Coating: 09900

3. Installation of Pressure Pipelines: 15051.

4. Manual Valves: 15100.

C. Submittals

1. Shop drawings shall be submitted in accordance with Section 01300 and the following:

2. Submit catalogue order sheets for materials of pipe, flanges, valves, fittings, saddles, companion flanges and unions, showing metal composition and conformance to industry standards (ASTM, etc.) specified.

PART 2 – MATERIALS

A. Copper Pipe and Tubing

Copper piping shall conform to ASTM B 88. Copper pipe and tubing shall be cylindrical, of uniform wall thickness, and shall be free from any cracks, seams, or other defects. Piping located above floors or suspended from ceilings shall be Type L. Piping buried or located beneath floor slabs shall be Type K hard copper tube. Copper pipe shall be as manufactured by Cerro Copper Products Company, IUSA/Reading, Halstead Industries, Inc., Cambridge-Lee Industries, Inc., Mueller, or approved equal.

B. Copper Fittings

Copper fittings shall be copper conforming to ASTM B 75 and ANSI B16.22, with compression end joints ("Quick Joint Connections" manufactured by Ford, NO EQUAL). If bends are required, due to vertical alignment or utility conflicts, in the copper service and combination air valve assemblies copper tubing from the corporation stop to the 90 degree bend below the angle meter stop, solder end joints will be acceptable on the copper fittings.

C. Solder

Solder shall be tin-silver solder conforming to ASTM B 32, latest revision, Grade Sn94, Sn95 or Sn96. Cored solder shall not be used. Solder and flux used in joints of potable waterlines shall contain no more than 0.2 percent lead. Solder end joints will only be allowed for this Contract as specifically called for on the Drawings (i.e.: bends and splices due to long runs in the copper service and combination air valve assemblies copper tubing from the corporation stop to the 90 degree bend below the angle meter stop).

D. Brass Pipe and Nipples

Short threaded nipples and brass pipe shall conform to ASTM B 43, regular wall thickness, except that nipples and pipe of sizes 1 inch and smaller shall be extra strong. Threads shall conform to ANSI B1.20.1. Brass material shall conform to ANSI/AWWA Standard C800, latest revision, with a maximum lead content of 0.25% by average weight.

E. Appurtenances

1. General: All items manufactured of bronze shall conform to ASTM B62, "Composition Brass or Ounce Metal Castings." All items manufactured of brass shall conform to ANSI/AWWA Standard C800, latest revision, with a maximum lead content of 0.25% by average weight.

2. Service Saddles on PVC Mains: Service saddles on PVC mains shall be tapped with a female iron pipe thread outlet. The seal with the pipe outer wall shall be either a rubber gasket or an O-ring. Service saddles shall be double band brass saddles with stainless steel bands, Style 202BS as manufactured by Ford, or approved equal.

3. Service Saddles on DIP Mains: Service saddles on DIP mains shall be tapped with a 2-1/2 inch female iron pipe thread outlet. The seal with the pipe outer wall shall be EPDM rubber gasket. Service saddles shall be epoxy coated double band service saddle, Style FC202 as manufactured by Ford, or approved equal. The body shall be made of high strength ductile iron per ASTM A536. The double wide band shall be made of 18-8 type 304 stainless steel.

The stainless steel bolts and stainless steel nuts and washers shall be Type 316. The finish on the saddle body shall be fusion bonded epoxy coat approximately 12 mils thick.

4. Corporation Stops: The inlet fitting of the corporation stop shall be a male iron pipe thread and the outlet connection shall be a compression type connection with compression gasket and integral stainless steel gripper band (Quick Joint as manufactured by Ford, No Equal).

   Corporation stops shall be of the “ball valve” type and rated for at a minimum 250 psi working pressure. Corporation stops shall be as manufactured by Ford FB1000-7-Q NL style, No Equal.

5. Angle Meter Stops: Angle meter stops shall be “ball valve” type and shall be rated for a minimum 250 psi working pressure. The inlet connection of the angle meter stop shall be a compression type connection with compression gasket and integral stainless steel gripper band (Quick Joint as manufactured by Ford, or approved equal). The outlet fitting shall be a meter flange with a EPDM drop-in style meter gasket.

   The inlet and outlet shall form an angle of 90 degrees on a vertical plane through the centerline of the meter stop. A solid one piece tee-head and stem with a padlock wing shall be provided on the top of the fitting to operate the shutoff mechanism. Two-inch angle meter stops shall be provided with "slotted" holes for 2- inch or 1-1/2” flanged meter connection. Angle meter stops shall be of the “ball valve” type as manufactured by Ford BFA43-777W-Q-NL Style, No Equal.

6. Customer Service Valve: Customer service valves shall be manufactured with a lever-type turn handle. Customer service valve shall be “ball valve” type and shall be rated for a minimum 250 psi working pressure. The valve inlet connection shall be meter flange and the outlet connection shall be female iron pipe thread. Recommended customer service valve manufacturer is Ford, No Equal.

F. Insulating Bushings and Unions

Pipe fittings, and appurtenances (air vacs, etc.) made of dissimilar metals shall be isolated from each other by means of stainless steel bushings, insulating pipe bushings, insulating unions, or insulating couplings. Insulating bushings, unions, and couplings shall be as manufactured by Pipeline Coating and Engineering Company, Smith-Blair, Pipe Seal and Insulator Company, or approved equal.

For applications where the main is ductile iron pipe, the service saddle shall be provided with a 2-1/2 inch female threaded outlet. The bronze corporation stop and copper pipe of the appurtenance shall be isolated from the main by means of a 2-1/2” by 2” Type 316 stainless steel bushing.

G. Flanges, Gaskets, Bolts and Nuts

1. Flanges for Valves and Fittings: Copper pipe shall be connected to flanged valves and fittings with bronze flanges conforming to ANSI B16.24, Class 125 or Class 150, to match the connecting flange. Threaded companion flanges shall be used for brass, bronze or stainless steel pipe connections.

2. Gaskets: Gaskets for flanged-end fittings shall be made of synthetic rubber binder and shall be full-face, 1/8-inch thick Johns-Manville, John Crane Co. "Cranite", or approved equal.

3. Flanged Connections: All flanged connections shall be made using Type 316 stainless-steel bolts and nuts conforming to ASTM A 193, Grade B8M for bolts and ASTM A 194, Grade 8M for nuts. Washers shall be provided for each nut. Washers shall be of the same material as the nuts.

H . Union

Unions for copper piping systems (non-buried applications) shall conform to the following: unions shall be the same size as the pipe; shall be of three part type; and shall have compression grip connections. Unions shall be bronze, conforming to ASTM B 61 or B 62. Dielectric unions shall be used when connecting copper pipe to ferrous metals. Unions shall be Ford, Mueller H-15403, Jones, or approved equal.

PART 3 – EXECUTION

A . General

Pipe shall be installed without springing, forcing, or stressing the pipe or any adjacent connecting valves or equipment. Pipe hangers and supports, and pipe penetrations through walls, slabs, and floors shall be as detailed on the drawings.

B. Installing Flange Bolts and Nuts

1. Bolt Thread Lubrication: Bolt threads shall be lubricated with anti-seize compound prior to installation. Anti-seize compound shall be manufactured by Tri-Flow, Permatex or Crouse-Hinds.

2. Flange Alignment: Flanges pipe shall be set with the flange bolt holes straddling the pipe horizontal and vertical centerlines. This is referred to as the “two holing” procedure.

C. Installation

1. Related Installation Specification: Pipe shall be installed in accordance with the requirements of Section 15051, Installation of Pressure Pipelines.

2. Pipe/Tubing Preparation: Tubing shall be cut square and burrs removed. Both the inside and outside of fitting and pipe ends shall be cleaned with steel wool and muriatic acid before soldering. Care shall be taken to prevent overheating (or annealing) of fittings and tubing when making connections. Miter joints shall not be permitted in lieu of elbows. Notching straight runs of pipe in lieu of tees shall not be permitted.

3. Pipe Bends: Bends in soft copper tubing shall be long sweep. Bends shall be shaped with shaping tools. Bends shall be formed without flattening, buckling, or thinning the tubing wall at any point.

4. Brazing: Brazing procedures shall be in accordance with Articles XII and XIII, Section IX, of the ASME Boiler and Pressure Vessel Code. Solder shall penetrate to the full depth of the bell in joints and fittings. Solders shall comply with ANSI B31.3, paragraph 328.

5. Pipe Flexibility and Minimum Cover for Service Lines: Buried piping shall be installed with some slack to provide flexibility in the event of a load due to settlement, expansion or contraction. A minimum cover of 30-inches below the finished top of curb shall be adhered to. The tubing shall be bedded and covered with sand or select material in accordance with Section 02223.

6. Copper Service Laterals: All copper service laterals and laterals for air-vacuum assemblies shall be 2-inch Type K hard copper tubing. End connections for the corporation stop and angle meter stop shall be compression grip type fittings. The 90º fittings below the angle meter stop shall be compression grip type. If bends are required, due to vertical alignment or utility conflicts, in the copper service laterals from the corporation stop to the 90 degree bend below the angle meter stop, solder end joints will be acceptable on the copper bends. If the copper service lateral is a long run and requires a splice, solder end joints will be acceptable for the splice.

D. Service Saddles

1. Proximity to Valves, Couplings, Joints, and Fittings: Service saddles shall be no closer than 18-inches to valves, couplings, joints, or fittings unless it is at the end of the main.

2. Pipe Surface Preparation: The surface of the pipe shall be cleaned, smoothed and de-burred to remove all loose material and to provide a hard, clean surface before installing the service saddle.

3. Installation: The service saddle shall be tightened firmly to ensure a tight seal; however, care shall be used to prevent damage or distortion of the pipe by over-tightening.

4. Pipe Tap: The tap into the pipe shall be made in accordance with the pipe manufacturer's recommendation.

END OF SECTION

SECTION 15066

GRAVITY SEWER PIPELINES

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Gravity sewer pipelines

1. Vitrified clay pipe (VCP)
2. Polyvinyl chloride (PVC) pipe

1.02 RELATED REQUIREMENTS

A. Section 02223, Trenching, Backfilling, and Compacting

B. Section 03461, Precast Reinforced Concrete Manholes

C. Section 15043, Testing of Non-Pressure Sewer Pipelines and Manholes

1.03 REFERENCED STANDARDS

A. ASTM International

1. ASTM C301: Standard Test Methods for Vitrified Clay Pipe
2. ASTM C425: Standard Specification for Compression Joints for Vitrified Clay Pipe and Fittings
3. ASTM C700: Standard Specification for Vitrified Clay Pipe, Extra Strength, Standard Strength, and Perforated
4. ASTM D395: Standard Test Methods for Rubber Property – Compression Set
5. ASTM D412: Standard Test Methods for Vulcanized Rubber and Thermoplastic Elastomers - Tension
6. ASTM D573: Standard Test Method for Rubber – Deterioration in an Air Oven
7. ASTM D1149: Standard Test Methods for Rubber Deterioration – Cracking in an Ozone Controlled Environment
8. ASTM D1784: Standard Specification for Rigid Poly (Vinyl Chloride) (PVC) Compounds and Chlorinated Poly (Vinyl Chloride) (CPVC) Compounds
9. ASTM D2240: Standard Test Method for Rubber Property – Durometer Hardness
10. ASTM D3034: Standard Specification for Type PSM Poly (Vinyl Chloride) (PVC) Sewer Pipe and Fittings

B. National Association of Sewer Service Companies (NASSCO)

1. Pipeline Assessment Certification Program (PACP)

1.04 SUBMITTALS

A. Vitrified Clay Pipe

1. Provide certificates of compliance with all standards referenced in this section to the District.
2. Provide copies of the manufacturer's required tests of the following conducted on project pipe:
    a. Crushing test
    b. Record of retests and rejections

B. PVC Gravity Sewer Pipe

1. Provide materials list showing material of pipe and fittings with ASTM references and grade.
2. Provide certificates of compliance with all standards referenced in this section to the District.

C. Installation

1. An installation schedule (tabulated layout) shall be submitted which includes:
    a. Order of installation and closures
    b. Pipe centerline station and elevation at each change of grade and alignment
    c. Locations of manholes

1.05 DELIVERY, STORAGE AND HANDLING

A. Per manufacturer's recommendations and the following:

1. Onsite Storage Limitation: Onsite pipe storage shall be protected from UV exposure and limited to a maximum of one week, unless exception is accepted by the District.
2. Care of Pipe: At times when the pipe laying is not in progress, the open end of the pipe shall be closed with a tight-fitting cap or plug to prevent the entrance of foreign matter into the pipe. These provisions shall apply at all times. In no event shall the sewers be used as drains for removing water which has infiltrated into the construction trenches.
3. Moving Pipe: Pipes shall be lifted with handling beams or wide belt slings as recommended by the pipe manufacturer. Cable slings shall not be used. Pipe shall be handled in a manner to avoid damage to the pipe. Pipe shall not be dropped or dumped from trucks or into trenches under any circumstances.
4. Inspection of Pipe: The pipe and accessories shall be inspected for defects prior to lowering into the trench. Any defective, damaged or unsound pipe in the District's determination shall be replaced at no additional cost to the District. All foreign matter or dirt shall be removed from the interior of the pipe before lowering into position in the trench.

PART 2 PRODUCTS

2.01 VITRIFIED CLAY PIPE (VCP)

A. General: All VCP and fittings shall be of one class; designated extra strength; of the best quality; vitrified; homogenous in structure; thoroughly burned through their entire thickness; impervious to moisture; sound; and free from cracks, checks, blister, broken extremities, or other imperfections. Pipe shall be bell and spigot pipe unless otherwise specified. Pipe ends shall be square with the longitudinal axis, and sockets shall be true, circular, and concentric with the barrel of the pipe. The thickness of the shell, the depth of the socket, and the dimension of the annular space shall be within the limits of permissible variation to dimension standards of the specifications of ASTM C700, for the size of pipe indicated on the plans.

B. Pipe Marking: All pipe or fittings shall be clearly marked with the name of the manufacturer or with a trademark and with the size and strength of the pipe as shown on the plans and as herein specified.

C. Source Testing:

1. Perform factory test of pipes per requirements in ASTM C301.
2. Tests shall be witnessed by a reputable testing laboratory. Pipe selected for testing shall be delivered to the place and at the time designated by the testing laboratory. All costs of furnishing, transporting, and handling the pipe for testing and conducting the tests shall be borne by the Contractor.
3. In lieu of witnessing by a testing laboratory, a certified statement from the pipe manufacturer may be furnished stating that all prescribed tests have been made and the pipe to be used on the project has met all requirements of the specifications.
4. The testing laboratory shall select, at random, for testing as herein specified, no less than 0.5-percent of the number of pipe sections in each size of pipe furnished, except that no less than two specimens shall be tested.
5. The specimens selected for testing shall be sound pipe having dimensions consistent with these specifications. The lot or lots from which the tests samples are taken shall be sufficient to fill the entire order for that size of pipe used in the work under the contract and, if they pass the tests, shall be so designated and marked.
6. All pipe shall be subject to inspection at the factory, trench, or other point of delivery by the District. The purpose of the inspection shall be to cull and reject any pipe that, independent of the physical tests herein specified, fails to conform to the requirements of these specifications or that may have been damaged during transportation or in subsequent handling.
7. If all of the minimum designated percentage or number of the specimens tested meet the requirements of the test, then all of the pipe in the lot, shipment, or delivery corresponding to the sizes and classes so tested shall be considered as complying with the test. If, however, 10-percent or more of the specimens tested fail to meet the requirements of the test or if more than one specimen fails to meet the requirements of the test when the number to be tested is less than ten, then a second selection of pipe shall be made for that test. The number of specimens to be tested in the second selection of pipe shall be five for each specimen of the first selection that failed to meet the requirements.

8. If 90-percent or more of the specimens tested, including those first tested, meet the requirements of the test, all the pipe in the lot, shipment, or delivery corresponding to the sizes and classes so tested shall be considered as complying with that test, otherwise all pipe of these sizes and classes shall be rejected.

9. Causes for Rejection: The following imperfections in a pipe or special fitting shall be considered injurious and cause for rejection without consideration of the test results specified above.

    a. A single crack in the barrel of the pipe

    b. Surface imperfections, such as lumps, blisters, pits or flakes, on the interior surface of a pipe or fitting

    c. When the bore or socket of the pipe varies from a true circle more than 3-percent of its nominal diameter

    d. If the pipe or fitting is designated to be straight and it deviates from a straight line more than 1/16-inch per lineal foot. The deviation shall be measured from a straight edge at a point midway between the ends of the pipe.

    e. A joint of pipe with a piece broken from either the socket or spigot end

    f. Pipe joints that have tramp clays, grog or other foreign matter flushed permanently to the exterior or interior surface of the pipe or fittings

D. Joints: All VCP fittings shall be furnished with compression joints.

1. The compression joint on the spigot and bell ends of the pipe shall be factory made of plastisol, polyurethane elastomer, or other approved resilient element bonded onto the outside of the spigot and the inside of the bell to the pipe and molded and cured to a uniform hardness and compressibility to form a tight compression coupling when assembled. Materials for compression joints shall conform to ASTM C425.

2. Where pipe from different manufacturers is to be jointed together, an adapter pipe with the proper matching joint on each end for the respective manufacturer or an adapter with bushing or sleeves and stainless steel bands, matching each pipe end shall be used. Hot poured joints or concrete encasement of plain end joints shall not be permitted.

E. Branches: Branches of the type shown on the plans shall be furnished with connections of the sizes specified and shall be securely and completely fastened to the barrel of the pipe in the process of manufacture. Tee branches shall have their axis perpendicular to the longitudinal axis of the pipe. Wye branches shall have their axis approximately 45 degrees (unless otherwise specified on the plans) to the longitudinal axis of the pipe, measured from the socket end. All branches shall terminate in sockets and the barrel of the branch shall be of sufficient length to permit making a proper joint.

F. Stoppers: The stoppers for all pipe 8-inches in diameter and smaller, in which a sealing component for a flexible compression-type joint is cast, shall be neoprene, polyethylene, or polyurethane. Stoppers in all other cases shall be discs of the same material as the pipe, equal in diameter to the outside of the pipe barrel, and made and installed as accepted by the District.

1. Neoprene stoppers shall be manufactured from a compound containing not less than 50 percent neoprene by volume, which shall be the sole elastomer. Stoppers shall not be adversely affected when exposed to the chemical and bacteriological environments normally found in wastewater.

2. When installed and braced in place in branch spurs, stoppers shall withstand a hydrostatic pressure test of 10 psi with no leakage. When unbraced, stoppers shall remain in place when subjected to a maximum air pressure test of 5 psi.

2.02 POLYVINYL CHLORIDE (PVC) PIPE

A. Pipe and Fittings

1. ASTM Requirements: Pipe, fittings, couplings, and joints shall be in conformance with the size, material and performance requirements of ASTM D3034, SDR 35, and shall have gasketed joints. Pipe shall be made of PVC plastic having a cell classification of 12364 or 12454 as defined in ASTM D1784. Fittings shall be made of PVC plastic having a cell classification of 12454. All pipe shall be of solid wall construction with smooth interior and exterior surfaces.

2. Manufacturer's Testing Certification: During production of the pipe, the manufacturer shall perform the specified tests for each pipe marking. A certification by the manufacturer indicating compliance with specification requirements shall be delivered with the pipe. The certification shall include the test result data.

3. Pipe Marking: All pipe, fittings, and couplings shall be clearly marked at an interval not to exceed 5-feet as follows:

   a. Nominal pipe diameter

   b. PVC cell classification

   c. Company, plant, shift, ASTM, SDR, and date designation

   d. Service designation or legend

   For fittings and couplings, the SDR designation is not required. All pipe shall have a home mark on the spigot end to indicate proper penetration when the joint is made.

4. Additional Pipe Tests Following Delivery: When pipe is delivered to the jobsite, the District may require additional testing to determine conformance with the requirements of pipe flattening, impact resistance, pipe stiffness, and extrusion quality. When testing is required, one test pipe shall be selected at random by the District from each 1,200 feet or fraction thereof of each size of pipe delivered to the jobsite but not less than one test pipe per lot. A lot shall be defined as pipe having the same identification marking. The length of specimen for each selected pipe shall be a minimum of 8-feet.

5. Pipe Retest: Pipe which is not installed within 120 days of the latest test shall not be used without prior acceptance by the District.

6. Fitting and Coupling End Configurations: The socket and spigot configurations for fittings and couplings shall be compatible with those used for the pipe.

B. Gaskets for PVC Pipe

1. General: Unless otherwise specified, gaskets shall be manufactured from a synthetic elastomer, and shall be extruded or molded and cured in such a manner as to be dense, homogeneous and of smooth surface, free of pitting, blisters, porosity, and other imperfections. The compound shall contain not less than 50 percent by volume of first-grade synthetic rubber. The remainder of the compound shall consist of pulverized fillers free of rubber substitutes, reclaimed rubber, and deleterious substances. The tolerance for any diameter measured at any cross section shall be ≤1/32-inch (.8mm).

2. Gasket Material Requirements: When required by the District, the Contractor shall furnish test samples of gaskets from each batch used in the work. Gasket material shall meet the following requirements:

Property	Value	ASTM Test Method
Tensile Strength (min. psi)	2,000	D412
Elongation at break (% min.)	350	D412
Shore durometer, Type A (Pipe manufacturer shall select value suitable for type of joint)	40 to 65*	D2240
Compression set (constant deflection) max % of original deflection	16	D395
Compression strength after oven aging (96 hours, 158°F {70°C}) % of tensile strength before aging	80	D573
Increase in Shore durometer hardness after oven aging. Maximum increase over original Shore durometer	10	D2240
Physical requirements after exposure to ozone concentration (150 pphm. 70 hours, 140°F {40°C}), 20% strain)	No Cracks	D1149

*This applies only to the sealing component of the gasket.

PART 3 EXECUTION

3.01 PLACEMENT OF PIPE IN TRENCH

A. General:

1. The Contractor shall follow all manufacturer's installation instructions. If conflicts exist between manufacturer's installation instructions and this specification, the more stringent requirements shall be used.

2. All pipe shall be laid to the line and grade given to form a close concentric joint with the adjoining pipe and prevent sudden offsets of the flow line. Pipe shall be laid from the downstream structure to the upstream structure, without grade breaks, with the bell ends of the pipe upstream.

B. Trench Excavation: Dewatering, excavation, shoring, sheeting, bracing, backfill material placement, material compaction, compaction testing, and pipe laying requirements and limitations shall be in accordance with Section 02223.

C. Subgrade at Joints: At each joint in the pipe, the pipe subgrade shall be recessed in firm bedding material so as to relieve the bell of the pipe of all load and to ensure continuous bearing along the pipe barrel.

D. Cleaning: The interior of the sewer pipe shall be cleaned of all dirt and superfluous materials as the work progresses.

E. Joints: The mating surfaces of the pipe to be joined shall be wiped clean of all dirt and foreign matter and a lubricant applied that is approved by the pipe manufacturer. Then, with the surfaces properly lubricated, the spigot end of the pipe shall be positioned inside the bell and the joint shoved home.

F. For larger diameter pipe where a lever attachment is required, the necessary precautions shall be taken to insure an undamaged pipe installation.

G. Pipe Alignment: Unless specified otherwise, pipeline line and grade shall be as shown on the plans. Grade shall be measured along the pipe invert.

H. PVC Pipe Curvature:

1. Construction of curved reaches of PVC pipe shall not be accomplished by deflecting joints or by beveling pipe ends.

2. Longitudinal bending of pipe barrel:

    a. Limit bend radius to no less than 200-percent of manufacturer's published allowable amount.

        1) Ensure a constant bend radius is achieved throughout the length of each pipe section and ensure there are no points of a shorter bend radius (i.e. tighter curvature).

    b. Do not deflect joints when also longitudinally bending the pipe barrel.

        1) Implement construction measures to prevent any deflection of the joints when longitudinally bending the pipe barrel.

I. Short Lengths of VCP Pipe: When using VCP, two 1-foot lengths of sewer pipe shall be used to provide curve flexibility and prevent cracking or shearing failures as shown on the plans or as may be required by the District during construction. The use of short lengths of pipe is particularly required, but not necessarily limited to these locations: (1) inlets and outlets to all manholes; (2) ends of steel casing pipe; (3) ends of concrete encasement; (4) vertical and horizontal curvilinear sewers; and (5) deep lateral connections.

J. Backfill: Backfill shall be placed and compacted in accordance with the requirements of Section 02223. Backfill within the pipe zone shall be 3/4-inch crushed rock for PVC pipe and VCP. Wrap rock with filter fabric.

3.02 CLEANING

A. Before testing, each pipe shall be thoroughly cleaned from manhole to manhole with a sewer scrubbing ball, and all debris and trash shall be removed from each manhole.

3.03 TESTING

A. The pipe, manholes, and other appurtenances shall be tested for leakage and infiltration per Section 15043.

3.04 CLOSED-CIRCUIT TELEVISION INSPECTION

A. General: In addition to the regular leakage and infiltration test, the entire length of all new sewer lines shall be inspected using closed-circuit television equipment. The inspection shall be conducted after the line has been successfully tested and prior to paving. The inspection shall be conducted in the presence of the District.

B. Responsibility: All labor and equipment necessary to conduct this inspection shall be furnished by the Contractor.

C. Notification: Requests for sewer line inspection shall be made to the District a minimum of five working days in advance of the requested inspection date.

D. Flushing: Each sewer section shall be flushed with water being introduced at the upstream manhole of each section prior to video recording.

E. Stationing: The video shall show stationing corresponding to sewer stationing shown on plans for each manhole and wye location.

F. Sag Gauge: All closed-circuit television equipment shall be installed with a sag gauge visible in the video to determine sag depths.

G. Submittal: The video shall be MPEG format compatible with the District's current viewer software and shall be submitted to the District with reports showing manhole numbers and stationing, wye stationing, and distance between manholes prior to Final Acceptance of the project by the District. The electronic file and reports shall be labeled with the project name, tract number, street names, and the Contractor's name and shall list the station of any defects, dirt, sags, etc. in the pipe. Reports and videos shall include defect coding in accordance with the National Association of Sewer Service Companies (NASSCO) Pipeline Assessment Certification Program (PACP).

H. Repair of Defects: Even though the sewer line may have successfully passed the leakage and infiltration tests, any defects or sags in the line shall be repaired to the satisfaction of the District.

I. Acceptance: Any sewer section having sags or defects shall be repaired by the Contractor prior to Final Acceptance of the project by the District. Sags in the line will not be allowed.

3.05 FINAL INSPECTION

A. After paving has been completed and all manholes raised to grade, a final visual inspection shall be made. The necessary labor shall be furnished to assist the District in making the final inspection. Additional cleaning may be required if the lines are dirty, even though lines were previously cleaned. The Contractor shall furnish a responsible person or supervisor for the final inspection to remove manhole covers and to note any corrections required by the District in order to obtain final acceptance. Final District inspection shall be requested through the District by giving at least five days of notice.

END OF SECTION

SECTION 15072

DISPOSAL OF ASBESTOS CEMENT PIPE

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Connection to and disposal of existing asbestos cement distribution pipe (ACP)

1.02 RELATED REQUIREMENTS

A. Section 15064, PVC Pressure Distribution Pipe

B. Section 15162, Pipe Couplings and Adapters

1.03 REFERENCED STANDARDS

A. California Code of Regulations (CCR), Title 8, Section 1529, Asbestos

B. ASTM D4397: Standard Specification for Polyethylene Sheeting for Construction, Industrial, and Agricultural Applications

1.04 SUBMITTAL

A. Copies of the Contractor's certification from the Contractors State Licensing Board for asbestos removal shall be submitted to the District prior to the commencement of any asbestos removal activities.

B. The Contractor is to provide manifests/disposal records to the District.

1.05 QUALITY ASSURANCE

A. Cutting, removal, handling, and disposal of ACP shall be performed by a Contractor registered by the California Division of Occupational Safety and Health (Cal/OSHA) and certified by the Contractors State Licensing Board for asbestos removal.

B. The Contractor or subcontractor shall comply with all State and Federal laws regarding handling and removal of asbestos materials. The Contractor shall provide sufficient supervision and monitoring to assure said conformance.

C. Workers handling ACP shall be trained in accordance with applicable State regulations.

D. Comply with requirements of CCR Title 8, Section 1529.

1.06 HEALTH HAZARD

A. The Contractor is warned that asbestos is a known human carcinogen and poses serious health risks. Asbestos fibers are easily inhaled and can result in chronic respiratory illness, cancer, and other severe health effects.

PART 2 PRODUCTS

2.01 CONTAINMENT

A. 6 mil (150-micron) polyethylene sheeting or bags and appropriate tape, in accordance with ASTM D4397-16

2.02 TRANSITION COUPLINGS

A. Refer to requirements of Section 15162.

PART 3 EXECUTION

3.01 CUTTING, REMOVAL, AND HANDLING

A. Adequate care shall be taken to maintain the materials in a non-friable state.

B. Pipe cutting will be permitted only when repairing or joining existing ACP, as determined by the District.

C. All cutting of ACP shall be by snap-cut method.

D. ACP shall be wrapped in 6 mil (150-micron) polyethylene sheeting or bags sealed with appropriate tape, and properly labeled and removed away from the construction area to prevent damage.

3.02 DISPOSAL

A. Asbestos materials are considered hazardous materials regulated as a hazardous waste in California.

B. The Contractor shall be responsible for the proper identification, removal and disposal of all asbestos materials.

3.03 CONNECTING TO EXISTING ACP

A. Connect to existing ACP with a transition coupling.

B. Provide minimum 3-foot length PVC pipe spool between the transition coupling and new valve, fitting, or piping.

END OF SECTION

SECTION 15100

MANUAL VALVES

PART 1 - GENERAL

A. Description

This section includes materials, testing, and installation of manually operated valves.

B. Related Work Specified Elsewhere

1. Painting and Coating: 09900.

2. Hydrostatic Testing of Pressure Pipelines: 15042.

3. Domestic and Recycled Water Facilities Identification: 15151.

C. Submittals

1. Submit shop drawings in accordance with Section 01300 and the following.

2. Submit manufacturer's catalog data and detail construction sheets showing all valve parts and describing material of construction by material and specification (such as AISI, ASTM, SAE, or CDA).

3. Show valve dimensions including laying lengths. Show dimensions and orientation of valve operators, as installed on the valves. Show valve linings and coatings.

PART 2 - MATERIALS

A. General

Valves shall be provided complete with operating handwheels, chainwheels, extension stems, floor stands, worm gear operators, operating nuts, chains, and wrenches required for operation.
Valves shall have the name of the manufacturer and the size of the valve cast or molded onto the valve body or bonnet or shown on a permanently attached corrosion-resistant plate.

Bolts for all valves shall be Type 316 stainless steel.

B. Valve Operators

1. Operators for Exposed Valves Smaller than 6-Inches: Lever or wrench operators having adjustable, open stop memory positions shall be provided for exposed valves smaller than 6-inches.

2. Operators for Buried Valves

    a. Direct acting 2-inch square AWWA wrench nuts shall be provided for all buried valves. The wrench nut shall have an arrow cast thereon, indicating the direction on of opening. The wrench nut shall be suitably fastened to the actuator input shaft.

    b. Watertight shaft seals and watertight valve and actuator cover gaskets shall be provided. Totally enclosed operators designed for buried service shall be provided.

    c. Buried valves shall have a water tight seal plate in place of the valve position indicator. No rotating part indicating position shall be allowed for valves intended for buried service.

3. Operators for Valves 6-Inches and Larger

    Gear operators shall be provided on all butterfly valves 6-inches and larger. Butterfly valves less than 24-inch in diameter shall have gear operators of the "traveling nut type". Traveling-nut operators shall be furnished on all valves in this size range unless torque or pressure conditions dictate otherwise. Gear operators for valves larger than 24-inches shall be of the "worm gear type". Worm gear operators shall be furnished on all valves in this size range.

    Plug valves 6-inches and larger shall be provided with gear operators of the worm and gear type.

4. General Requirements for Gear Operators - Actuators

    a. Gear operators shall be enclosed, suitable for running in oil grease with seals provided on shafts to prevent entry of dirt and water into the operator. External trim and all threaded parts of the actuator shall be Type 316 stainless steel material.

    b. Gear operators shall be of the totally enclosed design, proportioned to permit operation of the valve under full operating head with a maximum pull of 80 pounds on the hand wheel or with a maximum input of 150 ft-lbs applied to the AWWA wrench nut. Design and torque capacity shall consider flow and shut-off in "Both" directions.

c. Operators shall be provided with “open” and “closed” position stop limiting devices. Operators shall be of the self-locking type to prevent the disc or plug from creeping.

5. Specific Requirements for Traveling Nut Gear Operators - Actuators

a. Traveling nut actuators shall withstand 450 foot pounds of input torque against the stop limiting devices without causing damage.

b. Signed factory compliance shall accompany submittals.

c. All exposed threaded parts, including cap screws, case bolts, carriage bolts, cover screws, machine screws, set screws, bonnet bolts on the worm gear housing or any other exterior location of the actuator, its cover or housing shall be Type 316 stainless steel.

d. Traveling nut type gear operators shall be able to rotate the valve element (disc) from the fully “closed” position to the fully “open” position with a number of turns of the operator nut or wheel, not fewer than thirty (30) turns and not more than three (3) times the number of diameter inches.

Where the number of turns may fall outside of the range for turn limits above, the use of a factory attached spur gear reducer shall be used to provide the appropriate number of rotations from the fully “open” to the fully “closed” position. Spur gear assemblies shall be mounted integrally to the actuator by approved means and shall meet all of the other component and torque requirements listed herein.

e. Actuators shall be Pratt Series MDT or approved equal.

6. Specific Requirements for Worm Gear Operators - Actuators

a. Worm gears shall be of the “self-locking” one-piece design of gear bronze material (ASTM B-427), accurately machine cut.

b. The worm shall be hardened alloy steel (ASTM A 322, Grade G 41500; or ASTM A 148, Grade 105-85), with thread ground and polished.

c. The reduction gearing shall run in a proper lubricant inside a ductile iron housing.

d. All exposed (at the exterior of the actuator) threaded parts, including cap screws, case bolts, carriage bolts, cover screws, machine screws, set screws, bonnet bolts on the worm gear housing or any other exterior

location of the actuator, its cover or housing shall be Type 316 stainless steel.

e. Operator components shall be designed to withstand a pull of 200 pounds for hand wheel or chain wheel operators between the input and stop limiting devices without damage, and an input torque of 300-foot-pounds for operating nuts when operating against the stops.

f. Gear operators shall be able to rotate the valve element (disc) from the fully "closed" position to the fully "open" position with a number of turns of the operator nut or wheel, not fewer than one-and-a-half (1.5) times the number of diameter inches and not more than three (3) times the number of diameter inches.

Where the number of turns may fall outside of the range for turn limits above, the use of a factory attached spur gear reducer shall be used to provide the appropriate number of rotations from the fully "open" to the fully "closed" position. Spur gear assemblies shall be mounted integrally to the actuator by approved means and shall meet all of the other component and torque requirements listed herein.

g. Actuators shall be Limitorque Model HBC or PT Series, EIM Model WB Series, or Auma GS Series. There is no equals.

7. Operating Torque Requirement for Buried Valves: Operators on buried valves shall be designed to produce the specified torque with a maximum input of 150 ft-lbs applied to the wrench nut (at the maximum rated pressure and a velocity of 15 cfs). Submittals shall include factory torque sheets minimally supplying operator output and valve input torque requirements. Torque safety factors shall comply with the latest versions of AWWA Standards.

8. Hand wheels: Valves for above-ground applications shall be provided with a hand wheel. Minimum hand wheel diameter shall be 12-inches. The hand wheel shall have an arrow thereon, indicating the direction of the opening. The hand wheel shall be suitably fastened to the actuator input shaft.

Actuators equipped with hand wheels shall be designed to produce the specified torque with a maximum pull of 80 pounds of the hand wheel rim. Submittals shall include factory torque sheets minimally supplying operator output and valve input torque requirements. Torque safety factors shall comply with the latest versions of AWWA Standards.

9. Opening Direction: Valve operators, handwheels, or levers shall open by turning counterclockwise. (Commonly stated as, "open-left – close-right")

10. Position Indicators: Valve position indicators shall be provided for all above ground valves.

C. Valve Boxes for Buried Valves

1. General: Valve wells shall be 8-inch SDR 35 PVC pipe.

2. Valve Box Caps: Valve box caps shall be cast-iron, and shall be designed to rest without a frame on a cast-in-place concrete ring surrounding the valve extension pipe. The cap skirt shall be tapered for a close fit inside the upper sleeve portion of the valve box. Caps for sewer valve boxes shall be triangular with the word "S" or "Sewer" cast on the cap. Caps shall be coated and colored in accordance with Section 09900, Painting and Coating, System No. C-1.

3. Manufacturers: Valve boxes for recycled water lines shall be triangular in shape and shall be Eisel Enterprises, Inc. No. 4TT, No Equal.

D. Extension Stems for Buried Valve Operators

Where the depth of the valve is such that its operating nut is more than 4-feet below grade, operating extension stems shall be provided to bring the operating nut to a point between 24 to 36-inches below the surface of the ground and/or box cover. Extension stems shall be solid steel, and shall be complete with 2-inch-square operating nut. Stem shall be provided with a 1/8-inch centerguide to keep stem centered. Pinned couplings are not permitted. Extension stems shall conform to the Drawings.

E. Bolts, Nuts, and Gaskets for Flanged Valves

Bolts and nuts for flanged valves shall be heavy hex head Type 316 stainless steel (B8M) described in the detailed individual piping specifications.

F. Painting and Coating

1. Exterior Coating for All Metallic Valves: All valves (except bronze and stainless-steel valves) whether they are to be installed above ground, in vaults, in structures, or they are to be buried, shall be coated in accordance with Section 09900, System No. C-1 or System No. G-1 to a total minimum dry film thickness of 12 mils.

   The specified prime coat shall be applied at the place of manufacture. Intermediate and finish coats shall be applied in field. Finish coat shall match the color of the adjacent piping. Handwheels shall receive the same coating as the valves. Exposed portions of the valve shaft shall not be coated.

2. Interior Coating: Metal valves 4-inches and larger shall be coated on the interior metal parts, excluding seating areas and bronze and stainless-steel pieces, per Section 09900, Painting and Coating, System No. G-1. Coating shall be factory applied by the valve manufacturer. Valve coatings shall be field spark tested and shall be holiday-free.

G. Valves

1. Resilient Seated Gate Valves, 3-Inches Through 12-Inches: Resilient seated wedge-type, gate valves shall conform to AWWA 509 and the following requirements. Valve shall have a wedge-type resilient seat, fully encapsulated in peroxide-cured EPDM. Valves shall be designed for a minimum working pressure of 250 psi, and shall be bubble-tight at that pressure. Valves shall have non-rising stems fabricated of stainless steel of Type 304 or Type 316 alloy. As an alternative stem material may be high strength bronze alloy. Stem nuts shall be independent of the gate and shall be made of bronze. Materials of construction shall be as follows:

Component	**Material**	**Specification**
Body operating nut, bonnet, seal plate	Cast iron Ductile Iron	ASTM A126, Class B ASTM A-536, Grade 65-45-12
Gate	Cast iron Ductile iron	ASTM A126, Class B ASTM A536, Grade 65-45-12
Stem	Stainless Steel Or high-strength Low zinc Bronze	AISI 430F, ASTM A-582 Type 304 or Type 316 ASTM B-584 CDA 867
Stem Nut	Bronze	ASTM A-584 CDA 844
Bonnet and seal plate or Gland Nuts and Bolts	Stainless-steel	ASTM A276, Type 316
Valve Seat	EPDM Rubber	ASTM D-412
O-rings	Synthetic-rubber	ASTM D2000

Low friction, torque reduction thrust bearings shall be provided both above and below the stem collar. Stuffing boxes shall be O-ring seal type with two rings located in stem above thrust collar.

Each valve shall have a smooth unobstructed waterway free from any sediment pockets.

Valves shall be Clow Resilient Wedge Gate Valve, Mueller A2360, M&H Style 4067, or approved equal.

2. Butterfly Valves: Butterfly valves shall be short body, flanged type, conforming to AWWA C504, Class 150B or Class 250. Wafer style valves are not permitted. The working differential pressure across the valve disc shall be 250 psi. Valve ends shall match the class rating of the valve (i.e. class 250 valves shall have 250 lb. flanges). Flanged ends shall have 250 lb. flanges, Class 250 ANSI B16.1. Valve shafts shall be 17-4 PH stainless steel for class 250 valves. Valve shafts shall be stub shaft or one-piece units extending completely through the valve disc. Valve bodies shall be tested at a pressure equal to twice the design working pressure. Gears shall be sized for bi-directional flow at 15 fps and at full rated pressure differential. Materials of construction shall be as follows:

Component	**Material**	**Specification**
Body	Cast Iron or Ductile iron	ASTM A126, Class B; or ASTM A536, Grade 65-45-12
Valve Shaft	Stainless Steel	Type 17-4 PH
Exposed body capscrews, bolts & nuts (including squeeze-pins)	Stainless-steel	ASTM A276, Type 316
Discs	Cast iron, Ductile iron	ASTM A48, Class 40; ASTM A536, Grade 65-45-12
Valve Seat	EPDM Rubber	ASTM D-412
O-Rings	Synthetic Rubber	ASTM D-2000

All butterfly valves 12-inches in diameter and larger are required to have flanged ends to meet the requirements for valve leakage testing and shall be tested per Part 3.D of this Technical Specification.

The rubber seat shall be made form peroxide-cured EPDM rubber and shall be fastened integrally with the valve body. Rubber seats fastened to the disc by any means shall not be allowed.

Factory signed and dated certification of compliance shall accompany all submittals. Signatures of agents or distributors of the factory will not be accepted.

Valves shall be Pratt Groundhog, Dezurik Figure 670, Kennedy AWWA Butterfly, Mueller Lineseal, or approved equal.

3. Ball Valves 2-Inches and Smaller: Ball valves, 2-inches and smaller, for water service shall be three-piece body style and shall be manufactured of Type 316 stainless steel. The minimum design operating pressure rating shall be 300 psi WOG at a temperature of 150°F. Valves shall have plastic coated lever operators with a locking mechanism. Valves shall have full bore ports, female iron pipe thread screwed ends, and non-blowout stems. Materials of construction shall be as follows:

Component	**Material**	**Specification**
Body, ball, stem	Stainless-steel	Type 316, ASTM A276
Seat, seals	Teflon	

Valves shall be Apollo, Sharpe, Xomox, or Stockham Figure S-127 or approved equal.

4. Sewage plug valves shall be of the non-lubricating, eccentric type and shall be designed for a working pressure of 175 psi. Ends shall be flanged, Class 125 per ANSI B-16.1. Plugs shall be provided with Polytetrafluoroethylene (PTFE) grit excluders to protect the upper and lower journal bearings from entry of grit and foreign solids into bearing areas.

Body and plug shall be ductile iron, ASTM A536, Grade 65-45-12. The journal bearings shall be sintered stainless steel, ANSI 316. All bearings including stem bearing, bottom bearing and shaft bearings shall be sleeve type metal bearings and shall be sintered, oil impregnated permanently lubricated Type 316 stainless steel. The plugs shall have neoprene, Buna-N facing to provide drip-tight shutoff. All internal metal parts, except the body and plug, shall be Type 316 stainless steel.

Valve body seats shall have a raised welded-in overlay of not less than 90 percent nickel. Plug shall be of the one-piece design. Proof of design shall accompany submittals and leak tests shall accompany shipment.

External valve trim and all exposed threaded components shall be stainless steel, Type 316. Exposed nuts, bolts and washers shall be Type 316 stainless steel.

Ferrous surfaces of valves shall be epoxy-coated.

Plug valves 4-inches and larger shall have actuators of the "worm gear type". All gearing shall be enclosed and seals on all shafts to prevent entry of dirt and water. Hand-operated valves shall have handwheels, and where located more than 6 feet above ground level, a chain drive. The operator shall visibly and clearly indicate valve position to someone standing at ground level.

Valves shall be Dezurik Series 100 PEC, Pratt-Milliken 600 Series or approved equal.

For valves installed in a vertical position, install the valve with the seat at the top to prevent drain-back solids from settling into the valve body. For valves installed in a horizontal position, install the valve so the plug rotates up when opened.

5. Rubber Flapper Swing Check Valve: The rubber flapper check valve shall be full opening with a seating surface on a 45º angle to minimize disc travel. Per AWWA C508, when open the valve shall have full sized waterway through the valve. The body and cover shall be ductile iron, ASTM A536, Grade 65-45-12. The cover bolts and nuts shall be 316 stainless steel. The rubber flapper shall be Bruna-N and internally reinforced and shall be easily removed without removal of the valve. The closing speed of the rubber flapper shall be adjustable in the field for rapid closure. The flanges shall be rated for a 125 lb. class flanges per ANSI B16.1. The valve shall be designed to a minimum working pressure of 150 psig and shall be fusion epoxy lined. Limit switches shall be provided to indicate an open or closed position. A backflow device attached to the body plug shall be provided. The valve shall be suitable for sewage service application.

   Rubber Flapper Swing Check Valves shall be Valmatic Surgebuster, APCO Model 100 or approved equal.

PART 3 - EXECUTION

A. Joints

1. Flanged Joints: Boltholes of flanged valves shall straddle the horizontal and vertical centerlines of the pipe run to which the valves are attached. Flanges shall be cleaned by wire brushing before installing flanged valves. Flange bolts and nuts shall be cleaned by wire brushing, threads shall be lubricated with oil and graphite, and nuts shall be tightened uniformly and progressively. If flanges leak under pressure testing, nuts and bolts shall be loosened or removed, the gasket shall be reseated or replaced, the bolts and nuts shall be reinstalled or re-tightened, and the joint retested. Joints shall be watertight.

2. Threaded Joints: Threaded joints shall be cleaned by wire brushing or swabbing. Teflon joint compound or Teflon tape shall be applied to pipe threads before installing threaded valves. Joints shall be watertight.

B. Valve Installation

1. Buried Valves: Buried valves shall be wrapped with two layers of 8-mil polyethylene wrap per AWWA C105.

2. Valve Supports: Valves shall be anchored in concrete as shown on the valve detail drawings.

3. Backfill: Backfill within 24-inches of valves shall be clean washed sand in accordance with the requirements of Section 02223, Trenching, Backfilling, and Compacting.

4. Valves in horizontal runs of pipe shall be installed with their operating stems horizontal.

C. Valve Boxes

Valve boxes shall be firmly supported and shall be kept centered and plumb over the operating nut of the valve. Beveled sections of pipe will not be allowed at the top of the valve extension pipe. The top cut shall be square and machine made.

D. Valve Leakage Testing

1. Valves shall be tested for leakage at the same time that the connecting pipelines are tested. See Section 15042, Hydrostatic Testing of Pressure Pipelines, for pressure testing requirements.

2. Valve Leakage Witness – Pressure Testing:

   All butterfly valves 12-inches in diameter and larger, shall be flanged to facilitate testing. Valves may be tested in a horizontal position. All valves shall be tested bi-directionally after the actuator / operator is installed and the adjustment stops are set. Each side of the valve is to be tested for a duration of at least five (5) minutes at the pressure class rating of the valve with zero loss or leakage.

   The pressure test shall be witnessed by the District's field representative. Final tests shall be performed within 75 miles of the project site. A minimum of 72 hours advance notice to the District for testing scheduling is required.

END OF SECTION

SECTION 15112

BACKFLOW PREVENTERS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Backflow prevention assemblies

1.02 RELATED REQUIREMENTS

A. Section 15056, Ductile-Iron Pipe and Fittings

B. Section 15057, Copper, Brass and Bronze Pipe Fittings and Appurtenances

C. Section 15100, Manual Valves

1.03 REFERENCED STANDARDS

A. Foundation for Cross-Connection Control and Hydraulic Research, University of Southern California, School of Engineering

1. "Manual of Cross-Connection Control"

B. American Water Works Association (AWWA)

1. AWWA C510: Double Check Valve Backflow Prevention Assembly
2. AWWA C511: Reduced-Pressure Principle Backflow Prevention Assembly

1.04 SUBMITTALS

A. Product Data Sheet and Drawings

B. Certification of approved device per the California State Water Resources Control Board

C. Field testing certificate

PART 2 MATERIALS

2.01 BACKFLOW PREVENTION ASSEMBLY

A. All backflow prevention assemblies shall conform to the latest edition of AWWA C510 or C511.

B. Backflow prevention assemblies shall be on the latest approved list of backflow prevention devices from the U.S.C./F.C.C.C. & H.R. Institute and comply with the California State Water Resources Control Board.

2.02 SHUT-OFF VALVES

A. The shut-off valves for assemblies 3-inch and larger shall be resilient seat gate valves. Ball valves shall be used on assemblies smaller than 3-inch. Shut-off valves shall conform to Section 15100.

B. Shut-off valves shall have outside stems and yokes.

2.03 BYPASS PIPING

A. Bypass piping shall be copper or brass conforming to Section 15057.

2.04 FIRE SERVICE BYPASS METER

A. The bypass meter shall conform to the District's requirements and shall be compatible with the backflow device on which it is installed. The backflow prevention assembly and the bypass meter shall be furnished as one complete unit. All bypass meters shall be 3/4-inch, with registers reading in cubic feet.

PART 3 EXECUTION

3.01 INSTALLATION

A. Installation shall comply with the requirements of the latest edition of the Manual of Cross-Connection Control.

3.02 TESTING

A. Upon completion of the installation of the device, a test shall be performed and a certificate of the adequacy and operational compliance shall be furnished to the District. The tests shall be performed by a testing agency approved by the Orange County Health Department.

END OF SECTION

SECTION 15125

PRESSURE GAUGES

PART 1 - GENERAL

A. Description

Work Included:

1. This section specifies pressure measurement and their appurtenances. Where catalog numbers or types are shown, they are not intended to limit requirements.

2. Provide all materials, work, installation, piping, sample tubing, mounting brackets, and all items needed to provide complete installation.

B. Related Work

Section 15065 Stainless Steel Pipe

C. Submittals

1. Shop Drawings: Shop drawings shall include each type of instrument; accuracy, description of operation, operating instructions, and calibration procedures.

2. Parts List: Submit a parts list with current net prices, a list of recommended spares, and local manufacturers or supplier's office.

D. Quality Control

1. Maintainability: All equipment shall be designed for ease of maintenance and repair, and access to critical parts shall not require disassembly. Internal field adjustments shall be easily accessible upon removal of a panel or cover.

2. Materials and Installation: Materials and installation shall be as specified. Improve as needed to comply with the requirements of the current editions of referenced electrical codes and standards and the codes and standards referred to shall be used for establishing the minimum quality of the materials and equipment supplied and installed. All equipment of the same type shall be products of the same manufacturer. Capacities of all equipment shall not be less than that indicated on the drawings or specified.

PART 2 - PRODUCTS

A. Manufacturer

Measurement devices furnished shall be manufactured by firms regularly and currently engaged in the design and manufacture of this equipment. All equipment furnished shall be new and of current design, and shall be manufacturer's latest model.

B. Pressure Gauges

Pressure gauges shall be glycerin filled 3.5 inches in diameter in a stainless steel weatherproof case. The dial shall be plastic coated with black figures on a white face. The scale shall have a 270-degree-minimum arc. The movement shall be stainless steel and nylon or all stainless steel, whichever is the manufacturer's standard. An over-range pressure of up to 130% of maximum scale reading shall not affect calibration of the gauge. Accuracy shall be within 1.5% of scale range. All pressure gauges shall be provided with stainless-steel gauge cocks and pulsation dampeners rated for a least 100 psi (discharge). Range shall be 0 to 160 psi with negative pressure. The pressure gauges shall be Ashcroft Duralife Type 1009, Noshok or approved equal.

C. Annular Ring, Pressure Sleeve

1. The unit shall sense pressure in a process line and transfer to a pressure monitoring device(s), such as a pressure gauge and pressure transmitter.

2. It shall be annular fluid-filled device that measures pressure around the full inside circumference of the pipeline and shall be slip-in type with bolted flanges. Sensing Fluid shall be silicon fluid locked in and sealed sensing fluid which is factory filled and assembled to the pressure device(s).

3. The unit shall be suitable for line pressures up to pipe flange rating.

4. The unit shall be provided with the following:

    a. Body: 316 stainless steel.

    b. Flanges: 316 stainless steel.

    c. Flexible Liner: Buna-N, unless otherwise noted.

    d. Sensing Fluid: silicon fluid, unless otherwise noted.

5. The unit shall be factory filled locked-in and sealed sensing fluid which is factory filled and assembled to the pressure device(s).

6. Process Connections shall be ANSI 125-pound flanges, with pipe size as noted.

7. Unit shall be manufactured by Onyx Valve Co. Series PSR, Red Valve Company, Ashcraft Iso-Ring or approved equal. The web site for Onyx Valve Co. is www.onyxvalve.com.

PART 3 - EXECUTION

A. Installation

1. Installation, testing, calibration, validation, start-up, and instruction shall be provided by the Contractor.

2. Calibrate all instruments to match process conditions. Obtain process data from Owner's Representative.

B. Spare Parts

The Contractor shall furnish to the District one additional pressure gauge prior to final acceptance of the work.

END OF SECTION

SECTION 15142

WALL PIPES, SEEP RINGS, AND PENETRATIONS

PART 1 - GENERAL

A. Description

This section includes materials, installation, and testing of steel and cast-iron wall pipes and sleeves (including wall collars and seepage rings), and penetrations.

B. Related Work Specified Elsewhere

1. Cast-in-Place Concrete: 03300.

2. Painting and Coating: 09900.

C. Submittals

1. Submit shop drawings.

2. Submit detail drawings for fabricated steel or cast-iron wall and floor pipes and sleeves, wall flanges, seep rings, and sealing materials. Show dimensions and wall thickness.

3. Show flange sizes and the appropriate ANSI or AWWA flange dimensional standard where flanges end wall pipes or penetrations are used.

4. Show grooved-end dimensions and AWWA grooved-end dimensional standard where grooved-end wall pipes or penetrations are used.

5. List coating systems to be applied, manufacturer, and dry thickness of coatings. Call out coatings where coatings are to be applied.

6. List materials of construction, with ASTM material reference and grade.

7. Submit manufacturer's instructions for installing rubber annular hydrostatic sealing devices.

8. Submit six copies of the results of the leakage test for cast-iron sleeves having shrink-fit steel collars or collar halves bottomed in a groove and steel sleeves having welded steel collars.

PART 2 - MATERIALS

A. General

Use fabricated steel wall sleeves when containing rubber annular hydrostatic sealing devices through which piping passes.

B. Fabricated Steel Wall Flanges, Anchors, and Sleeves

1. Provide fabricated steel wall pipes with ends as shown on the drawings for connection to adjacent steel pipes, or for containing pipes, where they pass through concrete walls. Provide seepage ring or wall flange on wall pipes and sleeves passing through concrete walls and slabs which are to be watertight. Wall thickness shall be the same as the pipe wall thickness when connecting to steel pipe. Wall thickness for sleeves containing pipes shall be standard weight per ANSI B36.10.

2. Wall flanges shall be in the form of a steel wall collar welded to the steel sleeve or penetration. Cut welded wall collars from a steel ring of the size indicated on the drawings. Attach the collar to a steel wall pipe or sleeve with full circle fillet welds. Welding procedures shall be in accordance with ANSI B31.3, Chapter V.

3. Steel pipe used in fabricating wall sleeves containing pipes shall comply with ASTM A 53 (Type E or S), Grade B; ASTM A 135, Grade B; ASTM A 139, Grade B; or API 5L or 5LX. Wall sleeves connecting to steel pipe shall be of the same material as the connecting pipe. Wall collar material shall comply with ASTM A 105, A 181, or A 182.

4. Pressure test at least one of each size of fabricated steel wall sleeve or penetration and collar assemblies at the place of fabrication to demonstrate watertightness of the seal between the collar and the sleeve. The test shall be at a pressure of 20 psig for four hours' duration and shall show zero water leakage.

C. Rubber Annular Hydrostatic Sealing Devices

1. Rubber annular hydrostatic sealing devices shall be of the modular mechanical type, utilizing interlocking synthetic rubber links shaped to continuously fill the annular space between the pipe sleeve and the passing pipe. Assemble links to form a continuous rubber belt around the pipe, with a pressure plate under each bolthead and nut.

2. Materials of construction shall be as follows:

	Compound	Material
a.	Pressure plate	Carbon steel
b.	Bolts and nuts for links	Type 303 or 316 stainless steel
c.	Sealing element	EPDM rubber

3. The size of the wall sleeve needed to accommodate the passing pipe shall be as recommended by the rubber annular seal manufacturer.

D. Polyethylene Foam Filler for Pipe Penetrations

Packing foam shall be an extruded closed-cell polyethylene foam rod, such as Minicel baker rod, manufactured by Industrial Systems Department, Plastic Products Group of Hercules, Inc., Middletown, Delaware; Ethaform, as manufactured by Dow Chemical Company, Midland, Michigan; or equal. The rod shall be 1/2 inch larger in diameter than the annular space.

E. Painting and Coating

1. Coat penetrations and sleeves exposed, above ground, or in vaults and structures in accordance with Section 09900.

2. Coat buried sleeves and penetrations per Section 09900.

PART 3 - EXECUTION

A. Location of Pipes and Sleeves

1. Provide a wall or floor pipe where shown on the drawings.

2. Provide a floor sleeve where shown on the drawings and wherever plastic pipe, carbon steel or stainless steel pipe 3 inches and smaller or copper tubing passes through a floor or slab. Provide a rubber annular sealing device in the annular space between the sleeve and the passing pipe or tubing.

3. Provide wall sleeves where shown on the drawings and wherever plastic pipe, steel or stainless-steel pipe 3 inches and smaller, or stainless-steel or copper tubing passes through a wall. Provide a single rubber annular seal when the wall is 8 inches thick or less. Provide two rubber annular seals (one at each end of the sleeve) when the wall is more than 8 inches thick. Pack the annular space with polyethylene foam filler and fill the ends of the penetration with 2 inches of elastomeric sealant on both sides of the structure.

4. Where sleeves are installed in which water or soil is on one or both sides of the channel or wall, provide two rubber annular seals (one at each end of the sleeve).

5. Where pipes pass through walls or slabs and no sleeves or wall or floor pipe with seep ring is provided, pack the annular space with polyethylene foam filler and fill the ends of the penetration with 2 inches of elastomeric sealant on both sides of the structure.

B. Installation in Existing Concrete Walls and Slabs

Core drill holes 2 inches larger in diameter than the diameter of the wall flange or collar. Install wall pipe and collar assembly axially aligned with the piping to which it will be connected or will contain. Pack the void space between the sleeve and concrete with grout. See Section 03300 for grouting specification.

C. Installation in New Concrete Walls and Slabs

Install wall pipes in walls before placing concrete. Do not allow any portion of the sleeve to touch any of the reinforcing steel. Install wall sleeve and collar assembly axially aligned with the piping to which it will be attached or will contain.

D. Installation of Wall Pipes Having Flanged End Connections

1. Check alignment before grouting in place or pouring concrete. Realign if the sleeve is not properly aligned.

2. Install flanged end wall sleeves or penetrations with bolt holes of the end flanges straddling the horizontal and vertical centerlines of the sleeve.

3. Lubricate flange bolts with oil and graphite prior to installation.

E. Qualifications of Welders

Welder qualifications shall be in accordance with AWS B3.0.

F. Installation of Rubber Annular Hydrostatic Sealing Devices

Install in accordance with the manufacturer's instructions.

G. Field Testing

Check each wall penetration for leakage at the time the hydraulic structure is tested for leakage; see Section 03300. Penetrations shall show zero leakage.

END OF SECTION

SECTION 15144

PIPE HANGERS AND SUPPORTS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. This section includes materials and installation of pipe hangers and supports including accessory items, such as anchor bolts and screws and neoprene isolation pads.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Painting and Coating: 09900.

B. Pipe Couplings and Adapters: 15162.

C. Wall and Slab Penetrations: 15170.

1.03 SUBMITTALS

A. Submit shop drawings.

B. Provide line drawings of each typical piping system to the scale shown on the drawings, locating each support or hanger. Identify each type of hanger or support by the manufacturer's catalog number or figure.

C. Provide installation drawings and manufacturer's catalog information on each type of hanger and support used.

PART 2 MATERIALS

2.01 DESIGN CRITERIA

A. No attempt has been made to show or detail in the drawings every pipe support or hanger required. Provide pipe supports for every piping system installed.

B. Pipe support and hanger components shall withstand the dead loads imposed by the weight of the pipes filled with water and shall have a minimum safety factor of five based on material ultimate strength. Contractor shall include seismic restraint systems for the piping. Seismic restraints shall be designed by a California Registered Structural Engineer.

2.02 HANGER AND SUPPORT SYSTEMS

A. Pipe hangers and supports shall comply with MSS SP-58 for the standard types referenced on the drawings. Construct special hangers and supports as detailed on the drawings. Type numbers for standard hangers and supports shall be in accordance with MSS SP-58 as listed below:

Type Number	Description	Manufacturer and Model (or Equal)
1	Adjustable steel clevis	Grinnell Fig. 590 or 260, Kin-Line 455, or 12C
3	Steel double-bolt pipe clamp	Kin-Line 473, Grinnell Fig. 295A or 295H
5	Pipe hanger	Kin-Line 450
7	Adjustable steel band hanger	Grinnell Fig. 269, Atlanta Engineering Fig. 22
8	Extension pipe or riser clamp	Grinnell Fig. 261, Atlanta Engineering Fig. 39
9	Adjustable band hanger	Grinnell Fig. 97
10	Adjustable swivel ring band hanger	Grinnell Fig. 70
13	Steel turnbuckle	Grinnel Fig. 230
14	Steel clevis	Grinnell Fig. 299
15	Swivel turnbuckle	Grinnell Fig. 114
18	Steel or malleable iron concrete insert	Grinnel Fig. 281, Superstrut 452
24	U-bolt	Grinnell Fig. 137, Kin-Line 437
26	Clip	Grinnell Fig. 262, Kin-Line 477
31	Light welded steel	Grinnell Fig. 194
32	Medium welded steel bracket	Grinnell Fig. 195
33	Heavy welded steel bracket	Grinnell Fig. 199

Type Number	Description	Manufacturer and Model (or Equal)
36	Pipe saddle support	Grinnell Fig. 258
37	Pipe stanchion saddle	Grinnell Fig. 259, Kin-Line 467
38	Adjustable pipe saddle support	Grinnel Fig. 264, Atlanta Engineering Fig. 308

B. Pipe hangers and supports shall be hot-dipped galvanized per ASTM A 153 carbon steel (ASTM A 36, A 575, or A 576). Bases, rollers, and anchors shall be steel as described above or may be cast iron (ASTM A 48). Pipe clamps shall be steel as described above or may be malleable iron (ASTM A 47).

C. Pipe hangers and supports shall be as manufactured by Grinnell, Kin-Line, Unistrut, Superstrut, or equal.

2.03 OFFSET PIPE CLAMP

A. Grinnell Figure 103, or equal. Material shall be Type 316 stainless steel.

2.04 STEEL CHANNEL FRAMING SYSTEM

A. Steel channel frames shall be 1-5/8 inches wide by 1-5/8 or 3-1/4 inches high by 12-gauge metal thickness (for steel construction), unless otherwise shown on the drawings. Material shall conform to ASTM A 36, A 446, A 527, or A 570 (Grade 33 minimum) unless stainless steel is indicated on the drawings. Stainless steel shall be type 304. One side of the channel shall have a continuous open slot with inturned clamping ridges. Maximum allowable stress under any combination of applied uniformly distributed loads and concentrated loads shall not exceed those recommended in the AISC or AISI. Deflection shall not exceed 1/240 of span. Use multiple back-to-back channels to achieve these criteria if single channels are not sufficient. Products: Unistrut P1000 or P5000 Series, Kin-Line 4112 Series, or equal.

B. Steel channels shall be hot-dipped galvanized per ASTM A 153.

C. Nuts shall be machined and case hardened. Provide rectangular nuts with the ends shaped to permit a quarter turn crosswise in the framing channel. Provide two serrated grooves in the nut to engage the inturned edges of the channel.

D. Pipe clamps (including attachment screws and nuts) shall be Unistrut P1100 or P2000 Series, Kin-Line 412 Series, or equal. Material shall be Type 304 stainless steel.

E. Accessory fittings and brackets shall be the same material as the channel. Provide coating on carbon steel fittings and brackets as specified for the channels and frames.

1. Flat Plate Fittings: Unistrut P1065, P1066, P1925; Superstrut AB-206, AB-207; or equal.

2. Post Bases: Unistrut P2072A; Superstrut AP-232, or equal.

3. 90-Degree Brackets: Unistrut P1326, P1346; Superstrut AB-203; or equal.

4. Rounded-End Flat Plate Fittings: Unistrut P2325; Superstrut X-240, or equal.

F. Parallel pipe clamps shall be Unistrut P1563 through P1573, Superstrut AG-719, or equal. Material shall be carbon steel, coated as specified for channels and frames.

2.05 ANCHOR BOLTS AND SCREWS

A. Anchor bolts and screws for attaching pipe supports and hangers to walls, floors, ceilings, and roof beams shall be Type 316 stainless steel, ASTM A 276. Nuts shall be type 316 stainless steel, ASTM A 194, Grade 8M, or ASTM F 594, Type 316 stainless steel.

2.06 NEOPRENE ISOLATING SLEEVES FOR METAL PIPE 2 INCHES AND SMALLER

A. Unistrut P2600, Kin-Line 418 and 419, or equal.

PART 3 EXECUTION

3.01 PIPE HANGER AND WALL SUPPORT SPACING

A. Install pipe hangers and wall supports on horizontal and vertical runs at the spacing shown or detailed on the drawings. Provide hanger rods (for horizontal runs) and wall supports of the sizes shown or detailed on the drawings. If no spacing or rod sizes are given in the drawings or in the specifications for a particular piping system, use the following:

1. Pipe Hanger and Wall Support Spacing for Steel Pipe:

Maximum Support Pipe Size (inches)	Maximum Rod or Hanger Spacing (feet)	Size (inches)
3/8 and smaller	4	3/8
1/2 through 1	6	3/8
1-1/4 through 2	8	3/8
2-1/2 and 3	10	1/2
3-1/2 and 4	10	5/8
6	12	3/4
8	12	7/8
10 and 12	14	7/8
14 and 16	16	1
18	15	1
20 through 24	9	1
30	6	1

2. Pipe Hanger or Wall Support Spacing for PVC Pipe:

Maximum Support Pipe Size (inches)	Maximum Rod or Hanger Spacing (feet)	Size (inches)
3/4	4	3/8
1	4	3/8
1-1/2	5	3/8
2	5	3/8
2-1/2	5	1/2
3 through 6	6	1/2

3. Provide sway bracing for hangers where detailed on the drawings. If no bracing is detailed, provide bracing at 10-foot-maximum center-to-center intervals.

3.02 PIPE SUPPORT SPACING FOR SUPPORTS ON TOP OF SLABS OR GRADE

A. Install pipe supports on horizontal runs at the spacing shown or detailed on the drawings. Provide supports of the type shown or detailed on the drawings. If no spacings are given on the drawings or in the specifications for a particular piping system, use the following:

1. Pipe Support Spacing for Steel Pipe:

Pipe Size (inches)	Maximum Support Spacing (feet)
3/8 and smaller	4
1/2 through 1	6
1-1/4 through 2	8
2-1/2 and 3	10
3-1/2 and 4	10
6	12
8	12
10 and 12	14
14 and 16	16
18	16
20 through 24	18
30	18

B. Pipe support spacing for other pipe materials shall be the same as described above in Section A.

3.03 INSTALLING PIPE HANGERS AND SUPPORTS

A. Provide separate hangers and supports at valves. Provide one hanger or support around each end of the valve body or on the adjacent connecting pipe within one pipe diameter of the valve end.

B. Provide separate hangers and supports at each pipe elbow, tee, or fitting. Provide separate hangers and supports on both sides of each nonrigid joint or flexible pipe coupling.

C. Install piping without springing, forcing, or stressing the pipe or any connecting valves, pumps, and other equipment to which the pipe is connected.

D. Use 1-5/8-inch-high channel frames unless 3-1/4-inch is needed to provide clearance from walls. Use multiple back-to-back channels if additional clearance is needed.

3.04 INSTALLING NEOPRENE ISOLATING SLEEVES

A. Install a sleeve around each metal pipe 2 inches and smaller at the point of bearing or contact with the pipe hanger or support.

3.05 PAINTING AND COATING

A. Paint exposed nongalvanized pipe hangers and supports to match the color of the adjacent wall per Section 09900. Coat galvanized pipe supports per Section 09900. Color of finish coat shall match adjacent piping. If the adjacent wall is not painted, paint the hangers and supports to match color code of the largest pipe on the support.

END OF SECTION

SECTION 15150

METERS

PART 1 – GENERAL

A. Description

This section describes the purchase, materials, installation and testing of meter assemblies.

B. Related Work Specified Elsewhere

1. Cast-in-Place Concrete: 03300

2. Painting and Coating: 09900

3. Ductile-Iron Pipe and Fittings: 15056

4. Manual Valves: 15100

C. Submittals

1. Submit shop drawings in accordance with Section 01300 and the following.

2. Submit manufacturer's catalog data and detail construction sheets showing all meter parts and describing material of construction by material and specification (such as AISI, ASTM, SAE, or CDA).

3. Show meter dimensions including laying lengths. Show meter linings and coatings.

PART 2 – MATERIALS

A. General

1. All meters shall be new and of current manufacture design.

2. All parts of the meters of the same size and model shall be interchangeable.

B. Stainless Steel Hardware

All bolts, nuts, capscrews, studs, and washers shall be Type 316 stainless steel ASTM A 193 B8M for bolts, and ASTM A 194 8M for nuts.

C. Electromagnetic Flow Meter

The electromagnetic flowmeter shall be a microprocessor-based and flanged. It shall indicate, and totalize flow in full pipes. The flowmeter shall utilize the DC bi-polar pulsed coil excitation, automatically re-zeroing after every cycle. The accuracy shall be plus or minus 1% of rate over a 33:1 turndown at all flow rates above 1 fps. Accuracy shall be verified by calibration in a flow laboratory traceable to the NIST. The flow sensor liner shall be polyurethane and be suitable for 150 psi service. The flow sensor electrodes shall be 316SS. The flow meter shall be supplied with grounding rings (316 stainless steel).

The electronics shall be remote mounted. The flow sensor and transmitter enclosures shall have NEMA-4X ratings. The meter remote electronics shall include an isolated 4-20mA / HART output as flow signal. The meter shall incorporate HI-Z circuitry. External ultrasonic electrode cleaning shall not be acceptable. The flow meter system shall include a remote microprocessor signal converter. The enclosure shall be NEMA 4X. The signal converter shall have an external totalizer reset contact which is software configurable, and dual range (system can be set for automatic or manual switching). A 16-character alphanumeric liquid crystal display shall indicate user defined flow units and total flow. All menu advice and commands shall be viewed on this display. The meter software shall incorporate a password feature preventing inadvertent program changes. All printed circuit boards shall be contained in a plug-in module and be interchangeable for any size without requiring test equipment.

The flowmeter shall be ABB Watermaster, Toshiba, Krohne or approved equal. The flowmeter shall be warranted against defective workmanship or materials for a period of one year from shipment date.

D. Ductile-Iron Pipe and Fittings

All piping for meter assemblies 3-inch and larger shall conform with Section 15056.

E. Manual Valves

All valves shall conform with Section 15100.

PART 3 – EXECUTION

A. Meter Installations

Meter shall be installed per construction plans and these specifications.

B. Valves

All valves installed shall conform with the Section 15100.

C. Painting and Coating

1. All exposed and buried piping shall be painted or coated in accordance with Section 09900.

2. The meter reading lids on all recycled water services shall be painted in accordance with Section 09900.

END OF SECTION

SECTION 15151

FACILITIES IDENTIFICATION

PART 1 – GENERAL

A. Description

This section describes materials and installation of domestic, sewer and recycled water facilities identification for pipe, valves, valve boxes, and other pipeline appurtenances. This section describes special identification, markings, materials and their installation procedures for sewer and recycled water facilities. All domestic water systems and appurtenances shall be identified as herein described.

B. Related Work Specified Elsewhere

1. Painting and Coating: 09900

2. Ductile Iron Pipe & Fittings: 15056

3. PVC Pressure Distribution Pipe: 15064

4. Manual Valves: 15100

C. Approved Manufacturers

1. Warning Tape and Pipe Sleeves

   a. Griffolyn Company, Inc.
   10020 Mykawa Road
   P.O. Box 33248
   Houston, TX 77033
   Phone: (713) 943-0070 or (800) 231-6074

   b. Terra Tape, Division of Reef Industries
   P. O. Box 33310
   Houston, TX 77233
   Phone: (800) 231-2417

   c. T. Christy Enterprises, Inc.
   655 E. Ball Road
   Anaheim, CA 92805
   Phone: (714) 507-3300

2. Warning Labels

In all cases the warning labels must be approved prior to installation. Failure to receive prior approval may result in the Contractor removing and providing approved replacement(s). All costs shall be borne by the Contractor for the replacements.

D. Recycled Water Identification

For buried PVC pipe carrying recycled water:

1. Purple colored pipe marked with the wording "CAUTION: RECYCLED WATER, DO NOT DRINK" on opposite sides of the pipe. Lettering shall be a minimum of ½-inch high black letters, and shall be repeated every 12-inches.

2. Purple identification tape with the wording "CAUTION: RECYCLED WATER, DO NOT DRINK" may be attached directly to the top of the pipe with plastic adhesive tape.

3. Encase PVC pipe with purple colored polyethylene encasement with the wording "CAUTION: RECYCLED WATER, DO NOT DRINK".

For buried Ductile Iron Pipe:

1. Attach purple colored identification tape with the wording "CAUTION: RECYCLED WATER, DO NOT DRINK" directly to the top of the ductile iron pipe and polyethylene encasement with plastic adhesive tape.

2. Encase ductile iron pipe with purple colored polyethylene encasement with the wording "CAUTION: RECYCLED WATER, DO NOT DRINK". Polyethylene encasement shall conform to the requirements of Section 15056.3.C "Wrapping pipe with Polyethylene Encasement".

E. Recycled Water Warning Tape

For PVC or ductile iron pipe, all pipelines shall have purple colored warning tape placed in the trench 12-inches above the pipe with the wording, "CAUTION: RECYCLED WATER LINE BURIED BELOW".

The warning tape shall extend up into the meter box, air-vacuum release assembly or other appurtenances a minimum of 12-inches, so that it can be read clearly by opening the box or enclosure.

F. Sewer Identification

For buried PVC pipe carrying wastewater:

4. Green colored pipe marked with the wording "CAUTION: SEWER LINE" on opposite sides of the pipe. Lettering shall be a minimum of ½-inch high black letters, and shall be repeated every 12-inches.

5. Green identification tape with the wording "CAUTION: SEWER LINE" may be attached directly to the top of the pipe with plastic adhesive tape.

6. Encase PVC pipe with green colored polyethylene encasement with the wording "CAUTION: SEWER LINE".

For buried Ductile Iron Pipe:

3. Attach green colored identification tape with the wording "CAUTION: SEWER LINE" directly to the top of the ductile iron pipe and polyethylene encasement with plastic adhesive tape.

4. Encase ductile iron pipe with green colored polyethylene encasement with the wording "CAUTION: SEWER LINE". Polyethylene encasement shall conform to the requirements of Section 15056.3.C "Wrapping pipe with Polyethylene Encasement".

G. Sewer Warning Tape

For PVC or ductile iron pipe, all pipelines shall have green colored warning tape placed in the trench 12-inches above the pipe with the wording, "CAUTION: SEWER LINE BURIED BELOW".

The warning tape shall extend up into the valve box or other appurtenances a minimum of 12-inches, so that it can be read clearly by opening the box or enclosure.

H. Valve Boxes

Valve boxes shall be as specified in Section 15100.

I. Color and Painting Schedule

Recycled water facilities shall be painted purple (Pantone 512) per Section 09900. Sewer facilities shall be painted green (Pantone 451) per section 09900.

J. Warning Signs and Labels

1. The District requires warning labels to be installed on all appurtenances in vaults, such as, but not limited to, air release valves, blow offs, and meters, and on designated facilities, such as, but not limited to, pressure reducing valves, above ground valves, and controller panels.

2. Each and every pipe shall be identified with a painted label. In a fenced area, at least one sign shall be posted on the fence which can be readily seen by all operations personnel utilizing the facilities.

3. Painted labels may, at the District representative's discretion be acceptable in lieu of plastic labels.

K. Domestic Water Piping

1. All buried domestic water piping shall be installed with domestic water identification.

2. All PVC domestic water piping shall be blue or shall be white with blue stenciling appearing on both sides of the pipe with the marking "DOMESTIC WATER" in 5/8-inch letters repeated every 12 inches.

3. Blue warning tape identifying it as a domestic water line and stating "CAUTION: DOMESTIC WATER-LINE BURIED BELOW" may be used as an alternate to blue or stenciled pipe. The tape shall run continuously for the entire length of the main line piping. The tape shall be attached to the top of the pipe with plastic tape banded around the warning tape and pipe every 5 feet on center.

L. Submittals

Submit shop drawings on the following materials: warning tape, tags, and labels.

PART 2 – MATERIALS

A. Buried Piping Warning Tape

The plastic warning tape shall be virgin low-density polyethylene specifically formulated for prolonged underground use. Warning tape for recycled water pipeline shall be purple (Pantone 512) with 2-inch black printing having the words, “CAUTION: RECYCLED WATER, DO NOT DRINK”. Warning tape for sewer pipeline shall be green (Pantone 451) with 2-inch black printing having the words, “CAUTION: SEWER”.

The minimum thickness shall be 4 mils and the overall width of the tape shall be 12 inches (for 8-inch pipe and larger) and 6 inches (for 6-inch and smaller pipe).

B. Warning Tags

Warning tags shall be inert plastic film or polyurethane specifically formulated for prolonged exposure. The warning tag shall incorporate an integral attachment neck and reinforced attachment hole. The size of the tag shall be 3-inch by 4-inch with a minimum thickness of 10 mils. Warning tags shall be attached with heavy-duty nylon fasteners.

The size, type of label and location will be dictated by each individual application and subject to acceptance by the Districts representative. The minimum size shall be 1/2-inch letters.

Recycled water warning tags shall be prepared on purple field, and shall have the words: "CAUTION: RECYCLED WATER – DO NOT DRINK" printed on the field in black letters. Minimum letter height shall be ½-inch.

C. Warning Labels

Warning labels shall be a minimum 3.5 mil flexible vinyl base with a permanent acrylic adhesive backing on a 90# stayflat liner. Both the background and legend are printed with a UV cured vinyl ink. The entire decal shall be clear flood over-printed for superior weathering and UV protection. The size shall be 3.5-inch by 4.3-inch for controllers, 2.5-inch by 8.25-inch for pumping equipment, and 1.25-inch by 5.75-inch for potable water decals.

PART 3 – EXECUTION

A. Installation of Pipe Warning Tape

For PVC or ductile iron pipe, all pipelines shall have warning tape placed in the trench 12-inches above the pipe with the appropriate wording for Recycled Water, Sewer or Domestic Water.

For those applications where warning tape is used to identify the pipeline, in addition to the warning tape located 12-inches above the pipe, the warning tape shall be installed directly on the top of the pipe longitudinally and shall be centered. The warning tape shall be installed continuously for the length of the pipe and shall be fastened to each pipe length by plastic adhesive tape banded around the pipe and warning tape at no more than 5-foot intervals. Taping attached to the sections of pipe before installing in the trench shall have 5-foot minimum overlap for continuous coverage. All laterals and appurtenance piping shall be installed with warning tape as well.

B. Installation of Warning Tags and Labels

Warning tags shall be firmly attached to all appurtenances using heavy-duty nylon fasteners. One warning tag shall be attached to each appurtenance as follows: attach to valve stem directly or with plastic tie wrap; attach to solenoid wire directly or with plastic tie wrap; attach to valve cover with existing valve cover bolt; or attach to the body of the relative appurtenance with a plastic tie-wrap. Warning labels (decals) shall be placed on all controllers and pumping equipment.

END OF SECTION

SECTION 15162

PIPE COUPLINGS AND ADAPTERS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Sleeve-Type Couplings

B. Restrained Sleeve-Type Couplings

C. Restrained One-Piece Coupling

1.02 RELATED REQUIREMENTS

A. Section 09900, Painting and Coating

B. Section 15042, Hydrostatic Testing of Pressure Pipelines

1.03 DEFINITIONS

A. Straight coupling: A coupling that uses end rings of the same size and a center sleeve with ends of proper inside diameters to join pipes of the same outside diameters

B. Reducer coupling: A coupling that uses end rings of different sizes and a center sleeve with ends of proper inside diameters to join pipes of different outside diameters

C. Transition coupling: A coupling used to join pipe of the same nominal size, but of differing outside diameters. Differences in pipe outside diameters are accommodated by specially sized gaskets and, when necessary, specially sized end rings.

D. Flange coupling adapters: A coupling used to connect plain-end pipe to a flange. It consists of a flange, center sleeve, gasket, and an end ring connected with bolts and nuts.

1.04 REFERENCED STANDARDS

A. American Water Works Association

1. AWWA C105: Polyethylene Encasement for Ductile-Iron Pipe Systems
2. AWWA C111: Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings
3. AWWA C213: Fusion-Bonded Epoxy Coating for the Interior and Exterior of Steel Water Pipelines
4. AWWA C219: Bolted, Sleeve-Type Couplings for Plain-End Pipe
5. AWWA M11: Steel Pipe: A Guide for Design and Installation

B. ASTM International

1. ASTM A36: Standard Specification for Carbon Structural Steel
2. ASTM A193: Standard Specification for Alloy-Steel and Stainless Steel Bolting for High Temperature or High Pressure Service and Other Special Purpose Applications
3. ASTM A194: Standard Specification for Carbon Steel, Alloy Steel, and Stainless Steel Nuts for Bolts for High Pressure or High Temperature Service, or Both
4. ASTM A283: Standard Specification for Low and Intermediate Tensile Strength Carbon Steel Plates
5. ASTM A285: Standard Specification for Pressure Vessel Plates, Carbon Steel, Low- and Intermediate-Tensile Strength
6. ASTM A536: Standard Specification for Ductile Iron Castings
7. ASTM A576: Standard Specification for Steel Bars, Carbon, Hot-Wrought, Special Quality

C. NSF International (NSF)

1. NSF 61: Drinking Water System Components – Health Effects

1.05 SUBMITTALS

A. Product data sheets

1. Materials
2. Pipe material and outside diameter dimensions suitable for coupling
3. Pressure rating

B. Shop drawings

PART 2 PRODUCTS

2.01 SLEEVE-TYPE COUPLINGS

A. Design:

1. Comply with AWWA C219
2. Assembly consisting of a center sleeve, gaskets, and end rings connected with bolts and nuts. Tightening of the fasteners transfers the load through the end rings and compresses the gaskets into the space between the inside of the center sleeve and the outside surface of the pipe ends.
3. Types: Straight couplings, reducing couplings, transition couplings, and flange coupling adapters

B. Pressure rating: Greater than or equal to the pressure rating of adjacent piping

C. Materials:

1. Center rings/sleeve: Ductile iron per ASTM A536, grade 65-45-12 or carbon steel per ASTM A283, grade C
2. End Rings/followers: Ductile iron per ASTM A536, grade 65-45-12 or carbon steel per ASTM A576, grade 1020
3. Gaskets: Styrene-butadiene (SBR)
4. Sleeve Bolts: Type 316 stainless steel per ASTM A-193 (Grade B8M)
5. Nuts: Type 316 stainless steel per ASTM A-194 (Grade B8M)

2.02 RESTRAINED SLEEVE-TYPE COUPLINGS

A. General:

1. Comply with AWWA C219
2. Sleeve-type coupling with restraining end rings/followers consisting of multiple gripping lugs/wedges/pads around the pipe circumference
    a. Specifically designed for the pipe material being connected to coupling
    b. Proper actuation of the gripping lugs/wedges/pads achieved through use of torque limiting twist off nuts
3. Types: Straight couplings, reducing couplings, transition couplings, and flange coupling adapters

B. Pressure rating: Greater than or equal to the pressure rating of adjacent piping

C. Materials:

1. Center rings/sleeve: Ductile iron per ASTM A536, grade 65-45-12 or carbon steel per ASTM A283, grade C
2. End Rings/followers: Ductile iron per ASTM A536, grade 65-45-12 or carbon steel per ASTM A576, grade 1020
3. Gaskets: Styrene-butadiene (SBR)
4. Sleeve Bolts: Type 316 stainless steel per ASTM A-193 (Grade B8M)
5. Nuts: Type 316 stainless steel per ASTM A-194 (Grade B8M)
6. Restraining lugs/wedges/pads: Heat treated ductile iron

2.03 RESTRAINED ONE-PIECE COUPLING

A. General:

1. One-piece coupling with one bolt and nut per end and no loose components. When tightened, coupling shall simultaneously seal and restrain pipe end using rotating end rings, draw hook fasteners, and individual grippers. Individual grippers compensate for angular deflection and distribute load evenly around pipe circumference.
    a. Specifically designed for the pipe material being connected to coupling
2. Types: Straight couplings and flange coupling adapters

B. Pressure rating: Greater than or equal to the pressure rating of adjacent piping

C. Materials:

1. Center rings, end rings, and bolt guides: Ductile iron per ASTM A536, grade 65-45-12
2. Grippers: Ductile iron per ASTM A536, grade 65-45-12, machine sharpened, heat treated, Xylan 1424 coated
3. Gaskets: Styrene-butadiene (SBR)
4. Draw hook fasteners: Type 304L stainless steel
5. Bolts and nuts: Type 316 stainless steel

2.04 FACTORY FINISHES

A. Coat all interior and exterior ferrous surfaces as follows:

1. Center rings/sleeves and all interior/wetted surfaces: Fusion bonded epoxy meeting requirements of AWWA C213 and NSF 61
2. End rings/followers and other exterior surfaces: Fusion bonded polyester, 5 mil thickness

PART 3 EXECUTION

3.01 INSTALLATION OF FLEXIBLE PIPE COUPLINGS

A. Clean oil, scale, rust, and dirt from pipe ends. Clean gaskets in flexible pipe couplings before installing.

B. Install expansion joints per manufacturer's written recommendations.

C. Install expansion joints so that 50-percent of total travel is available for expansion and 50-percent is available for contraction.

D. Lubricate bolt threads with graphite and oil prior to installation.

3.02 FIELD COATING

A. Wrap the couplings with 8-mil polyethylene wrap per AWWA C105. Wrap beyond coupling by 12 inches on both sides.

B. Apply cosmoline grease corrosion guard, per Section 15056, to all hardware.

C. Coat all non-buried pipe couplings per requirements of Section 09900. Apply prime coat at factory.

3.03 HYDROSTATIC TESTING

A. Hydrostatically test flexible pipe couplings, expansion joints, and expansion compensators in place with the pipe being tested. Test in accordance within Section 15042.

END OF SECTION

SECTION 16010

GENERAL ELECTRICAL REQUIREMENTS

PART 1 – GENERAL

A. Description

1. This section includes general requirements for materials and installation of the electrical system.

2. The Contractor shall furnish all labor, supervision, tools, equipment, and materials necessary for a tested and working electrical system as indicated on the Plans and hereinafter specified.

3. The electrical plans are diagrammatic, approximately to scale. However, they shall not be used for exact locations. The Contractor shall verify all dimensions from the detailed drawings and approved shop drawings and shall coordinate these dimensions with the actual field conditions. Actual distances, locations, and elevations shall be governed by field conditions.

B. Submittals

1. Complete fabrication, assembly, and installation drawings; wiring and schematic diagrams; and details, specifications, and data covering the materials used and the parts, devices, and accessories forming a part of the equipment furnished shall be submitted in accordance with the submittal section.

2. Submittal data shall be grouped and submitted in three separate stages. The submittal for each stage shall be substantially complete. Individual drawings and data sheets submitted at random intervals will not be accepted for review. Equipment tag numbers indicated on the contract drawings shall be referenced in submittals where applicable. Submittal data for multifunctional instruments shall include complete descriptions of the intended functions and configurations of the instruments.

    a. First-Stage Submittal:

        i. Product catalog cut sheets clearly marked to show the model number, optional features, and intended service of the device; and

        ii. A detailed list of any exceptions, functional differences, or discrepancies between the supplier's proposed system and the contract requirements.

b. Second-Stage Submittal:

i. Complete panel fabrication drawings and details of panel wiring, piping, and painting. Panel and subpanels drawings shall include overall dimensions, metal thickness, door swing, mounting details, and front of panel arrangement to show general appearance, with spacing and mounting height of instruments and control devices.

ii. System wiring and installation drawings for all interconnection wiring between components of the systems furnished and for all interconnecting wiring between the related equipment and the equipment furnished under this section. Wiring diagrams shall show complete circuits and indicate all connections.

iii. If panel terminal designations, device interconnections, device features and options, or other features are modified as a result of the fabrication process or factory testing, revised drawings shall be resubmitted.

iv. At the supplier's option and for projects with very few fabrication drawings, the first-stage and second-stage submittals may be combined.

v. Signed copy of approved electric utility company service drawings.

c. Third-Stage Submittal:

i. Complete system documentation, in the form of operation and maintenance manuals, shall be provided. Manuals shall include complete product instruction books for each item of equipment furnished.

ii. Where instruction booklets cover more than one specific model or range of instrument, product data sheets shall be included which indicate the instrument model number, calibrated range, and all other special features. A complete set of "as-built" wiring, fabrication, and interconnection drawings shall be included with the manuals.

d. Submit AutoCAD (latest version) format digital drawing files for all shop drawings in addition to hard copy requirements.

C. Regulatory Agencies and Standards

1. Regulatory Agencies: Installations, materials, equipment, and workmanship shall conform to the applicable provisions of the following agencies (latest version):

a. American National Standards Institute (ANSI)

b. American Society of Testing and Materials (ASTM)

c. Institute of Electrical and Electronics Engineers (IEEE)

d. Insulated Cable Engineers Association (ICEA)

e. International Electrical Testing Association (NETA)

f. National Electrical Contractors Association (NECA)

g. National Electrical Manufacturers Association (NEMA)

h. State Department of Industrial Safety (CAL/OSHA)

i. Underwriters' Laboratories (UL)

i. Materials, appliances, equipment, and devices shall conform to the applicable UL standards. The label of, or listing by UL is required wherever applicable.

j. Local authorities having lawful jurisdiction pertaining to the work required.

2. Standards: Where referenced in these specifications or on the drawings, the latest publications and standards shall apply:

a. NFPA 70 National Electrical Code (NEC)

b. California Building Code (CBC)

3. In case of difference between the building codes, Drawings, Specifications, state law, local ordinances, industry standards, utility company regulations, fire insurance carrier's requirements, and the Contract Documents, the most stringent shall govern. The Contractor shall promptly notify the Engineer in writing of such differences.

D. Utility Company Requirements

1. The Contractor shall make any service and installation agreements that the utility companies may require.

2. Install electric service entrance equipment in accordance with the serving utility's requirements. Coordinate with the servicing utility to ensure timely connection by the utility. Obtain utility company approval of service entrance and metering equipment shop drawings prior to starting fabrication.

3. Electric utility service will be provided by Southern California Edison (SCE).

PART 2 – PRODUCTS

A. General

1. Similar materials and equipment shall be the product of a single manufacturer.

2. Provide only products which are new, undamaged, and in the original cartons or containers.

3. Materials and equipment shall be the standard products of manufacturers regularly engaged in the production of such materials and shall be the manufacturer's current design.

4. Materials and equipment shall be suitable for storage, installation, and operation in an ambient of 0°C to 50°C except where more stringent conditions are stated in individual equipment specifications.

5. Electrical equipment and panels shall be factory finished with manufacturer's standard primer and enamel topcoats, unless stated otherwise in the individual equipment specifications. Provide 1 pint of the equipment manufacturer's touchup paint per 500 square feet of painted surface for repair of damaged enamel topcoats.

B. Operation, Maintenance, and Repair Manuals

1. The organization of the initial submittals as required by these contract documents shall be compatible to eventual inclusion as one volume of the operation, maintenance, and repair manuals.

2. Prepare and submit to the Engineer six copies of operation manuals for preliminary review. When the Engineer is satisfied that these are complete and properly prepared, six final sets shall be delivered to the Owner.

3. The complete operation manual shall contain all the information included in the preliminary equipment submittal, the detailed installation submittal, programming instructions, instructions for ordering replacement parts, and the additional information required herein, all bound in hard-cover binders and arranged for convenient use including tab sheets, all indexed and cross referenced, and all final as-built drawings.

4. The operation manuals shall contain:

    i. Operating instructions written for the benefit of plant operating personnel for normal operational conditions;

    ii. Calibration and maintenance instructions;

    iii. Troubleshooting instructions; and

iv. Instructions for ordering replacement parts.

C. As-Built Drawings

1. As-built drawings shall be submitted at the completion of work, which depict the final configuration of all installed equipment. All shop drawings shall be updated by the originator to "as-built" status. As-built drawings shall be provided to the District in both hard copy and digital formats. Digital format shall be AutoCAD (latest edition).

2. The Contractor shall clearly indicate on as-built plans the following information:

   a. Locations and routing of all underground conduits exactly as installed.

   b. Forming, cabling, and identification of all power and control circuits within pull boxes and terminal boxes.

   c. All changes and/or deviations in locations, routing, or dimensions or additions to any part of the electrical work.

   d. Interior views of each pull box identifying each conduit entrance by conduit number.

   e. Complete and accurate wiring, schematic, and interconnecting wiring diagrams for all equipment supplied and all work performed.

PART 3 – EXECUTION

A. Installation

1. The drawings indicate connections for typical equipment only. If the equipment furnished is different from what is shown, provide the modifications necessary for a safe and properly operating installation in accordance with the equipment manufacturer's recommendations.

2. The drawings indicate diagrammatically the desired location and arrangement of outlets, conduit runs, equipment, and other items. Field determine exact location based on physical size and arrangement of equipment, finished elevations, and obstructions.

3. Work or equipment not indicated or specified which is necessary for the complete and proper operation of the electrical systems shall be accomplished without additional cost to the Owner.

B. Foreign Power Isolation in Equipment Enclosure

1. Provide foreign power circuit isolation devices in equipment enclosures. PLC input/output circuits, for example, are a source of foreign power when they exist in an equipment enclosure such as a local control panel which has a separate source of control power. Circuits which are a source of foreign power shall pass through an isolation device where the wiring enters the equipment enclosure. Isolation devices are required in control cabinets, MCC buckets, etc., to provide an easily accessible isolation point whenever the power source for the circuit would be considered foreign power in the enclosure. Isolation devices shall be clearly labeled. Labeling shall be black micarta with 1/8-inch high white lettering and machine screwed on the back door of equipment.

2. Equipment manufacturers shall supply isolation devices integral with their equipment whenever possible (isolation switches integral with disconnect handles, for example).

3. The Contractor shall be responsible for supplying isolation devices as needed such that the complete system of power distribution installed at the facility complies with this specification.

C. Performance Tests

1. After the electrical installation is complete, test it to demonstrate that the entire system is in proper working order and in accordance with the drawings and specifications.

2. Equipment start-up and performance test requirements are provided in the Special Provisions.

END OF SECTION

SECTION 16025

POWER SYSTEM ANALYSIS REPORT

PART 1 - GENERAL

A. Description

1. This section includes requirements for the Power System Analysis Report (hereinafter referred to as The Report) showing results for the following:

    a. Short Circuit Analysis

    b. Time-Current Characteristic (TCC) Curves

    c. Protective Device Coordination Study

    d. Arc Flash Analysis

B. Related Sections

General Electrical Requirements: 16010.

Division 16 Sections as applicable for electrical equipment modeled in The Report

C. References

ANSI/IEEE 141	Recommended Practice for Electrical Power Distribution for Industrial Plants
ANSI/IEEE 242	Recommended Practice for Protection and Coordination of Industrial and Commercial Power Systems
IEEE C37.5	Calculations of Fault Currents for Application of Power Circuit Breakers
IEEE 584	Arc-Flash Hazard Calculations for Arc Flash Safety
NFPA 70E	Standard for Electrical Safety in the Workplace

D. Submittals

1. Submittals shall be made in accordance with General Requirements, Section 16010 “General Electrical Requirements,” and as specified herein.

2. Submit a report including each analysis type specified in this Section. The Report shall include a list of any errors or alerts produced during the analysis. The Contractor shall indicate in the submittal any changes to the protection scheme or equipment selection that will result in improved selective coordination, system reliability, or safety.

3. The Report shall be submitted and approved by the Engineer prior to fabrication of electrical equipment. Electrical equipment shop drawing submittals will be rejected until The Report has been approved.

4. Final settings of protective devices shall be approved by the Engineer prior to project acceptance and shall be based on the results of the Protective Device Coordination Study.

E. Quality Assurance

1. The Report shall be signed and sealed by a professional electrical engineer registered in the State of California.

PART 2 - PRODUCTS

A. General

1. The Report shall include a single line diagram of the system as modeled in the computer analysis software. At minimum, the single line diagram shall include the following:

    a. All power system equipment and devices, including but not limited to switchgear, switchboards, motor control centers, transformers, panelboards, circuit breakers, fuses, relays, wire and cables,

    b. Electric utility company information, including impedance, X/R ratio, available fault current, and quantity, size, and type of cables.

    c. Voltage, continuous current, short circuit withstand and interrupting ratings for all equipment and devices.

    d. Impedances

    e. Wire and cable quantities, sizes and materials

B. Short Circuit Analysis

1. The Contractor shall provide a complete short circuit study of the entire electrical system in accordance with ANSI C 37.5, IEEE 141 and IEEE 242.

2. Provide a tabulation of supplied equipment short circuit current and device interrupt ratings compared to calculated fault current at the equipment bus and/or device.

3. Demonstrate that the Report takes into consideration the maximum available fault current from the electric utility company.

C. Protective Device Coordination Study

1. The Contractor shall provide a protective device coordination study to determine the selection, ratings, and settings of protective devices, including power fuse ratings, protective relay characteristics and settings, ratios and characteristics of associated current transformers, and low voltage circuit breaker trip characteristics and settings.

2. The results of the coordination study shall govern the final selection, ratings, and settings of protective devices. Results are subject to review and acceptance by the Engineer.

3. The coordination study shall consider all devices in the distribution system starting with the smallest 120/208-volt circuit protective device on the load end to the nearest protective device on the electric utility company's line side.

4. The study shall include, but not be limited to, the following:

    a. Tabulation of all protective relay and circuit breaker trip settings.

    b. Recommended medium voltage fuse sizes and types.

    c. Time-Current Characteristic (TCC) curves for applicable equipment and devices. Include the following on the TCC curve graphs:

        a. Device settings and ratings. Identify curves by device.

        b. Maximum available fault current

        c. Cable and equipment damage curves

        d. Motor and generator operating curves

        e. Magnetizing inrush current points for transformers

        f. Single line diagram of devices shown on the TCC graph

    d. Motor starting profiles for all motors sized 50 horsepower and above.

    e. Transformer damage curves and protection evaluated in accordance with ANSI/IEEE C57.109.

    f. Coordination curve(s) from the power company, if available.

D. Arc Flash Analysis

1. The Contractor shall provide a complete arc flash study of the electrical system, including but not limited to the switchboard, MCCs, and panelboards.

2. Identify protection boundaries, incident energy levels (IE) and personal protective equipment (PPE) to be worn by maintenance personnel when working on energized equipment.

3. The analysis shall be based on the calculation methods as described in IEEE 584 "Arc-Flash Hazard Calculation for Arc Flash Safety." Recommended PPE levels shall be as recommended in NFPA 70E "Standard for Electrical Safety in the Workplace," 2009 edition.

4. The electrical system shall be modeled to include the incoming electric utility service, utility transformer, switchboard, motor control centers, emergency generators, VFDs, solid state starters, motors, circuit breakers, auxiliary equipment, step-down transformers, and wiring between electrical components. Completion of the coordination study is required prior to performing the arc flash analysis.

5. Using the selected protective device settings, provide analysis of alternative scenarios to determine the worst case incident energy levels and select appropriate PPE levels. The scenarios shall include but not limited to: (1) maximum available short circuit current available from the utility; (2) minimum short circuit current available from the utility; and (3) available short circuit current when operating the electrical system from the emergency generator.

6. The Arc Flash Analysis shall include the single line diagram, coordination curves, selected protective device settings, available short circuit currents, documentation of input characteristics for the electrical system, incident energy levels, protection boundaries, and PPE levels.

7. Provide a sample of the Arc Flash labels in the report.

8. The analysis shall be provided in accordance with the submittal section. After review and acceptance of the Arc Flash analysis by the Engineer, Contractor shall provide and install Arc Flash labels on the equipment.

9. Provide mitigation instructions, modification on the switchboard if PPE required is greater than 8 cal/cm^2.

PART 3 - EXECUTION

A. Examination

1. The Contractor shall be responsible for obtaining all of the required relay, fuse, and circuit breaker coordination curves, transformer damage curves, motor data, etc., for all new and existing electrical equipment to be included in the Protective Device Coordination Study.

2. The Contractor shall be responsible for all fieldwork required to obtain necessary data on relays, circuit breakers, fuses, and transformer to be included in the Protective Device Coordination Study.

3. The Contractor shall be responsible for coordinating with the electric utility company to obtain the required protective device curves and maximum available fault current.

B. Adjustments

1. The Contractor shall be responsible for setting installed devices in accordance with results of the Engineer approved Protective Device Coordination Study.

END OF SECTION

SECTION 16051

MISCELLANEOUS ELECTRICAL DEVICES

PART 1 – GENERAL

A. Summary

1. Section includes photoelectric switches, time clocks, intrusion alarm switches, and intrusion override key switches.

B. References

NEMA KS-1	"Enclosed and Miscellaneous Distribution Equipment Switches (600 Volts Maximum)."
UL 98	"Enclosed and Dead-Front Switches."

C. Submittals

1. Product Data: Submit ratings and characteristics including voltage ratings, continuous current ratings, short circuit current ratings, cable terminal sizes, conduit entry restrictions, and enclosure type and dimensions.

PART 2 – PRODUCTS

A. Photoelectric Switches

1. Photoelectric switches shall provide automatic switching of outdoor lighting by natural daylight by switching lights on when daylight diminishes and off at sunrise.

2. Photoelectric switches shall be tamperproof, hermetically sealed cells with adjustable turn-on light level selector. Switches shall be enclosed in a die-cast aluminum or zinc housing, gasketed for weatherproofing.

3. Units shall operate in a temperature range of 0°F to 140°F with fail-safe operation. Provide switches with a delay of up to two minutes to prevent false switching. Provide single-pole single-throw snap action switches rated 2,000 watts (tungsten), 120/277-volt a-c.

4. Provide Tork 2100 Series, Omron, IDEC, or Allen Bradley.

B. Intrusion Alarm Switches

1. Provide concealed magnetic contact type switch with SPDT contacts rated for 24-volt d-c and 10 volt-amperes. Switches shall be UL listed.

2. Provide magnetic contact switches with stainless steel flex cable, GE Series 2500, Omron, IDEC, Allen Bradley, or Hubbell.

C. Intrusion Override Key Switches

1. Intrusion override key switches shall be the access control type. Key switches shall come complete with mortise cylinder and 24-volt a-c/d-c SPDT maintained contacts. Key the lock to match the El Toro Water District master key.

2. Intrusion override key switches shall be 30.5mm, Class 9001, 2 position operator key switch, Square D model KS11K1H13, Omron, Hubbell, or Allen Bradley.

PART 3 – EXECUTION

A. Installing Intrusion Alarm Switches

1. The switches shall be interfaced with the PLC. Mount switch on inside door frame such that when the door is opened, the normally closed switch contacts will close, and when the door is closed, the normally closed switch contacts will open.

B. Installing Intrusion Override Key Switches

1. Key switch shall be flush mounted on the control panel as shown on the Drawings. Mount 48 inches above finished floor or grade.

C. Field Testing

1. Thermostats: Adjust thermostats above and below the ambient temperature. Verify that the equipment controlled operates per the plans or other sections of these specifications.

2. Intrusion Alarm and Override Switches: Verify operation by closing and opening each door or hatch and operating key switch and checking receipt of signals at the PLC.

3. Photoelectric Switch: Simulate nighttime by placing object over sensor or witness nighttime automatic controls. Verify lights turn on and off.

END OF SECTION

SECTION 16060

GROUNDING AND BONDING

PART 1 – GENERAL

A. Summary

1. Section Includes:

   a. Grounding electrodes and connections.

   b. Equipment grounding conductors.

   c. Bonding methods and materials.

B. References

IEEE 142	Recommended Practice for Grounding of Industrial and Commercial Power Systems
NECA 1	Standard Practice of Good Workmanship in Electrical Construction
NETA ATS	Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems
UL 467	Grounding and Bonding Equipment

C. Action Submittals

Product Data: For each type of product indicated.

D. Informational Submittals

Field quality-control reports and test reports. Indicate overall resistance to ground.

E. Quality Assurance

1. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2. Comply with UL 467.

PART 2 – PRODUCTS

A. Grounding Electrodes

1. Ground Rods: Copper-clad steel, 3/4-inch diameter by 10 feet long.

    a. Acceptable Manufacturers: Subject to compliance with requirements, provide ground rods by one of the following, or approved equal:

        i. Erico Eritech

        ii. Harger

B. Ground Rod Well

1. Well Pipe: 12 inch NPS by 24-inch long concrete pipe with belled end.

2. Well Cover: Cast iron with legend "GROUND" embossed on cover.

C. Connectors

1. Listed and labeled by UL for applications in which used and for specific types, sizes, and combinations of conductors and other items connected.

2. Bolted Connectors for Conductors and Pipes: Copper or copper alloy, pressure type with at least two bolts.

    a. Pipe Connectors: Clamp type, sized for pipe.

3. Welded Connectors: Exothermic-welding kits of types recommended by kit manufacturer for materials being joined and installation conditions.

4. Acceptable Manufacturers: Subject to compliance with requirements, provide products by one of the following, or equal:

    a. Continental Industries thermOweld

    b. Erico Cadweld

D. Equipment Grounding Conductors

1. Insulated Conductors: Copper wire or cable insulated for 600 V unless otherwise required by applicable Code or authorities having jurisdiction.

2. Bare Copper Conductors:

    a. Solid Conductors: ASTM B 3.

    b. Stranded Conductors: ASTM B 8.

    c. Tinned Conductors: ASTM B 33.

    d. Bonding Conductor: 4 or 6 AWG, stranded copper conductor.

PART 3 – EXECUTION

A. Applications

1. Underground Grounding Electrode and Ground Loop Conductors: Install bare copper conductor, size as indicated on the Drawings. Bury conductors at least 24 inches below grade. Coordinate conductor burial depth with depth of ground rod well for connection to ground rods.

2. Equipment Grounding Conductors: Install copper conductor with green-colored insulation.

3. Conductor Terminations and Connections:

    a. Pipe and Equipment Grounding Conductor Terminations: Bolted connectors.

    b. Underground Connections: Welded connectors except at test wells and as otherwise indicated.

    c. Connections to Ground Rods at Test Wells: Bolted connectors.

    d. Connections to Structural Steel: Welded connectors.

B. Equipment Grounding

1. Install insulated equipment grounding conductors with the following items, in addition to those required by NFPA 70:

    a. Feeders and branch circuits.

    b. Lighting circuits.

    c. Receptacle circuits.

    d. Single-phase motor and appliance branch circuits.

e. Three-phase motor and appliance branch circuits.

f. Flexible raceway runs.

g. Armored and metal-clad cable runs.

h. Busway Supply Circuits: Install insulated equipment grounding conductor from grounding bus in the switchgear, switchboard, or distribution panel to equipment grounding bar terminal on busway.

i. Computer and Rack-Mounted Electronic Equipment Circuits: Install insulated equipment grounding conductor in branch-circuit runs from equipment-area power panels and power-distribution units.

j. Cable Tray structures: Install grounding bonding jumpers between cable tray sections and ground the cable tray system to ground grid.

2. Air-Duct Equipment Circuits: Install insulated equipment grounding conductor to duct-mounted electrical devices operating at 120 V and more, including air cleaners, heaters, dampers, humidifiers, and other duct electrical equipment. Bond conductor to each unit and to air duct and connected metallic piping.

3. Water Heater, Heat-Tracing, and Antifrost Heating Cables: Install a separate insulated equipment grounding conductor to each electric water heater and heat-tracing cable. Bond conductor to heater units, piping, connected equipment, and components.

4. Signal and Communication Equipment: In addition to grounding and bonding required by NFPA 70, provide a separate grounding system complying with requirements in TIA/ATIS J-STD-607-A.

   a. For telephone, alarm, voice and data, and other communication equipment, provide 4 AWG minimum insulated grounding conductor in raceway from grounding electrode system to each service location, terminal cabinet, wiring closet, and central equipment location.

   b. Terminal Cabinets: Terminate grounding conductor at cabinet grounding terminal.

C. Installation

1. Grounding Conductors: Route along shortest and straightest paths possible unless otherwise indicated or required by Code. Avoid obstructing access or placing conductors where they may be subjected to strain, impact, or damage.

2. Ground Rods: Drive rods until tops are 2 inches below finished floor or final grade unless otherwise indicated. Verify final backfill and compaction has been completed before driving rod electrodes.

a. Interconnect ground rods with grounding electrode conductor below grade and as otherwise indicated. Make connections without exposing steel or damaging coating, if any.

b. For grounding electrode system, install at least four rods spaced at least one-rod length from each other and located at least the same distance from other grounding electrodes, and connect to the service grounding electrode conductor.

3. Test Wells: Ground rod driven through drilled hole in bottom of handhole. Handholes are specified in Section 16130 "Raceways and Boxes," and shall be at least 12 inches deep, with cover.

4. Bonding Straps and Jumpers: Install in locations accessible for inspection and maintenance except where routed through short lengths of conduit.

   a. Bonding to Structure: Bond straps directly to basic structure, taking care not to penetrate any adjacent parts.

   b. Bonding to Equipment Mounted on Vibration Isolation Hangers and Supports: Install bonding so vibration is not transmitted to rigidly mounted equipment.

   c. Use exothermic-welded connectors for outdoor locations; if a disconnect-type connection is required, use a bolted clamp.

5. Grounding and Bonding for Piping:

   a. Metal Water Service Pipe: Install insulated copper grounding conductors, in conduit, from building's main service equipment, or grounding bus, to main metal water service entrances to building. Connect grounding conductors to main metal water service pipes; use a bolted clamp connector or bolt a lug-type connector to a pipe flange using one of the lug bolts of the flange. Where a dielectric main water fitting is installed, connect grounding conductor on street side of fitting. Bond metal grounding conductor conduit or sleeve to conductor at each end.

   b. Water Meter Piping: Use braided-type bonding jumpers to electrically bypass water meters. Connect to pipe with a bolted connector.

   c. Bond each aboveground portion of gas piping system downstream from equipment shutoff valve.

6. Bonding Interior Metal Ducts: Bond metal air ducts to equipment grounding conductors of associated fans, blowers, electric heaters, and air cleaners. Install bonding jumper to bond across flexible duct connections to achieve continuity.

7. Metallic raceways shall be terminated with double lock nuts and bushings. Conduits terminating in switchboards and motor control centers shall be equipped with grounding bushing and connected to equipment ground bus.

D. Labeling

1. Comply with requirements in Section 16075 "Electrical Identification" for instruction signs. The label or its text shall be green.

2. Install labels at the telecommunications bonding conductor and grounding equalizer and at the grounding electrode conductor where exposed.

E. Field Quality Control

1. Perform the following tests and inspections and prepare test reports:

   a. After installing grounding system but before permanent electrical circuits have been energized, test for compliance with requirements.

   b. Inspect physical and mechanical condition. Verify tightness of accessible, bolted, electrical connections with a calibrated torque wrench according to manufacturer's written instructions.

   c. Test completed grounding system at each location where a maximum ground-resistance level is specified, at service disconnect enclosure grounding terminal, and at ground test wells. Make tests at ground rods before any conductors are connected.

2. Report measured ground resistances that exceed the following values:

   a. Power and Lighting Equipment or System with Capacity of 500 kVA and Less: 10 ohms.

   b. Power and Lighting Equipment or System with Capacity of 500 to 1000 kVA: 5 ohms.

   c. Power Distribution Units or Panelboards Serving Electronic Equipment: 3 ohms.

3. Excessive Ground Resistance: If resistance to ground exceeds specified values, notify Engineer promptly and include recommendations to reduce ground resistance.

END OF SECTION

SECTION 16073

HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

A. Summary

1. Section includes:

    a. Electrical equipment support frames and associated hardware.

    b. Anchors, fasteners, hangers, and supports for electrical equipment and systems.

    c. Construction requirements for concrete equipment pads.

B. Related Sections

1. Cast-In-Place Concrete: 03300.

2. General Electrical Requirements: 16010.

C. References

NECA 1 Standard Practice of Good Workmanship in Electrical Construction

D. Performance Requirements

1. Delegated Design: Design supports for multiple raceways, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

2. Design supports for multiple raceways capable of supporting combined weight of supported systems and its contents.

3. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.

4. Rated Strength: Adequate in tension, shear, and pullout force to resist maximum loads calculated or imposed for this Project, with a minimum structural safety factor of five times the applied force.

E. Action Submittals

1. Product Data:

    a. 316 Stainless Steel slotted support systems

    b. Manufacturer’s catalog data for anchors and fasteners

    c. Dimensions, ratings, and performance data

2. Shop Drawings: Show fabrication and installation details and include calculations for the following:

    a. Trapeze hangers: Include Product Data for components.

    b. 316 Stainless Steel slotted channel systems: Include Product Data for components.

    c. Equipment supports.

F. Informational Submittals

Welding certificates

G. Quality Assurance

1. Welding: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

2. Comply with NFPA 70.

3. Seismic-Restraint to comply with latest IBC.

PART 2 - PRODUCTS

A. Support, Anchorage, and Attachment Components

1. Steel Slotted Support Systems: Comply with MFMA-4, factory-fabricated components for field assembly.

    a. Acceptable Manufacturers: Subject to compliance with requirements, provide products by one of the following, or equal:

        i. Allied Tube & Conduit

        ii. Eaton

        iii. Thomas & Betts Superstrut

        iv. Tyco Unistrut

    b. Metallic Coatings: Hot-dip galvanized after fabrication and applied according to MFMA-4.

    c. Nonmetallic Coatings: Manufacturer's standard PVC, polyurethane, or polyester coating applied according to MFMA-4.

    d. Painted Coatings: Manufacturer's standard painted coating applied according to MFMA-4.

    e. Channel Dimensions: Selected for applicable load criteria.

2. Raceway and Cable Supports: As described in NECA 1 and NECA 101.

3. Conduit and Cable Support Devices: Steel and malleable-iron hangers, clamps, and associated fittings, designed for types and sizes of raceway or cable to be supported.

4. Support for Conductors in Vertical Conduit: Factory-fabricated assembly consisting of threaded body and insulating wedging plug or plugs for non-armored electrical conductors or cables in riser conduits. Plugs shall have number, size, and shape of conductor gripping pieces as required to suit individual conductors or cables supported. Body shall be malleable iron.

5. Structural Steel for Fabricated Supports and Restraints: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.

6. Mounting, Anchoring, and Attachment Components: Items for fastening electrical items or their supports to building surfaces include the following:

    a. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened concrete, steel, or wood, with tension, shear, and pullout capacities appropriate for supported loads and building materials where used.

        i. Acceptable Manufacturers: Subject to compliance with requirements, provide products by one of the following, or equal:

            1) Hilti

            2) ITW Ramset/Red Head

            3) MKT Fastening

            4) Simpson Strong-Tie

    b. Mechanical-Expansion Anchors: Insert-wedge-type, stainless steel, for use in hardened concrete with tension, shear, and pullout capacities appropriate for supported loads and building materials in which used.

        i. Acceptable Manufacturers: Subject to compliance with requirements, provide products by one of the following, or equal:

            1) Hilti

            2) Eaton

            3) ITW Ramset/Red Head

            4) MKT Fastening

    c. Concrete Inserts: Steel or malleable-iron, slotted support system units similar to MSS Type 18; complying with MFMA-4 or MSS SP-58.

    d. Clamps for Attachment to Steel Structural Elements: MSS SP-58, type suitable for attached structural element.

e. Through Bolts: Structural type, hex head, and high strength. Comply with ASTM A 325.

f. Toggle Bolts: All-steel springhead type.

g. Hanger Rods: Threaded steel.

B. Fabricated Metal Equipment Support Assemblies

1. Description: Welded or bolted, structural-steel shapes, shop or field fabricated to fit dimensions of supported equipment.

2. Materials: Comply with requirements in Section 05500 "Metal Fabrications and Castings" for steel shapes and plates.

C. Wall Plates

1. Weatherproof Cover Plate: Gasketed cast metal plate with hinged and gasketed device cover.

PART 3 - EXECUTION

A. General

1. Drawings are diagrammatic only. Do not scale the electrical drawings for locations of any electrical, architectural, structural, civil, or mechanical items or features.

B. Application

1. Comply with NECA 1 and NECA 101 for application of hangers and supports for electrical equipment and systems except if requirements in this Section are stricter.

2. Maximum Support Spacing and Minimum Hanger Rod Size for Raceway: Space supports for EMT, IMC, and RMC as required by NFPA 70. Minimum rod size shall be 1/4 inch in diameter.

3. Multiple Raceways or Cables: Install trapeze-type supports fabricated with steel slotted support system, sized so capacity can be increased by at least 25 percent in future without exceeding specified design load limits.

a. Secure raceways and cables to these supports with two-bolt conduit.

C. Support Installation

1. Comply with NECA 1 and NECA 101 for installation requirements except as specified in this Article.

2. Strength of Support Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static loads within specified loading limits. Minimum static design load used for strength determination shall be weight of supported components plus 200 lb.

3. Mounting and Anchorage of Surface-Mounted Equipment and Components: Anchor and fasten electrical items and their supports to building structural elements by the following methods unless otherwise indicated by code:

    a. To Wood: Fasten with lag screws or through bolts.

    b. To New Concrete: Bolt to concrete inserts.

    c. To Masonry: Approved toggle-type bolts on hollow masonry units and expansion anchor fasteners on solid masonry units.

    d. To Existing Concrete: Expansion anchor fasteners.

    e. Instead of expansion anchors, powder-actuated driven threaded studs provided with lock washers and nuts may be used in existing standard-weight concrete 4 inches thick or greater. Do not use for anchorage to lightweight-aggregate concrete or for slabs less than 4 inches thick.

    f. To Steel: Welded threaded studs complying with AWS D1.1/D1.1M, with lock washers and nuts.

    g. To Light Steel: Sheet metal screws.

    h. Items Mounted on Hollow Walls and Nonstructural Building Surfaces: Mount cabinets, panelboards, disconnect switches, control enclosures, pull and junction boxes, transformers, and other devices on slotted-channel racks attached to substrate by means that meet seismic-restraint strength and anchorage requirements.

4. Drill holes for expansion anchors in concrete at locations and to depths that avoid reinforcing bars.

D. Installation of Fabricated Metal Supports

1. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor electrical materials and equipment.

2. Field Welding: Comply with AWS D1.1/D1.1M.

E. Concrete Bases

1. Construct concrete bases of dimensions indicated but not less than 4 inches larger in both directions than supported unit, and so anchors will be a minimum of 10 bolt diameters from edge of the base.

2. Use 3,000-psi, 28-day compressive-strength concrete. Concrete materials, reinforcement, and placement requirements are specified in Section 03300 "Cast-In-Place Concrete."

3. Anchor equipment to concrete base:

    a. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.

    b. Install anchor bolts to elevations required for proper attachment to supported equipment.

    c. Install anchor bolts according to anchor-bolt manufacturer's written instructions.

F. Painting

1. Touchup: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.

    a. Apply paint by brush or spray to provide minimum dry film thickness of 2.0 mils.

2. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

G. Installation of Anchors and Fasteners

1. Locate and install anchors, fasteners, and supports in accordance with NECA 1.

2. Fabricate supports from nonmetallic members whenever possible. If loads warrant steel support, corrosion resistant stainless steel members shall be used.

3. Install nameplate parallel to equipment lines. Secure nameplate to equipment front using screws or rivets.

END OF SECTION

SECTION 16075

ELECTRICAL IDENTIFICATION

PART 1 – GENERAL

A. Summary

Provide electrical identification of equipment, boxes, and conductors as specified herein:

B. System Description

1. Identify Electrical components as follows:

    a. Nameplate for each electrical distribution and control equipment enclosure.

    b. Wire marker on both ends of each conductor at panelboard gutters, pull boxes, and outlet and junction boxes.

C. References

29 CFR 1910.144	Safety Color Code for Marking Physical Hazards
29 CFR 1910.145	Specifications for Accident Prevention Signs and Tags
ANSI A13.1	Scheme for the Identification of Piping Systems
ANSI Z535.1	Safety Colors
ANSI Z535.2	Environmental and Facility Safety Signs
ANSI Z535.3	Criteria for Safety Symbols
ANSI Z535.4	Product Safety Signs and Labels
ANSI Z535.5	Safety Tags and Barricade Tapes (for Temporary Hazards)
UL 969	Marking and Labeling Systems

D. Action Submittals

Product Data: For each electrical identification product indicated.

E. Quality Assurance

1. Comply with ANSI A13.1.

2. Comply with NFPA 70.

3. Comply with 29 CFR 1910.144 and 29 CFR 1910.145.

4. Comply with ANSI Z535.4 for safety signs and labels.

5. Adhesive-attached labeling materials, including label stocks, laminating adhesives, and inks used by label printers, shall comply with UL 969.

PART 2 – PRODUCTS

A. Nameplates

1. Product Description: Engraved three-layer laminated plastic nameplate, white letters on black background.

2. Letter Size:

   a. 1/8 inch letters for identifying individual equipment and loads.

   b. 1/4 inch letters for identifying grouped equipment and loads.

B. Power Raceway Identification Materials

1. Comply with ANSI A13.1 for minimum size of letters for legend and for minimum length of color field for each raceway size.

2. Colors for Raceways Carrying Circuits at 600 V or Less:

   a. Black letters on an orange field.

   b. Legend: Indicate voltage and system or service type.

3. Self-Adhesive Vinyl Labels for Raceways Carrying Circuits at 600 V or Less: Preprinted, flexible label laminated with a clear, weather- and chemical-resistant coating and matching wraparound adhesive tape for securing ends of legend label.

4. Snap-Around Labels for Raceways Carrying Circuits at 600 V or Less: Slit, pretensioned, flexible, preprinted, color-coded acrylic sleeve, with diameter sized to suit diameter of raceway or cable it identifies and to stay in place by gripping action.

5. Snap-Around, Color-Coding Bands for Raceways Carrying Circuits at 600 V or Less: Slit, pretensioned, flexible, solid-colored acrylic sleeve, 2 inches long, with diameter sized to suit diameter of raceway or cable it identifies and to stay in place by gripping action.

6. Write-On Tags: Polyester tag, 0.015 inch thick, with corrosion-resistant grommet and cable tie for attachment to conductor or cable.

    a. Marker for Tags: Permanent, waterproof, black ink marker recommended by tag manufacturer.
    b. Marker for Tags: Machine-printed, permanent, waterproof, black ink marker recommended by printer manufacturer.

C. Power and Control Cable Identification Materials

1. Comply with ANSI A13.1 for minimum size of letters for legend and for minimum length of color field for each raceway and cable size.

2. Cable identification shall be placed at each end of the cable.

3. Self-Adhesive Vinyl Labels: Preprinted, flexible label laminated with a clear, weather- and chemical-resistant coating and matching wraparound adhesive tape for securing ends of legend label.

4. Write-On Tags: Polyester tag, 0.015 inch thick, with corrosion-resistant grommet and cable tie for attachment to conductor or cable.

    a. Marker for Tags: Permanent, waterproof, black ink marker recommended by tag manufacturer.

    b. Marker for Tags: Machine-printed, permanent, waterproof, black ink marker recommended by printer manufacturer.

5. Snap-Around Labels: Slit, pretensioned, flexible, preprinted, color-coded acrylic sleeve, with diameter sized to suit diameter of raceway or cable it identifies and to stay in place by gripping action.

6. Snap-Around, Color-Coding Bands: Slit, pretensioned, flexible, solid-colored acrylic sleeve, 2 inches long, with diameter sized to suit diameter of raceway or cable it identifies and to stay in place by gripping action.

D. Conductor Identification Materials

1. Color-Coding Conductor Tape: Colored, self-adhesive vinyl tape not less than 3 mils thick by 1 to 2 inches wide.

2. Self-Adhesive Vinyl Labels: Preprinted, flexible label laminated with a clear, weather- and chemical-resistant coating and matching wraparound adhesive tape for securing ends of legend label.

3. Marker Tapes: Vinyl or vinyl-cloth, self-adhesive wraparound type, with circuit identification legend machine printed by thermal transfer or equivalent process.

4. Wire Markers: Shrink Tubing type wire markers with circuit or control wire number permanently stamped or printed.

5. Write-On Tags: Polyester tag, 0.015 inch thick, with corrosion-resistant grommet and cable tie for attachment to conductor or cable.

    a. Marker for Tags: Permanent, waterproof, black ink marker recommended by tag manufacturer.

    b. Marker for Tags: Machine-printed, permanent, waterproof, black ink marker recommended by printer manufacturer.

E. Underground Line Warning Tape

1. Tape:

    a. Recommended by manufacturer for the method of installation and suitable to identify and locate underground electrical and communications utility lines.

    b. Printing on tape shall be permanent and shall not be damaged by burial operations.

    c. Tape material and ink shall be chemically inert, and not subject to degrading when exposed to acids, alkalis, and other destructive substances commonly found in soils.

2. Color and Printing:

    a. Comply with ANSI Z535.1 through ANSI Z535.5.

    b. Inscriptions for Orange-Colored Tapes: TELEPHONE CABLE, CATV CABLE, COMMUNICATIONS CABLE, OPTICAL FIBER CABLE.

3. Tag: Type ID:

    a. Detectable three-layer laminate, consisting of a printed pigmented polyolefin film, a solid aluminum-foil core, and a clear protective film that allows inspection of the continuity of the conductive core, bright-colored, continuous-

printed on one side with the inscription of the utility compounded for direct-burial service.

b. Overall Thickness: 5 mils.

c. Foil Core Thickness: 0.35 mil.

d. Weight: 28 lb/1000 sq. ft.

e. 3-Inch Tensile According to ASTM D 882: 70 lbf, and 4600 psi.

F. Warning Labels and Signs

1. Comply with NFPA 70 and 29 CFR 1910.145.

2. Self-Adhesive Warning Labels: Factory-printed, multicolor, pressure-sensitive adhesive labels, configured for display on front cover, door, or other access to equipment unless otherwise indicated.

3. Baked-Enamel Warning Signs:

   a. Preprinted aluminum signs, punched or drilled for fasteners, with colors, legend, and size required for application.

   b. 1/4-inch grommets in corners for mounting.

   c. Nominal size, 7 by 10 inches.

4. Metal-Backed, Butyrate Warning Signs:

   a. Weather-resistant, nonfading, preprinted, cellulose-acetate butyrate signs with 0.0396-inch galvanized-steel backing; and with colors, legend, and size required for application.

   b. 1/4-inch grommets in corners for mounting.

   c. Nominal size, 10 by 14 inches.

5. Warning label and sign shall include, but are not limited to, the following legends:

   a. Multiple Power Source Warning: "DANGER - ELECTRICAL SHOCK HAZARD - EQUIPMENT HAS MULTIPLE POWER SOURCES."

   b. Workspace Clearance Warning: "WARNING - OSHA REGULATION - AREA IN FRONT OF ELECTRICAL EQUIPMENT MUST BE KEPT CLEAR FOR 36 INCHES."

c. Arc-flash warning signs and protective PPE requirement if any**.**

G. Instruction Signs

1. Coordinate this article with Drawings.

2. Engraved, laminated acrylic or melamine plastic, minimum 1/16 inch thick for signs up to 20 sq. inches and 1/8 inch thick for larger sizes.

   a. Engraved legend with black letters on white face.
   b. Punched or drilled for mechanical fasteners.

   c. Framed with mitered acrylic molding and arranged for attachment at applicable equipment.

3. Adhesive Film Label: Machine printed, in black, by thermal transfer or equivalent process. Minimum letter height shall be 3/8 inch.

4. Adhesive Film Label with Clear Protective Overlay: Machine printed, in black, by thermal transfer or equivalent process. Minimum letter height shall be 3/8 inch. Overlay shall provide a weatherproof and UV-resistant seal for label.

H. Equipment Identification Labels

1. Adhesive Film Label with Clear Protective Overlay: Machine printed, in black, by thermal transfer or equivalent process. Minimum letter height shall be 3/8 inch. Overlay shall provide a weatherproof and UV-resistant seal for label.

2. Self-Adhesive, Engraved, Laminated Acrylic or Melamine Label: Adhesive backed, with white letters on a dark-gray background. Minimum letter height shall be 3/8 inch.

3. Stenciled Legend: In nonfading, waterproof, black ink or paint. Minimum letter height shall be 1 inch.

I. Miscellaneous Identification Products

1. Paint: Comply with requirements in painting Sections for paint materials and application requirements. Select paint system applicable for surface material and location (exterior or interior).

2. Fasteners for Labels and Signs: Self-tapping, stainless-steel screws or stainless-steel machine screws with nuts and flat and lock washers.

PART 3 – EXECUTION

A. Installation

1. Location: Install identification materials and devices at locations for most convenient viewing without interference with operation and maintenance of equipment.

2. Cable and wire identification shall be placed at each end for each section of the cable or wire.

3. Apply identification devices to surfaces that require finish after completing finish work.

4. Self-Adhesive Identification Products: Clean surfaces before application, using materials and methods recommended by manufacturer of identification device.

5. Attach signs and plastic labels that are not self-adhesive type with mechanical fasteners appropriate to the location and substrate.

6. System Identification Color-Coding Bands for Raceways and Cables: Each color-coding band shall completely encircle cable or conduit. Place adjacent bands of two-color markings in contact, side by side. Locate bands at changes in direction, at penetrations of walls and floors, at 50-foot maximum intervals in straight runs, and at 25-foot maximum intervals in congested areas.

7. Underground-Line Warning Tape: During backfilling of trenches install continuous underground-line warning tape directly above line at 6 to 8 inches below finished grade. Use multiple tapes where width of multiple lines installed in a common trench exceeds 16 inches overall.

8. Painted Identification: Comply with requirements in painting Sections for surface preparation and paint application.

B. Identification Schedule

1. Accessible Raceways and Metal-Clad Cables, 600 V or Less, for Service, Feeder, and Branch Circuits More Than 30 A, and 120V to ground: Install labels at 10-foot maximum intervals.

2. Accessible Raceways and Cables within Buildings: Identify the covers of each junction and pull box of the following systems with self-adhesive vinyl labels with the wiring system legend and system voltage. System legends shall be as follows:

   a. Emergency Power.

b. Power.

c. UPS.

3. Power-Circuit Conductor Identification, 600 V or Less: For conductors in vaults, pull and junction boxes, manholes, and handholes, use color-coding conductor tape to identify the phase.

   a. Color-Coding for Phase and Voltage Level Identification, 600 V or Less: Use colors listed below for ungrounded feeder and branch-circuit conductors.

      i. Colors for 240/120V Circuits:

         Phase A: Black.

         Phase B: Red.

         Neutral: White.

      ii. Colors for 208/120V Circuits:

         Phase A: Black.

         Phase B: Red.

         Phase C: Blue.

         Neutral: White.

      iii. Colors for 480/277V Circuits:

         Phase A: Brown.

         Phase B: Orange.

         Phase C: Yellow.

         Neutral: Gray.

      iv. Color shall be factory applied for size 8 AWG and smaller. Color shall be factory applied or field applied for sizes larger than 8 AWG.

      v. Field-Applied, Color-Coding Conductor Tape: Apply in half-lapped turns for a minimum distance of 6 inches from terminal points and in boxes where splices or taps are made. Apply last two turns of tape with no

tension to prevent possible unwinding. Locate bands to avoid obscuring factory cable markings.

4. Install instructional sign including the color code for grounded and ungrounded conductors using adhesive-film-type labels.

5. Auxiliary Electrical Systems Conductor Identification: Identify field-installed alarm, control, and signal connections.

    a. Identify conductors, cables, and terminals in enclosures and at junctions, terminals, and pull points. Identify by system and circuit designation.
    b. Use system of marker tape designations that is uniform and consistent with system used by manufacturer for factory-installed connections.

    c. Coordinate identification with Project Drawings, manufacturer's wiring diagrams, and the Operation and Maintenance Manual.

    6. Locations of Underground Lines: Identify with underground-line warning tape for power, lighting, communication, and control wiring and optical fiber cable.

    a. Limit use of underground-line warning tape to direct-buried cables.

    b. Install underground-line warning tape for both direct-buried cables and cables in raceway.

7. Workspace Indication: Install floor marking tape to show working clearances in the direction of access to live parts. Workspace shall be as required by NFPA 70 and 29 CFR 1926.403 unless otherwise indicated. Do not install at flush-mounted panelboards and similar equipment in finished spaces.

8. Warning Labels for Indoor Cabinets, Boxes, and Enclosures for Power and Lighting: Self-adhesive warning labels or Baked-enamel warning signs.

    a. Comply with 29 CFR 1910.145.

    b. Identify system voltage with black letters on an orange background.

    c. Apply to exterior of door, cover, or other access.

    d. For equipment with multiple power or control sources, apply to door or cover of equipment including, but not limited to, the following:

        i. Power transfer switches.

        ii. Controls with external control power connections.

9. Operating Instruction Signs: Install instruction signs to facilitate proper operation and maintenance of electrical systems and items to which they connect. Install instruction signs with approved legend where instructions are needed for system or equipment operation.

10. Emergency Operating Instruction Signs: Install instruction signs with white legend on a red background with minimum 3/8-inch high letters for emergency instructions at equipment used for power transfer.

11. Equipment Identification Labels: On each unit of equipment, install unique designation label that is consistent with wiring diagrams, schedules, and the Operation and Maintenance Manual. Apply labels to disconnect switches and protection equipment, central or master units, control panels, control stations, terminal cabinets, and racks of each system. Systems include power, lighting, control, communication, signal, monitoring, and alarm systems unless equipment is provided with its own identification.

    a. Labeling Instructions:

        i. Indoor Equipment: Self-adhesive, engraved, laminated acrylic or melamine label. Unless otherwise indicated, provide a single line of text with 1/2-inch high letters on 1-1/2-inch high label; where two lines of text are required, use labels 2 inches high.

        ii. Outdoor Equipment: Engraved, laminated acrylic or melamine label or stenciled legend 4 inches high.

        iii. Elevated Components: Increase sizes of labels and letters to those appropriate for viewing from the floor.

        iv. Unless provided with self-adhesive means of attachment, fasten labels with appropriate mechanical fasteners that do not change the NEMA or NRTL rating of the enclosure.

END OF SECTION

SECTION 16120

LOW VOLTAGE WIRE AND CABLE

PART 1 – GENERAL

A. Summary

1. Section Includes:

    a. Building wires and cables rated 600 volts and less.

    b. Connectors, splices, and terminations rated 600 volts and less.

    c. Low voltage control cabling.

    d. Control circuit conductors.

B. Related Work Specified Elsewhere

1. General Electrical Requirements: 16010.

2. Raceways and Boxes: 16130.

3. General Instrumentation and Controls Systems: 17010.

C. References

ANSI/UL 62	Flexible Cord and Fixture Wire
ANSI/UL 510	Insulating Tape
ASTM B3	Soft or Annealed Copper Wire
ASTM B8	Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard or Soft
NECA 1	Standard Practice of Good Workmanship in Electrical Construction
NEMA WC 5	Thermoplastic Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy
NEMA WC 55	Instrumentation Cables and Thermocouple Wire

NEMA WC 57	Control Cables
NEMA WC 70	Power Cables Rated 2000 Volts or Less for the Distribution of Electrical Energy
UL 83	Thermoplastic-Insulated Wires and Cables
UL 486A-486B	Wire Connectors
UL 486D	Sealed Wire Connector Systems

D. Action Submittals

Product Data: For each conductor or cable type, indicate insulation material, conductor material, voltage rating, manufacturer and other data pertinent to the specific cable, such as type of shielding, number of conductors, and applicable standards.

E. Informational Submittals

1. Source quality-control reports.

2. Field quality control reports

F. Conductor Application

1. Unless otherwise indicated, all conductors shall be stranded copper.

2. Minimum Conductor Sizes:

    a. Power and Lighting Circuit Conductors: 12 AWG.

    b. Control Circuit Conductors:

        i. Class 1 remote-control and signal circuits: 14 AWG.

        ii. Class 2 low-energy, remote-control, and signal circuits: 16 AWG.

        iii. Class 3 low-energy, remote-control, alarm, and signal circuits: 12 AWG.

3. Feeders and Branch Circuits in Underground Conduit or concealed in ceilings, walls, partitions, and crawlspaces: Type THHN-2/THWN-2, single conductors in raceway.

4. Exposed Feeders and Branch Circuits: Type XHHW-2, single conductors in raceway, Armored cable (Type AC), Metal-clad cable (Type MC), and Nonmetallic-sheathed cable (Type NM).

5. Cord Drops and Portable Appliance Connections: Type SO, hard service cord with stainless-steel, wire-mesh, strain relief device at terminations to suit application.

6. Grounding: Comply with requirements in Section 16060 "Grounding and Bonding."

G. Qualifications

1. Company specializing in manufacturing products specified in this section with a minimum of 3 years documented experience.

PART 2 – PRODUCTS

A. Power Circuit Wire and Cable

1. Wire and cable shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2. Copper Conductors: Comply with NEMA WC 70/ICEA S-95-658.

3. Conductor Insulation: Comply with NEMA WC 70/ICEA S-95-658 and UL 83 for Type THHN-2/THWN-2.

4. Multiconductor Cable: Comply with NEMA WC 70/ICEA S-95-658 for armored cable, metal-clad cable, and nonmetallic-sheathed cable with ground wire.

5. Acceptable Manufacturers: Subject to compliance with requirements, provide power circuit wire and cable by one of the following, or approved equal:

   a. General Cable

   b. Houston Wire & Cable Company

   c. Okonite

   d. Southwire

B. Control Circuit Conductors

1. General: Control Circuit Conductors shall be stranded copper, XHHW-2, 600 volts, Type TC rated for cable tray use. Cable shall have corrugated aluminum sheath and shall be UL listed.

2. Multi-Conductor Control Cable: Cable shall consist of multi-conductor 14 AWG color-coded copper conductors, type MC, cross-linked polyethylene (XLPE)

insulation, listed for cable tray use, 90°C continuous rating, 130°C emergency rating, rated 600 volts, aluminum sheath, sunlight resistant, for cable tray use.

3. Comply with UL 44.

4. Acceptable Manufacturers: Subject to compliance with requirements, provide control circuit conductors by one of the following, or approved equal:

   a. Okonite, C-L-X Okoseal

C. Low Voltage Signal Cable

1. Signal cable shall be provided for instrument signal transmission, alarm, communication and any circuit operating at less than 100 volts. Cables shall be color coded black and white (or clear) for pairs or black, white and red for triads. Circuit shielding shall be provided in addition to cable shielding. Circuits for type a and b signals as specified in Section 17010, shall be provided in compliance with the instrument manufacturer's recommendations.

2. Single Analog Signal Cable: Cable shall consist of one pair or triad, 18 AWG conductors with 15 mils of 90 degree C polyvinylchloride (PVC) insulation, 4 mils nylon conduit or jacket, twisted on a 2-inch lay, and covered with a 100 percent 1.35 mil aluminum-Mylar tape shield with 20 AWG 7-strand tinned copper drain wire and a 45 mil PVC jacket overall. Cable shall have corrugated aluminum sheath, be UL listed, Type TC, rated 300 volts.

3. Multiple Analog Signal Cable: Cable shall consist of four or more pairs or triads which are made up of 16 AWG conductors with 15 mils of 90 degree C PVC insulation, 4 mils nylon jacket, twisted on a staggered lay 1-1/2 to 2-1/2 inches, and covered with a 100 percent 1.35 mil aluminum-Mylar tape shield with 22 AWG 7-strand tinned copper drain wire. Overall cable shield shall be 2.35 mil aluminum-Mylar tape with a 20 AWG 7-strand tinned copper drain wire. Cable shall have corrugated aluminum sheath, be UL listed, Type TC, 300 volts.

4. Acceptable Manufacturers: Subject to compliance with requirements, provide low voltage signal cable by one of the following, or approved equal:

   a. Okonite, C-L-X Okoseal, TYPE P-OS/SP-OS rated 105C for CT

D. Connectors and Splices

1. Description: Factory-fabricated connectors and splices of size, ampacity rating, material, type, and class for application and service indicated.

2. Solid Conductors: use 3M "Scotchlok", Ideal "Super Nut," Buchanan B-Cap, or equal.

3. Stranded Conductors No. 8 and Larger: Use T & B "Lock-Tie" connectors, Burndy Versitaps and heavy-duty connectors, O.Z. solderless connectors, or equal.

4. Control Wiring: Use crimp connectors with tools by same manufacturer and/or UL listed for connectors of all stranded conductors.

5. Retighten bolt-type connectors 24 to 48 hours after initial installation and before taping. Tape connections made with noninsulated-type connectors with rubbertype tape, one and one-half times the thickness of the conductor insulation, then cover with Scotch 33 tape.

PART 3 – EXECUTION

A. Examination

According to BICSI ITSIMM, telecommunications cables should be tested on receipt. Low-voltage wires and cables do not normally require testing before installation.

1. Test cables on receipt at Project site.

B. Preparation

1. Remove debris and moisture from the conduits, boxes, and cabinets prior to cable installation.

2. Use manufacturer-approved pulling compound or lubricant where necessary; compound used must not deteriorate conductor or insulation. Do not exceed manufacturer's recommended maximum pulling tensions and sidewall pressure values.

C. Installation

1. Comply with NECA 1 and NFPA 70.

2. All wire and cable shall be installed in raceway unless otherwise noted. Complete raceway installation between conductor and cable termination points according to Section 16130 "Raceways and Boxes" prior to pulling wire and cable.

3. Conceal cables not installed in raceway in finished walls, ceilings, and floors unless otherwise indicated.

4. Use pulling means, including fish tape, cable, rope, and basket-weave wire/cable grips, that will not damage cables or raceway.

5. Install exposed cables parallel and perpendicular to surfaces of exposed structural members, and follow surface contours where possible.

6. Support cables according to Section 16073 "Hangers and Supports for Electrical Systems."

    a. Retain one of first two subparagraphs below for UTP and optical-fiber cabling.

    b. Terminate all conductors; no cable shall contain unterminated elements. Make terminations only at indicated outlets and terminals.

    c. Cables may not be spliced.

    d. Secure and support cables at intervals not exceeding 30 inches and not more than 6 inches from cabinets, boxes, fittings, outlets, racks, frames, and terminals.

    e. Bundle, lace, and train conductors to terminal points without exceeding manufacturer's limitations on bending radii.

    f. Do not install bruised, kinked, scored, deformed, or abraded cable. Do not splice cable between termination, tap, or junction points. Remove and discard cable if damaged during installation and replace it with new cable.

    g. Pulling Cable: Comply with BICSI ITSIMM, Ch. 5, "Copper Structured Cabling Systems. Monitor cable pull tensions.

    h. Secure: Fasten securely in place with hardware specifically designed and installed so as to not damage cables.

D. Removal of Wire and Cable

1. Remove abandoned wire and cable. Abandoned wires and cables are those installed that are not terminated at equipment and are not identified for future use with a tag.

E. CONNECTIONS

1. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A-486B.

2. Make splices, terminations, and taps that are compatible with conductor material and that possess equivalent or better mechanical strength and insulation ratings than unspliced conductors.

3. Wiring at Outlets: Install conductor at each outlet, with at least 6 inches of slack.

F. Identification

1. Identify and color-code wires and cables according to Section 16075 "Electrical Identification."

2. Identify each spare conductor at each end with identity number and location of other end of conductor, and identify as spare conductor.

G. Sleeve and Sleeve-Seal Installation for Electrical Penetrations

1. Install sleeves and sleeve seals at penetrations of exterior floor and wall assemblies. Comply with requirements in Section 16130 "Raceways and Boxes."

H. Field Quality Control

1. After installing wires and cables and before electrical circuitry has been energized, test service entrance and feeder conductors for compliance with requirements.

2. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.

3. Test and Inspection Reports: Prepare a written report to record the following:

   a. Procedures used.

   b. Results that comply with requirements.

   c. Results that do not comply with requirements and corrective action taken to achieve compliance with requirements.

I. Source Quality Control

1. Cable will be considered defective if it does not pass tests and inspections.

2. Prepare test and inspection reports.

END OF SECTION

SECTION 16130

RACEWAYS AND BOXES

PART 1 – GENERAL

A. Summary

1. Section Includes:

   a. Conduit, tubing, and fittings

   b. Wireways and auxiliary gutters

   c. Surface raceways

   d. Pull and junction boxes

   e. Handholes and boxes for exterior underground cabling

B. References

ANSI C80.1	Electrical Rigid Steel Conduit
ANSI/SCTE 77	Specification for Underground Enclosure Integrity
NECA 1	Standard Practice of Good Workmanship in Electrical Construction
NECA 101	Standard for Installing Steel Conduits
NEMA FB 1	Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit and Cable Assemblies.
NEMA OS 1	Sheet-Steel Outlet Boxes, Device Boxes, Covers, and Box Supports.
NEMA OS 2	Nonmetallic Outlet Boxes, Device Boxes, Covers and Box Supports.
NEMA 250	Enclosures for Electrical Equipment (1000 Volts Maximum)
NEMA RN 1	Polyvinyl Chloride (PVC) Externally Coated Galvanized Rigid Steel Conduit and Intermediate Metal Conduit.

NEMA RV 3	Application and Installation Guidelines for Flexible and Liquidtight Flexible Metal Conduits
NEMA TC 2	Electrical Plastic Tubing and Conduit (EPC-40 and EPC-80)
NEMA TC 3	PVC Fittings for Use with Rigid PVC Conduit and Tubing
UL 5	Surface Metal Raceways and Fittings
UL 5A	Nonmetallic Surface Raceways and Fittings
UL 6	Electrical Rigid Metal Conduit – Steel
UL 50	Enclosures for Electrical Equipment, Non-Environmental Considerations
UL 94	Tests for Flammability of Plastic Materials for Parts in Devices and Appliances
UL 360	Liquid-Tight Flexible Metal Conduit
UL 514A	Metallic Outlet Boxes
UL 514B	Conduit, Tubing, and Cable Fittings
UL 514C	Nonmetallic Outlet Boxes, Flush-Device Boxes, and Covers
UL 651	Standard for Schedule 40, 80, Type EB and A Rigid PVC Conduit and Fittings
UL 797	Electrical Metallic Tubing – Steel
UL 1773	Termination Boxes

C. Action Submittals

Product Data: For conduits, surface raceways, wireways, fittings, boxes, and hinged-cover enclosures.

D. Informational Submittals

1. Coordination Drawings: Conduit routing plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of items involved:

    a. Structural members in paths of conduit groups with common supports.

2. Seismic Qualification Certificates: For enclosures, cabinets, and conduit racks and their mounting provisions, including those for internal components, from manufacturer.

E. Abbreviations

Abbreviations of conduit types used in this Section and on the Drawings are listed below.

GRS	Galvanized rigid steel conduit
EPC-40-PVC	Electrical plastic conduit, schedule 40 PVC
FMC	Flexible metal conduit
LFMC	Liquid-tight flexible metal conduit
PCS	PVC coated rigid steel conduit
PVC	Polyvinyl chloride
RNC	Rigid nonmetallic conduit

F. Delivery, Storage, and Handling

1. Protect conduit from corrosion and entrance of debris by storing above grade. Provide appropriate covering.

2. Protect PVC and PCS conduit from sunlight.

G. Raceway Application

Apply raceway products as specified below unless otherwise indicated:

1. Outdoors:

   a. Exposed Conduit: GRS.

   b. Concealed Conduit, Aboveground: GRS.

   c. Underground Conduit: EPC-40-PVC, direct buried or encased in concrete as shown on the Drawings.

   d. Connection to vibrating equipment, including transformers and hydraulic, pneumatic, electric solenoid, or motor driven equipment: LFMC**.**

e. Cabinets, Boxes, and Enclosures, above ground: NEMA 250, Type 3R.

2. Corrosive Locations, Indoors or Outdoors:

a. Raceway: PCS

b. Cabinets, Boxes, and Enclosures, above ground: NEMA 250, Type 4X stainless steel.

3. Minimum Raceway Size: 3/4-inch.

4. Raceway Fittings: Compatible with raceways and suitable for use and location.

a. Rigid and Intermediate Steel Conduit: Use threaded rigid steel conduit fittings unless otherwise indicated. Comply with NEMA FB 2.10.

b. PVC Externally Coated, Rigid Steel Conduits: Use only fittings listed for use with this type of conduit. Patch and seal all joints, nicks, and scrapes in PVC coating after installing conduits and fittings. Use sealant recommended by fitting manufacturer and apply in thickness and number of coats recommended by manufacturer.

c. EMT: Use setscrew, compression or steel cast-metal fittings. Comply with NEMA FB 2.10.

d. Flexible Conduit: Use only fittings listed for use with flexible conduit. Comply with NEMA FB 2.20.

5. Install surface raceways only where indicated on Drawings.

6. Do not use nonmetallic conduits for above ground installations.

PART 2 – PRODUCTS

A. Metal Conduits, Tubing, and Fittings

1. Listing and Labeling: Metal conduits, tubing, and fittings shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2. GRS: Comply with ANSI C80.1 and UL 6.

a. Manufacturers: Subject to compliance with requirements, provide products by one of the following, or approved equal:

i. Allied Tube and Conduit

ii. Western Tube and Conduit

iii. Wheatland Tube Company

3. PCS:

   a. Comply with NEMA RN 1.

   b. Exterior Conduit Coating Thickness: 0.040 inch.

   c. Interior Conduit Coating Thickness: 0.002 inch.

   d. Manufacturers: Subject to compliance with requirements, provide products by one of the following, or approved equal:

      i. Perma-Cote

      ii. Robroy Industries

      iii. Thomas & Betts Ocal

4. LFMC: Flexible steel conduit with PVC jacket and complying with UL 360.

   a. Manufacturers: Subject to compliance with requirements, provide products by one of the following, or approved equal:

      i. AFC Cable Systems

      ii. Electriflex

      iii. Southwire

5. Fittings for metal conduit: Comply with NEMA FB 1 and UL 514B.

   a. Fittings for EMT:

      i. Material: Steel or die cast.

      ii. Type: Setscrew or compression.

   b. Expansion Fittings: PVC or steel to match conduit type, complying with UL 651, rated for environmental conditions where installed, and including flexible external bonding jumper.

c. Coating for PCS conduit fittings: Minimum thickness of 0.040 inch, with overlapping sleeves protecting threaded joints.

B. Nonmetallic Conduits, Tubing, and Fittings

1. Listing and Labeling: Nonmetallic conduits, tubing, and fittings shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2. RNC: EPC-40-PVC complying with NEMA TC 2 and UL 651 unless otherwise indicated.

   a. Manufacturers: Subject to compliance with requirements, provide products by one of the following, or approved equal:

      i. Cantex

      ii. JM Eagle

      iii. Thomas & Betts Carlon

3. Fittings for RNC: Comply with NEMA TC 3; match to conduit or tubing type and material.

4. Solvent cements and adhesive primers shall have a VOC content of 510 and 550 g/L or less, respectively, when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

5. Solvent cements and adhesive primers shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

C. Metal Wireways and Auxiliary Gutters

1. Description: Sheet metal, complying with UL 870 and NEMA 250, Type 1, Type 3R, Type 4 and Type 12 unless otherwise indicated, and sized according to NFPA 70.

   a. Metal wireways installed outdoors shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2. Fittings and Accessories: Include covers, couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings to match and mate with wireways as required for complete system.

D. Nonmetallic Wireways and Auxiliary Gutters

1. Listing and Labeling: Nonmetallic wireways and auxiliary gutters shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2. Description: Fiberglass polyester, extruded and fabricated to required size and shape, without holes or knockouts. Cover shall be gasketed with oil-resistant gasket material and fastened with captive screws treated for corrosion resistance. Connections shall be flanged and have stainless-steel screws and oil-resistant gaskets.

3. Description: PVC, extruded and fabricated to required size and shape, and having snap-on cover, mechanically coupled connections, and plastic fasteners.

4. Fittings and Accessories: Couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings shall match and mate with wireways as required for complete system.

5. Solvent cements and adhesive primers shall have a VOC content of 510 and 550 g/L or less, respectively, when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

6. Solvent cements and adhesive primers shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

E. Surface Raceways

1. Listing and Labeling: Surface raceways and tele-power poles shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2. Surface Metal Raceways: GRS with snap-on covers complying with UL 5.

3. Surface Nonmetallic Raceways: Two- or three-piece construction, complying with UL 5A, and manufactured of rigid PVC. Product shall comply with UL 94 V-0 requirements for self-extinguishing characteristics.

F. Boxes

1. Sheet Metal Outlet and Device Boxes: Comply with NEMA OS 1 and UL 514A.

2. Cast-Metal Outlet and Device Boxes: Comply with NEMA FB 1, ferrous alloy, Type FD, with gasketed cover.

3. Nonmetallic Outlet and Device Boxes: Comply with NEMA OS 2 and UL 514C.

4. Small Sheet Metal Pull and Junction Boxes: NEMA OS 1.

5. Cast-Metal Access, Pull, and Junction Boxes: Comply with NEMA FB 1 and UL 1773, galvanized, cast iron with gasketed cover.

6. Box extensions used to accommodate new building finishes shall be of same material as recessed box.

7. Device Box Dimensions: 4 inches square by 2-1/8 inches deep.

8. Hinged-Cover Enclosures: Comply with UL 50 and NEMA 250, Type 1, Type 3R, Type 4 and Type 12 with continuous-hinge cover with flush latch unless otherwise indicated.

   a. Metal Enclosures: 316 Stainless Steel, finished inside and out with manufacturer's standard enamel.

   b. Interior Panels: Galvanized Steel; all sides finished with manufacturer's standard enamel.

9. Hinged door in front cover with flush latch and concealed hinge.

10. Key latch to match panelboards.

11. Metal barriers to separate wiring of different systems and voltage.

G. Handholes and Boxes for Exterior Underground Wiring

1. General Requirements for Handholes and Boxes:

   a. Boxes and handholes for use in underground systems shall be designed and identified as defined in NFPA 70, for intended location and application.

   b. Boxes installed in wet areas shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

   c. Pull boxes shall be precast type designed and manufactured for heavy traffic loading with heavy duty, hot dipped galvanized steel, traffic type covers.

d. All pull boxes shall have bolt-down covers complete with fiber gaskets for a weather-tight fit.

e. All joints between precast sections shall be sealed.

2. Polymer-Concrete Handholes and Boxes with Polymer-Concrete Cover: Molded of sand and aggregate, bound together with polymer resin, and reinforced with steel, fiberglass, or a combination of the two.

a. Standard: Comply with ANSI/SCTE 77.

b. Configuration: Designed for flush burial with open bottom unless otherwise indicated.

c. Cover: Weatherproof, secured by tamper-resistant locking devices and having structural load rating consistent with enclosure and handhole location.

d. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.

e. Cover Legend: Molded lettering, "ELECTRIC."

f. Conduit Entrance Provisions: Conduit-terminating fittings shall mate with entering ducts for secure, fixed installation in enclosure wall.

PART 3 – EXECUTION

A. Examination and Preparation

1. Verify outlet locations and routing and termination locations of raceway prior to rough-in.

2. Coordinate mounting heights, orientation and locations of outlets mounted above counters, benches, and backsplashes.

3. Arrange conduit stub-ups so curved portions of bends are not visible above finished floor or grade.

B. General Raceway Installation

1. Install work in accordance with state and municipality standards. Comply with NECA 1 and NECA 101 for installation requirements except where requirements on Drawings or in this Section are more stringent. Comply with NFPA 70 limitations for types of raceways allowed in specific occupancies and number of floors.

2. Ground and bond raceway and boxes in accordance with Section 16060 “Grounding and Bonding.”

3. Keep raceways at least 6 inches away from parallel runs of flues and steam or hot-water pipes. Install horizontal raceway runs above water and steam piping.
4. Install no more than the equivalent of three 90-degree bends in any conduit run except for control wiring conduits, for which fewer bends are allowed.

5. Support conduit within 12 inches of changes in direction. Support conduit within 12 inches of enclosures to which attached.

6. Conceal conduit and EMT within finished walls, ceilings, and floors unless otherwise indicated. Install conduits parallel or perpendicular to building lines.

7. Raceways Embedded in Slabs:

    a. Run conduit larger than 1-inch trade size, parallel or at right angles to main reinforcement. Where at right angles to reinforcement, place conduit close to slab support. Secure raceways to reinforcement at maximum 10-foot intervals.

    b. Arrange raceways to cross building expansion joints at right angles with expansion fittings.

    c. Do not embed threadless fittings in concrete.

    d. Change from Type EPC-40-PVC to GRS or PCS before rising above floor.

8. Threaded Conduit Joints, Exposed to Wet, Damp, Corrosive, or Outdoor Conditions: Apply listed compound to threads of raceway and fittings before making up joints. Follow compound manufacturer's written instructions.

9. Coat field-cut threads on PVC-coated raceway with a corrosion-preventing conductive compound prior to assembly.

10. Raceway Terminations at Locations Subject to Moisture or Vibration: Use insulating bushings to protect conductors including conductors smaller than 4 AWG.

11. Terminate threaded conduits into threaded hubs or with locknuts on inside and outside of boxes or cabinets. Install bushings on conduits up to 1-1/4-inch trade size and insulated throat metal bushings on 1-1/2-inch trade size and larger conduits terminated with locknuts. Install insulated throat metal grounding bushings on service conduits.

12. Install pull wires in empty raceways. Use polypropylene or monofilament plastic line with not less than 200-lb tensile strength. Leave at least 12 inches of slack at

each end of pull wire. Cap underground raceways designated as spare above grade alongside raceways in use.

13. Surface Raceways:

    a. Install surface raceway with a minimum 2-inch radius control at bend points.

    b. Secure surface raceway with screws or other anchor-type devices at intervals not exceeding 48 inches and with no less than two supports per straight raceway section. Support surface raceway according to manufacturer's written instructions. Tape and glue are not acceptable support methods.

14. Install raceway sealing fittings at accessible locations according to NFPA 70 and fill them with listed sealing compound. For concealed raceways, install each fitting in a flush steel box with a blank cover plate having a finish similar to that of adjacent plates or surfaces.

15. Install devices to seal raceway interiors at accessible locations. Locate seals so no fittings or boxes are between the seal and the following changes of environments. Seal the interior of all raceways at the following points:

    a. Where conduits pass from warm to cold locations, such as boundaries of refrigerated spaces.

    b. Where an underground service raceway enters a building or structure.

    c. Where otherwise required by NFPA 70.

16. Expansion-Joint Fittings:

    a. Install in each run of above ground conduit that is located where environmental temperature change may exceed 30 degrees and that has straight-run length that exceeds 25 feet.

    b. Install type and quantity of fittings that accommodate temperature change listed for each of the following locations:

        i. Outdoor Locations Not Exposed to Direct Sunlight: 125°F temperature change.

        ii. Indoor Spaces Connected with Outdoors without Physical Separation: 125°F temperature change.

        iii. Attics: 135°F temperature change.

c. Install fittings that provide expansion and contraction for at least 0.00041 inch per foot of length of straight run per degree F of temperature change for PVC conduits.

d. Install expansion fittings at all locations where conduits cross building or structure expansion joints.

e. Install each expansion-joint fitting with position, mounting, and piston setting selected according to manufacturer's written instructions for conditions at specific location at time of installation. Install conduit supports to allow for expansion movement.

17. Flexible Conduit Connections: Comply with NEMA RV 3. Use a maximum of 72 inches of flexible conduit for recessed and semi-recessed luminaires, equipment subject to vibration, noise transmission, or movement; and for transformers and motors.

C. Installation of Underground Conduit

1. Direct-Buried Conduit:

a. Excavate trench bottom to provide firm and uniform support for conduit. Prepare trench bottom for conduit less than 6 inches in nominal diameter.

b. After installing conduit, backfill and compact. Start at tie-in point, and work toward end of conduit run, leaving conduit at end of run free to move with expansion and contraction as temperature changes during this process. Firmly hand tamp backfill around conduit to provide maximum supporting strength. After placing controlled backfill to within 12 inches of finished grade, make final conduit connection at end of run and complete backfilling with normal compaction.

c. Install manufactured duct elbows for stub-up at poles and equipment and at building entrances through floor unless otherwise indicated. Encase elbows for stub-up ducts throughout length of elbow.

d. Install manufactured rigid steel conduit elbows for stub-ups at poles and equipment and at building entrances through floor.

i. Couple steel conduits to ducts with adapters designed for this purpose, and encase coupling with 3 inches of concrete for a minimum of 12 inches on each side of the coupling.

ii. For stub-ups at equipment mounted on outdoor concrete bases and where conduits penetrate building foundations, extend steel conduit horizontally a

minimum of 60 inches from edge of foundation or equipment base. Install insulated grounding bushings on terminations at equipment.

e. Underground Warning Tape: Comply with requirements in Section 16075 "Electrical Identification."

2. Conduit in duct banks: Concrete encased. See Section 16137 for requirements.

D. Installation of Underground Handholes and Boxes

1. Install handholes and boxes level and plumb and with orientation and depth coordinated with connecting conduits to minimize bends and deflections required for proper entrances.

2. Unless otherwise indicated, support units on a level bed of crushed stone or gravel, graded from 1/2-inch sieve to No. 4 sieve and compacted to same density as adjacent undisturbed earth.

3. Elevation: In paved areas, set boxes so cover surface will be flush with finished grade. In other areas, set boxes so covers are 1 inch above finished grade.

4. Field-cut openings for conduits according to enclosure manufacturer's written instructions. Cut wall of enclosure with a tool designed for material to be cut. Size holes for terminating fittings to be used, and seal around penetrations after fittings are installed.

5. Set floor boxes level and flush with finished floor surface.

E. Sleeve and Sleeve-Seal Installation for Electrical Penetrations

1. Install sleeves and sleeve seals at penetrations of exterior floor and wall assemblies.

F. Protection

1. Protect coatings, finishes, and cabinets from damage and deterioration.

a. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.

b. Repair damage to PVC coatings or paint finishes with matching touchup coating recommended by manufacturer.

END OF SECTION

SECTION 16135

CABINETS AND ENCLOSURES

PART 1 - GENERAL

A. Summary

1. Includes enclosures to house electrical controls, instruments, terminal blocks, and similar equipment.

B. Action Submittals

1. Product Data: For each type of product.

2. Shop Drawings: For custom enclosures and cabinets. Include plans, elevations, sections, and attachment details.

C. Application

1. Unless otherwise noted, provide cabinet and enclosure types as follows in accordance with NEMA 250.

    a. General indoor locations: NEMA 1

    b. General outdoor locations: NEMA 3R

    c. Wet or damp indoor and outdoor locations: NEMA 4

    d. Corrosive locations: NEMA 4X

PART 2 - PRODUCTS

A. Acceptable Manufacturers

1. Subject to compliance with requirements, provide products by one of the following, or equal:

    a. Carlon

    b. Hoffman / Pentair

B. Enclosure Design Requirements

1. Enclosures to house electrical controls, instruments, terminal blocks, and similar equipment shall be compatible with the conduit system being used.

2. Cabinets and enclosures installed in wet locations shall be listed for use in wet locations.

3. Accessory feet where required for freestanding equipment.

4. Nonmetallic cabinets shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

C. NEMA 4X Stainless Steel Enclosures

1. Fabricate enclosures from 14-gauge steel with seams that are continuously welded. Doors shall have full-length piano hinges with the door removable by pulling the stainless steel hinge pin.

2. Provide a rolled lip around 3 sides of the door and around all sides of the enclosure opening.

3. Attach gasket with oil-resistant adhesive and hold it in place with steel retaining strips.

4. Hardware, such as clamps, screws, and hinge pins, hasp and staple shall be provided for padlocking.

5. Provide a print pocket for each enclosure.

6. Do not paint NEMA 4X stainless steel enclosures. Door fronts shall be ground smooth. Print pockets and interior panels shall be unfinished brushed stainless steel.

D. Control Panels

1. Control panels shall be floor-mounted NEMA 4X gasketed enclosures constructed from 14-gage formed steel throughout. Access door shall have continuous hinges with sealing clamps. All exposed edges and welds on the enclosure shall be ground smooth.

2. The exterior of the enclosure shall be painted with rust inhibiting primer and two coats of epoxy beige color paint.

3. The interior shall be provided with a formed 12-gage subpanel for attaching surface-mounted components. The interior shall be painted with two coats of epoxy white paint.

PART 3 - EXECUTION

A. Installation

1. Install panels and enclosures in accessible locations and provide working clearances that meet NEC requirements for electrical equipment.

B. Panel Devices and Component Mounting

1. General: All components, except those on the front panels, shall be mounted behind on fixed or swing-out panels; terminal blocks for field connections shall be mounted on fixed channels located near the bottom of the sections but clear of the conduit entry area. Fixed panels shall be located so as not to prevent access within the cabinets to other components, wiring, and terminal blocks on fixed panels or front panels.

END OF SECTION

SECTION 16137

UNDERGROUND DUCT BANKS

PART 1 – GENERAL

A. Summary

1. Includes underground duct banks and accessories.

B. Quality Assurance

1. Reference Standards: Comply with applicable provisions and recommendations of the National Electrical Code and National Electrical Safety Code.

C. Submittals

1. Shop Drawings: Submit for approval the following:

    a. Layouts showing the proposed routing of duct banks and the locations of manholes, handholes and areas of reinforcement.

    b. Profiles of duct banks showing crossings with piping and other underground systems.

    c. Cross sections of each duct bank segment.

    d. Installation procedures.

2. Record Drawings: Include the actual routing of underground duct runs on Record Drawings, dimensioned and to scale.

PART 2 – PRODUCTS

A. Duct Bank

1. Duct: Provide conduit for duct banks as specified in Section 16130 “Raceway and Boxes.”

2. Duct spacers: Nonmetallic saddle type by one of the following, or equal:

    a. Cantex

    b. Carlon Snap-Loc

c. Osburn Associates

PART 3 – EXECUTION

A. Coordination

1. Duct bank routing on the Contract Drawings is diagrammatic. Coordinate installation with piping and other underground systems and structures and locate clear of interferences.

2. Review installation procedures under other Sections and coordinate the Work that must be installed with or attached to underground duct banks.

3. Manufacturers and suppliers of the equipment and materials specified herein shall be required to review and satisfy all relevant requirements of other Sections of the Contract Documents and the requirements of the Contract Drawings. The Contractor, manufacturer, supplier, fabricator and/or subcontractors furnishing and/or installing equipment, materials, services and specialties associated with this Section shall fully coordinate their efforts to avoid potential claims that are based on failure to review relevant Contract Documents, including the Contract Drawings.

4. The Contractor shall furnish and install all labor, equipment, materials, appurtenances, specialty items and services not provided by the Contractor's manufacturers, suppliers, fabricators and/or subcontractors but required for complete and operable systems.

B. Installation

1. Excavate, backfill, and compact duct bank trenches in accordance with Section 02220.

2. Install concrete encasement in accordance with Section 03110.

END OF SECTION

SECTION 16150

LOW VOLTAGE ELECTRIC MOTORS

PART 1 – GENERAL

A. Summary

1. Section includes materials, testing, and installation of squirrel cage induction type electric motors rated 600 volts or less, accessories, and appurtenances.

B. Related Work Specified Elsewhere

1. Motor Control Centers: 16443.

2. Low Voltage Solid State Starters: 16481.

C. References

ANSI/NEMA MG 1 Motors and Generators

D. Action Submittals

1. Product Data: For each type of product.

2. Submit shop drawings in accordance with the General Provisions and Section 16010 “General Electrical Requirements.”

3. Include the following motor data at minimum:

   a. Name of motor manufacturer.

   b. Motor type and model number.

   c. Dimension drawings, including weight of the motor.

   d. Nominal horsepower.

   e. NEMA design.

   f. Enclosure.

   g. Frame size.

   h. Winding insulation class and temperature rise.

i. Voltage, phase, and frequency ratings.

j. Full load speed.

k. Full load current at rated horsepower for application voltage.

l. Service factor.

m. Power factor and efficiency at full load, 3/4 and 1/2 load.

n. Space heater voltage and full load amperes.

o. Bearing data with recommended lubricants for relubricatable type bearings.

p. Provide written verification that motor is inverter duty type and that insulated bearings are included. Indicate minimum speed at which motor may be operated for the driven machinery.

q. Dimensions and location of all conduit termination boxes.

r. Quantity and size of conduit openings for each conduit box. Openings shall accommodate the quantity and size of conduits indicated on the Drawings.

s. Winding Temperature Setpoints: Alarm, Shutdown

t. Bearing Temperature Setpoints: Alarm, Shutdown

4. Submit copies of certified test reports for factory no load current and speed, locked rotor current, and high potential tests.

5. Submit certification that selected motor:

a. Is capable of satisfactory performance under the intended load.

b. Is suitable for operation with the proposed variable speed drive unit.

E. Informational Submittals

Field quality-control reports.

PART 2 – PRODUCTS

A. Acceptable Manufacturers

1. Subject to compliance with requirements, provide products by one of the following, or approved equal:

a. Baldor

b. US Motors

B. General Requirements

1. Identical Motors: Electric motors driving identical machines shall be identical.

2. Maximum Motor Loading: Maximum motor loading shall in all cases be equal to nameplate horsepower rating or less, exclusive of service factor and as verified with the approved submittal data of the driven machinery.

3. Minimum Motor Horsepower: All motors shall be sized to carry continuously all loads that may be imposed through their full range of operation. The motor horsepower shall be not less than the estimated minimum specified for each driven machine. If the estimated minimum horsepower specified is not adequate to satisfy the foregoing restrictions or any other requirements of these Specifications, the motor with the required horsepower shall be supplied at no additional cost to the Owner. In addition, any changes caused by increase in motor horsepower shall be made by the Contractor at no additional cost to the Owner; such changes may involve circuit breakers, magnetic starters, motor feeder conductors, conduit sizes, etc.

4. Exempt Motors: Motors that are for valve operators, submersible pumps, or motors that are an integral part of standard manufactured equipment, i.e., non-NEMA mounting, common shaft with driven element, part of domestic or commercial use apparatus, may be excepted from these Specifications to the extent that such variation reflects a necessary condition of motor service or a requirement of the driven equipment.

C. Design Requirements

1. Motors shall be squirrel cage induction type rated to operate at 460 volts AC, 60 Hz, three phase. Comply with ANSI/NEMA MG 1.

2. Horsepower: As indicated on the Drawings.

   a. Motor sizes indicated in the Specifications and on the Drawings are minimum sizes. Provide motors, electrical circuits, and equipment of ample horsepower capacity to operate the load without exceeding rated nameplate horsepower, full-load current at rated nameplate voltage, or overheating at maximum load capacity.

3. Speed: 1800 rpm, 4-pole

4. Service Factor: 1.15 at 40 degrees Celsius ambient

5. Torque and Power of Motors:

    a. Provide motors that develop sufficient torque for required service throughout acceleration range at voltage 10 percent less than motor nameplate rating.

    b. Provide motors that develop sufficient torque when started using reduced voltage starters.

6. Provide premium efficiency type motors, inverter duty rated

7. Manufactured with cast iron frames in accordance with NEMA MG 1, and in accordance with requirements specified in this Section.

8. Temperature Rating and Altitude Requirements: Where not otherwise specified or indicated on the Drawings, provide motors that are rated suitable for continuous operation in 40 degrees Celsius ambient temperature at project site altitude.

9. Temperature rise under full load: Not to exceed that for Class B insulation (80 degrees Celsius).

10. Motors shall be NEMA Design B except where driven load characteristics requires other than normal starting torque.

    a. Starting kilovolt ampere per horsepower (locked rotor) are not to exceed values specified in NEMA MG 1-10.37.

D. Insulation

1. Motor leads and insulating material: Insulated leads with non-wicking, non-hygroscopic material. Comply with NEMA 1-1.65.

2. Provide Class F insulation with Class B temperature rise.

3. Resistant to attack by moisture, acids, alkalies, and mechanical or thermal shock.

E. Grounding

1. Provide grounding lugs inside conduit boxes for motor frame grounding.

F. Motor Accessories

1. Hardware: Type: 316 stainless steel.

2. Non-Reversing Ratchet: Pump motors shall be provided with a non-reversing ratchet.

3. Motors over 50 HP shall be capable of reduced voltage starting with 50% to 80% of rated voltage applied.

G. Motor Bearings

1. Antifriction, re-greasable, and filled initially with grease suitable for ambient temperatures to 40 degrees Celsius.

2. Suitable for intended application and have AFBMA B-10 rating life of 60,000 hours or more.

3. Fit bearings with easily accessible grease supply, flush, drain, and relief fittings using extension tubes where necessary.

4. The thrust bearings shall be able to handle 150% of the maximum calculated down-thrust with a rated B-10 life of 5 years as defined by AFBMA standards.

5. Provide two pole motors with ball type bearings.

6. Provide insulated bearings to prevent circulating shaft currents.

H. Conduit Boxes

1. Cast iron.

2. Provide gaskets between following:

   a. Frames and conduit boxes.

   b. Conduit boxes and box covers.

   3. Provide oversized conduit box.

PART 3 – EXECUTION

A. Factory Tests

1. Include testing of:

   a. No load current.

   b. Locked rotor current.

c. Winding resistance.

d. High potential.

2. Perform in accordance with NEMA Standards.

3. Furnish copies of test reports.

B. Installation

1. Install motors according to manufacturer instructions.

END OF SECTION

SECTION 16200

POWER GENERATION

PART 1 – GENERAL

A. Description

This Section outlines the electrical work for permanent emergency stand-by power generation equipment and all the installation, including foundations and complete wiring, and forms a part of all other Specification Sections. The Contractor shall furnish and completely install the fully automatic operating electric generating plant as indicated and specified. The electric generating plant shall be capable of producing a continuous standby source of power during normal power interruption.

B. Submittals

1. Shop Drawings: Equipment descriptive data, operation and installation data, and shop drawings fully detailing each electric generating plant installation shall be submitted to the Owner for approval, including details for anchor bolts, vibration isolator mountings, silencer, exhaust pipe installations, sub-base fuel tank, load bank, connections for fuel, connections for power and control wiring, plans, elevations, equipment arrangements, diagrams, dimensions, weights, anchorage calculations to generator pad, locations for conduits and nameplate inscriptions.

2. Instruction Manuals: The Contractor shall obtain data from the electric generating plant manufacturer and submit instruction manuals that outline the complete description, installations and operations of each unit.

    a. Contents: Each manual shall have an index listing the contents. Information in the manuals shall include not less than (a) general, introduction and overall equipment description, purpose, functions, and operation, (b) specifications, (c) installation instruction, procedures, sequences, and precautions, including tolerances for level, horizontal, and vertical alignment, (d) grouting requirements including grout spaces and materials, (e) list showing lubricants, approximate quantities needed per year, and recommended lubrication intervals, (f) start-up and beginning operation procedures, (g) operational procedures, (h) shutdown procedures, (I) short and long term inactivation procedures, (j) maintenance, calibration, and repair instruction, (k) parts lists and spare parts recommendations, (l) prices of spare parts and maintenance materials, (m) lists of all special tools, instruments, accessories, and special lifting and handling devices required for periodic maintenance, repair, adjustment, and calibration, and (n) other information as may be specified or required for approval.

    b. Format and Binding: Drawings and pictorials shall be used to illustrate the text as necessary to fully present the information. Where the information covers a family of similar items, the inapplicable information shall be struck out or the applicable portions identified by heavily weighted arrows, boxes, or circles. Each manual shall be bound in sturdy covers labeled to indicate the equipment to which it applies. Manuals less than one inch thick shall be bound in standard three-ring binders; others shall have sturdy covers secured with removable fasteners and, when more than two

inches thick, shall be bound in locking-bar post binders with rigid covers.

c. Manual Submittals: Submittals shall include two copies of each manual, one of which will be returned to the Contractor marked to show the required corrections or approval. When approved, the Contractor shall deliver four copies of each approved manual to the Owner.

3. Equipment Data: For equipment under this Section not covered by the above instruction manuals, the Contractor shall submit complete technical and catalog data giving specified information on performance and operating curves and data, ratings, capacities, characteristics, efficiencies, and other data to fully illustrate and describe the items as may be specified or required for the Owner's approval. Contractor shall include the name, address and phone number of the service organization for the electric generating equipment.

4. Tools and Accessories: The Contractor shall furnish and deliver all special tools, instruments, accessories, and special lifting and handling devices shown in the approved instruction manuals. Unless otherwise specified or directed by the Owner, the items shall be delivered to the Owner, with the Contractor's written transmittal accompanying each shipment, in the manufacturers' original containers labeled to describe the contents and the equipment for which it is furnished. The Contractor shall deliver a copy of each transmittal to the Owner for record purposes.

5. Certified Data: Submit to the Owner certified copies of reports for each electric generating plant.

   a. Test Reports: Copies of the factory test reports shall be certified by the manufacturer and submitted to the Owner

   b. Installation and Operation Reports: Copies of the Manufacturers Certified Report for the equipment installations and operations shall be submitted to the Owner.

6. Manufacturer's Specification: Submit manufacturer's standard printed data to show equipment warranty, guaranteed fuel consumption at 25%, 50%, 75%, and full load including exhaust temperature at these same loads, engine brake horsepower, air pollutant emission rates, including but not limited to, nitrogen oxides, carbon monoxides, sulfur oxides, hydrocarbons, and dry particulate matter, and generator efficiency. The manufacturer's data shall include generator insulation class, generator transient and subtransient reactance and generator telephone influence factor.

7. Generator ratings, data and analysis calculations to verify the use of the generator to supply constant speed drive units for the motor/pump loads indicated on the Drawings.

8. The submittals shall include construction drawings to show detail of installation of anchor bolts in concrete pad complete with specification of material, rating of bolts and related data to verify the anchor design to meet 2016 California Building Code, ASCE 7-10 minimum design loads for buildings and other structures and ACI 318-14. The fuel tank shall be considered a "vessel" as referenced in section 15.7.5 of ASCE 7-10.

9. The following submittals and specific information shall be provided.

Air Emissions Data:

a. The Contractor shall submit all engine exhaust emissions data necessary to apply and pay for a Permit to Construct and Permit to Operate from the South Coast Air Quality Management District (SCAQMD).

b. This data shall include the effects of proposed engine modifications, if any, to meet the SCAQMD permit and operating conditions.

c. Provide, if required, additional emissions data on short notice in response to Agency demands following their review of the permit application.

10. Provide permitting per Project Specifications. When the selected equipment is an SCAQMD pre-approved provide SCAQMD certification.

C. Codes and Standards

The generator set shall conform to the requirements of the following codes and standards:

1. CSA C22.2, No. 14 – M91 Industrial Control Equipment.

2. CSA 282, 1989 Emergency Electrical Power Supply for Buildings.

3. FCC Part 15, Subpart B.

4. IEC8528 part 4. Control Systems for Generator Sets.

5. IEC Std 801.2, 801.3, and 801.5 for susceptibility, conducted, and radiated electromagnetic emissions.

6. IEEE446 – Recommended Practice for Emergency and Standby Power Systems for Commercial and Industrial Applications.

7. IEEE587 for voltage surge resistance.

8. Mil Std 461D – 1993. Military Standard, Electromagnetic Interference Characteristics.

9. Mil Std. 462D – 1993. Military Standard, Measurement of Electromagnetic Interference Characteristics.

10. NEMA ICS10-1993 – AC Generator sets.

D. Factory Tests

1. Static Tests. Set up and static test the entire unit including control panels and accessories. Verify that all safety devices and control circuits are properly installed and connected.

2. Operating Tests. Test the engine generator unit per applicable portions of ASME PTC-17, NEMA MG1, and NFPA-110. Provide fuel consumption tests.

3. Duration Tests. Test at full rated load for four (4) hours, followed by two (2) hours operating from full load to zero load. Test at 0.80 power factor. Testing at unity power factor is not acceptable.

4. Records. Provide test records as required by the applicable test codes. Also provide the average starting time for not less than 10 cold starts. Indicate the test cell temperatures and the number of cranking cycles before successful start.

5. Test Report. Submit the factory test report for review as specified elsewhere. The engine generator shall not be shipped from the manufacturer's facility until the factory test report submittal is approved.

6. Factory test reports shall show voltage, frequency and recovery time values when load is applied: from 0 to half load, from 0 to full load, from full load to 0 loads. Testing shall include manual override of governor to reduce speed to half normal while unit is fully loaded, then releasing override and recording time to recover normal speed. Voltage shall be recorded during test. The test report shall indicate the maximum horsepower that the engine generator can start across the line without stalling. The test report shall include the torsional vibration test. A certified report indicating the maximum noise rating of engine generator in dBA, at 25%, 50% and 100% load.

E. Job Conditions

The exact space requirements for all required equipment shall be determined by the approved equipment for the project. The Drawings indicate the major components that shall be included in the electric generating systems. Should there be a need to deviate from the Drawings and Specifications, all proposed changes shall be detailed in writing and submitted to the Owner for approval.

F. Quality Assurance

1. Requirements. All the equipment and materials, including their fabrication, assembly, testing and installations shall conform to the applicable codes and standards that are listed in Section 16010-"General Electrical Requirements". The equipment shall be approved by the Air Quality Management District (AQMD).

2. In addition, the installations shall comply with applicable requirements of National Fire Protection Association No. 37, Stationary Combustion Engines and Gas Turbines.

G. Product Delivery, Storage, and Handling

The electric generating plant shall be delivered to the site as a complete factory-assembled unit including structural base, with factory-applied weather protection. Units shall be stored under cover or shall be fully protected until installed.

H. Guarantee

The standby electric generating units, and all other equipment items provided under this Section, shall be guaranteed by the Contractor against defects in material, workmanship, or

operation for a period of one year after final acceptance by the Owner. In addition, the units shall bear the manufacturer's warranty for a period of 5 years from the date of installation.

PART 2 – MATERIALS

A. Generator

The generator shall provide emergency standby power as indicated and specified Unit, including all components, shall be new, fabricated, assembled complete, tested and shipped by the manufacturer of the generator so there is one source of supply and responsibility. The performance of the generating set shall be certified by an independent testing laboratory as to the set's full power rating, stability and voltage and frequency regulation. It shall have fixed louvers for the air intake and discharge with screens to prevent birds and rodents from entering the manufacturer supplied sound attenuated enclosure.

The electric plant shall be designed to start automatically on normal power failure and supply emergency power to all indicated loads. Components that are required to satisfactorily complete the generating systems and not described in this Section shall be provided by the Contractor. Diesel engine-driven plants shall be manufactured by Cummins, Caterpillar, Generac or approved equal. The plants shall be fabricated and assembled by a manufacturer with a minimum of 5 years experience in producing electric generating plants of similar size.

1. Ratings:

    a. Capacity. Each single electric generating unit shall have continuous *175* kilowatt standby rating at 0.80 power factor.

    b. Electrical Characteristics. The electric generating plants shall provide emergency power at 277/480 volts, three phase and 60 hertz as shown on the drawings.

    c. The rating of the engine shall be based upon a satisfactory operation at an elevation to 3,300 feet above sea level, an atmospheric temperature of 95 degrees Fahrenheit and a barometric pressure of 28.25 inches of mercury.

2. Engines: The engine shall be standby continuous duty, four cycle, water cooled with mounted radiator, fan and pump, and shall be equipped with all the required components that provides satisfactory operation. The engine shall be fueled with diesel fuel No. 2 as required by SCAQMD and shall have oil filters, oil pumps, water pumps and air filters. Engine shall have rigid supports and heavy structural base. The base shall be installed level, anchored to the concrete foundation and finished with grout. The grout shall be non-shrink type with a minimum compressive strength of 4,000 pounds per square inch after 28 days.

    a. Engine Controls: The engine driven electric generating unit shall contain a complete engine start-stop control, which automatically starts the engine on closing contact and stops the engine on opening contact. Once started, the engine shall remain in operation for a minimum, adjustable period of 5 to 45 minutes. A cranking limiter shall be provided to open the starting circuit in approximately 30 to 90 seconds if the engine is not started within that time. Engine controls for each engine shall also include a four-position selector switch or equivalent (TEST-OFF-MANUAL-AUTOMATIC)

complete with wiring. High engine temperature, low oil pressure, low tank fuel supply, overcrank and overspeed devices that shut down the engine and close the fuel line shall be provided with local signal lights, an audible alarm and terminals for remote alarm wiring. A switch shall be provided to silence the audible alarm until the alarm condition has been corrected. After the alarm condition has been corrected, the audible alarm shall sound until the switch is moved to the normal position.

b. Engine Instruments: The engine generator control panel shall contain a fuel oil pressure gauge, lubricating oil pressure gauge, engine temperature gauge, and battery charge rate ammeter.

c. Engine Fuel System: The engine shall be provided with a fuel system integral with the engine. The fuel system on the engine shall have the required heaters, pipes, valves, fittings, filters, and pressure gauge, pump and provision for external fuel pipe connection.

d. Engine Lubrication System: The engine shall be provided with a complete pressure lubrication system. The system integral with the engine shall be complete with all equipped pipes, valves, heaters, fittings, pump, pressure gauge, filters and other necessary components to complete the system.

e. Governor Controls: The governor shall be a load sensing electric actuator electronic solid state type Barber Colman with magnetic speed pick-up, and a mechanical governor for backup. The electronic governor shall incorporate isochronous operation. The governor shall be adjustable for speed droop of 0% (isochronous) to 5%. A remote speed adjustment switch shall be mounted in the control panel. Governor controls shall be provided complete for satisfactory operation.

f. Cooling System: An engine-mounted radiator with engine driven fan shall be provided for the cooling system. Radiator shall be at 110% rated load in 100°F ambient temperature against 0.5 inches of water as maybe imposed by enclosure. The engine driven cooling water pump shall have ample capacity to circulate the required flow of engine jacket water through the radiator to remove the heat rejected from the engine to the jacket water and to maintain the water temperatures as recommended by the manufacturer.

g. Antifreeze: The engine cooling system shall contain an environmentally - friendly, long life solution of propylene glycol or equivalent for protection to minus 10ºF.

h. Jacket Water Heater: A unit mounted thermal circulation type water heater incorporating a thermostat and switch shall be provided to maintain engine jacket water to 90 degrees Fahrenheit in an ambient temperature of plus 10ºF. The heater shall be single phase, 120 volts; 60 hertz rated minimum 1500 watts.

3. Generators: The generator shall be brushless, revolving field type, 277/480 volts, three phase, 60 hertz with tandem rotating permanent magnet generator (PMG), rotating exciter with rotating rectifiers and solid state voltage regulator. The stator shall be directly connected to the engine flywheel housing, and the rotor shall be driven through a semiflexible driving flange to ensure permanent alignment. The insulation shall be Class F as defined in NEMA MG1-1.65 with a temperature rise of 70ºC above ambient. The

stator winding shall be arranged for "wye" connection with both line and neutral leads of each 3-phase winding brought out into the terminal box on the generator frame. The generator shall be mounted on a common base with the engine, and shall be equipped with the required supports and hardware.

4. Performance: The frequency regulation shall not exceed three hertz from no load to full load. Voltage regulation shall be within plus or minus 2 percent of rated voltage, from no load to full rated load. The instantaneous voltage dip shall be less than 15 percent of rated voltage when full three-phase load and rated power factor is applied to the generator. Recovery to stable operation shall occur within 3 seconds. Stable or steady state operation is defined as operation with terminal voltage remaining constant within plus or minus one percent of the rated voltage. A rheostat shall provide a minimum of plus or minus 5 percent voltage adjustment from the rated voltage. Temperature rise shall be within the NEMA MG1-22.40 standard.

5. Generator Control Panels: The control panels shall be totally metal enclosed, assembled, wired, tested and shock mounted on the engine driven electric generating plant by the manufacturer. The panel shall contain the main circuit breaker, as shown on the Drawings and a digital control panel complete with programming and functions as follows:

    a. Circuit Breaker: The main emergency power circuit breaker shall be enclosed, molded case, thermal-magnetic, trip free, manual, quick-make, quick-break, 600 volt, three pole, with current trip ratings as shown on the Drawings.

    b. Generator Mounted Control Panel: Provide a generator mounted control panel for complete control and monitoring of the engine and generator set functions. Panel shall include automatic start/stop operation; adjustable cycle cranking, digital AC metering (0.5% true rms accuracy) with phase selector switch, digital engine monitoring, shutdown sensors and alarms with horn and reset, adjustable cooldown timer and emergency stop push-button. Panel shall incorporate self-diagnostics capabilities and fault logging. Critical components shall be environmentally sealed to protect against failure from moisture and dirt. Control panel shall be UL 508A Listed.

        i. Digital Readouts:

            a) Engine oil pressure

            b) Coolant temperature

            c) Engine RPM

            d) System DC volts

            e) Engine running hours

            f) Generator AC volts

            g) Generator AC amps

            h) Generator frequency

i) kW meter

j) Percentage of rated power

k) KVA meter

l) KVAr meter

m) Power factor meter

n) KWHR meter

ii. Alarms

a) Low oil pressure

b) High water temperature

c) Low coolant level

d) Overspeed

e) Overcrank

f) Emergency stop depressed

g) Approaching high coolant temperature

h) Approaching low oil pressure

i) Low coolant temperature

j) Low voltage in battery

k) Control switch not in auto. position

l) Low fuel main tank

m) Battery charger ac failure

n) High battery voltage

o) EPS supplying load

p) Alarm generator running

q) Spare

iii. Programmable Control Panel: Provide programmable protective relay functions

inside the control panel to include the following:

a) Undervoltage

b) Overvoltage

c) Overfrequency

d) Underfrequency

e) Reverse power

f) Overcurrent (phase and total)

g) KW level (overload)

h) Three spare LED's

i) Four spare inputs

iv. Customer Communication Module: The communications module (CCM) shall provide bi-directional communication between a personal computer (PC) or other RS-232 type device, and up to five additional control panels. CCM output shall be compatible for either direct connection or connection via a Hayes compatible modem. The module shall include a digital display to indicate the status of communications and fault conditions. The adaptor shall be microprocessor based 100% solid sate, and comply with FCC Class A requirements for computer equipment. It shall operate in -40ºC to 70ºC ambients and be suitable for switchgear or similar mounting. The CCU shall allow a remote user to:

a) Control:
   - engine start/stop
   - fault conditions reset
   - idle/rated speed switch for electronic governors
   - circuit breaker shunt trip
   - cool down
   - timer override

b) Monitor:
   - engine oil pressure
   - coolant temperature
   - speed
   - service hours
   - generator three-phase voltage and current
   - frequency
   - battery voltage
   - position of engine control switch
   - all alarms
   - shutdowns
   - three customer inputs

- diagnostic codes

c. Meter Switches: Phase selector switches with standard block knobs shall be panel type, heavy duty, non-illuminated with four positions (off-A-B-C).

d. Indicating Lights: Indicating lights shall be transformer type, 60 hertz with 6-volt lamps and color caps with lamps removable without entering the generating panel.

e. Wiring: Each panel wiring shall be complete to all equipment and terminal blocks. Alarm contacts shall be wired to terminals for connections to remote wiring. Wire shall be copper, single conductor, 600 volt, 90 degrees centigrade minimum. Provide the neutral and equipment grounding as indicated, specified and required.

f. Nameplates: Provide all the required nameplates as specified in Section 16010- "General Electrical Requirements." The nameplates shall have inscriptions that identify the equipment and all its positions.

6. Generator Set Mounting: Provide the equipment concrete foundations as shown on the Drawings, and as required. Each electric generating plant shall be equipped with vibration isolators as required and mounted on a welded structural steel base. Cross framing shall be used for additional stiffening. The entire welded steel base shall be mounted on sub-base fuel tank with steel spring or elastomeric isolators and the sub-base fuel tank shall be anchored to the concrete generator pad.

   Furnish submittals of the of the vibration isolators including drawing layout of the isolation system and steel spring or elastomeric isolator product sheets.

7. Battery and Charger

   a. Battery: The electric generating plant shall be provided with a heavy duty, 24 vdc lead acid starting battery. The battery voltage shall be compatible with the starting system. The battery shall have sufficient capacity for two and one half minutes total cranking time without recharging. Provide the battery racks and required cables.

   b. Battery Charger: A current limiting 24-vdc battery charger shall be furnished to automatically recharge the battery. The charger shall float at 2.17 volts per cell and equalize at 2.33 volts per cell, and shall be equipped with overload protection, silicon diode full wave rectifier, voltage surge suppressor, DC ammeter and fused AC power supply.

8. Exhaust System: The exhaust system shall be complete and shall include a flexible exhaust connection, exhaust piping and muffler located on the exterior of the factory sound attenuated enclosure. The exhaust system shall be provided with a means to prevent rain from entering the exhaust outlet, and shall include a condensate trap and drain valve in the exhaust piping.

   a. Flexible Exhaust Section: The flexible exhaust section shall consist of convoluted, seamless tube, without joints or packing. The section shall be capable of absorbing vibration from the engine or turbine and of compensating for the expansion and contraction caused by thermal expansion of exhaust gases.

b. Exhaust Muffler (Silencer): The exhaust muffler shall be mounted outside of the factory sound attenuated enclosure and shall be adequately supported. The muffler shall be capable of reducing the exhaust sound level to 67 dBA at 23 feet. The muffler shall be zinc coated and insulated on the outside to maintain temperatures lower than 120 degrees Fahrenheit.

9. Sub-Base Fuel Tank

a. Provide a sub-base fuel tank for the generator set, sized to allow full load operation of the generator set for 24 hours. Usable tank capacity shall be 350 gallons (80% of total tank capacity, 440 gallon nominal tank capacity). The fuel tank shall be UL 142 listed and labeled. Installation shall be in compliance with NFPA 37.

b. The fuel tank shall be double walled, steel construction and include the following features:

i. Emergency tank and basin vents.

ii. Mechanical level gauge.

iii. Fuel supply and return lines, connected to the generator set with flexible fuel lines as recommended by the engine manufacturer and in compliance with UL 2200 and NFPA 37 requirements.

iv. Leak detection provisions, wired to the generator set control for local and remote alarm indication.

v. High and low fuel level float switches to indicate fuel level. Wire switches to generator control for local and remote indication of fuel level.

vi. Fuel level transmitter: Provide an ultrasonic level transmitter capable of continuous fuel level measurement with a 4-20mA output signal as shown on the Drawings. Level transmitter shall be as manufactured by Flowline, or approved equal.

vii. Minimum 5-gallon capacity spill container at fuel fill point.

viii. Basin drain.

ix. Integral lifting provisions.

c. All tank and tank equipment materials shall be chemically inert to diesel fuel products (i.e. Diesel Fuel No. 2). Threaded fittings shall be made of material that is consistent with the UL label. All openings, including leak detection tube, shall be from the top only.

10. Sound Attenuated Enclosure

a. Provide factory sound attenuated enclosure, non-walk in enclosure that will limit sound pressure levels to 75 dBA at 23 feet, measured from the edge of the sound enclosure.

b. Enclosure material shall be aluminum panels assembled on aluminum frame. Install enclosure and generator set on top of sub-base fuel tank.

c. Enclosure shall include side service panels, air intake louvers and control panel access doors. All panels and doors are key lockable and side service panels shall have two (2) locking points.

d. Enclosure roof shall be peaked to aid in rain runoff.

e. Enclosure to be structurally stable in 100 mph wind.

f. Support roof load of 40 psf.

g. Fiberglass or mineral wool insulation to provide minimum R11 insulation in side walls and roof for thermal transmission, sound attenuation material can be in addition to or include the thermal insulation.

h. Enclosure shall be approved for installation in local seismic zone.

i. Exterior shall receive a factory corrosion resistant exterior coating and all fasteners, latches and hinges shall be stainless steel.

j. Enclosure and generator shall be delivered with all connection, conduits and wiring complete.

11. Load Bank with Controls:

a. The load bank shall be a complete system with all necessary power, controls, wiring, and devices to provide a functional system to maintain a controlled, fixed load on the generator during both exercising and emergency use conditions.

b. The load bank system equipment shall be mounted and installed by the manufacturer as an integral part of the engine generator unit.

c. The adjustable resistor load bank, capable of absorbing 60% minimum of the full generator output, shall be mounted on the exhaust side of the engine radiator within the enclosure for the engine-generator. Load bank resistive elements shall be stainless steel alloy mounted on ceramic insulators. The load bank shall be capable of continuous operation.

d. The load bank assembly shall consist of at least three individual sections (steps) of resistors, each step shall be controlled by contactor connected to the generator output.

e. The load control panel shall consist of devices and components to control the contactors for the step loads in accordance with the manufacturer's standard design. The panel, mounted within the engine-generator enclosure, shall have the following features:

1. A MANUAL-OFF-AUTOMATIC mode selector switch
2. Individual load step ON/OFF switches
3. Individual load step ON indicating light

f. In AUTO mode, the minimum generator load level shall be the sum of the individual load step switches that are ON. As the generator output increases due to the addition of plant load, a generator output current transformer senses the increased load in order to signal the load control to automatically remove a load step when the load increase is greater than a load step.

g. In MANUAL mode, the individual load step switches are used to add or remove load as needed.

h. During conditions when normal power fails and the engine generator is being exercised, an external dry contact for loss of normal power shall cause all load steps to be removed. After a time delay to allow the engine generator to stabilize and when in the AUTO mode, the steps shall be added as needed to meet the load level setting. In MANUAL mode, load steps would be added manually as needed.

12. Accessories: All accessories including hardware that shall be needed for the complete installation and proper operation of each electric generating plant shall be furnished.

a. Transfer Switch: The automatic transfer switches shall be installed with the motor control centers and as specified in Section 16446.

b. Screening shall be provided for all 1/4" mesh, openings into the generator housing, screening shall be stainless steel.

c. Provide communication between generator panel to local PLC for:

i. Water Temperature

ii. Oil Pressure

iii. Fuel Level

iv. Output Voltage

v. Battery Voltage

Manufacturer shall provide all conversion instruments needed for communication. Communication shall transmit all signals shown in Section 16200 2.1.D.

13. Finish: Metal surfaces shall be finished with Coating System No. C-2 as specified in Section 09900.

PART 3 – EXECUTION

A. Installation

Provide the concrete foundation. Install engine driven electric generating plant in accordance the approved submittals. All fuel, coolant, exhaust and electrical conduit must have flexible connections so that vibration is not transmitted along these lines. Install all required wiring for the components, including interconnections, for each electric generating plant.

B. Field Testing

Prior to final acceptance, a field test shall be conducted on the engine-generator set by simulating a normal treatment plant power failure. The Contractor shall fill the fuel tank before start-up. The Contractor, a representative of the engine-generator supplier, and the Owner's Representative will be present. Checks shall be made of fuel use, KW output, voltage regulation, and automatic operation of the unit. The Contractor shall be responsible for the proper conduct of the tests and to furnish equipment required to make the tests.

1. The Contractor shall provide all materials, supplies, and instruments required for the tests, including, but not limited to, fuel and all metering equipment.

2. Load test banks shall be moved to the site and the entire engine-generator unit, including cooling system and controls shall be tested for eight continuous hours.

3. If the equipment of engine-generator set and accessories do not operate in a satisfactory manner, the trouble shall be located and promptly repaired by the Contractor and all cost thereof shall be borne by the Contractor.

4. An analysis of the actual field test will determine the acceptability of the unit. If the unit does not perform in conformity with these Specifications and/or the certified test data, the Contractor shall be required to remove, replace, and restore the equipment to full compliance with these Specifications at his expense.

5. Upon completion of the test, final adjustment shall be made to the equipment, fuel and oil filters shall be replaced, and belt tensions checked.

END OF SECTION

SECTION 16429

SWITCHBOARDS

PART 1 – GENERAL

A. Summary

1. Section includes free-standing, deadfront type switchboards for use with AC circuits rated 600 volts and less.

B. References

ASCE/SEI 7	Minimum Design Loads for Buildings and Other Structures
ANSI C39.1	Electrical Analog Indicating Instruments
IEEE C12.1	Code for Electricity Metering
IEEE C57.12.28	Standard for Pad-Mounted Equipment – Enclosure Integrity
NEMA 250	Enclosures for Electrical Equipment (1000 Volts Maximum)
NEMA PB 2	Deadfront Distribution Switchboards
NEMA PB 2.1	Proper Handling, Installation, Operation and Maintenance of Deadfront Switchboards Rated 600 Volts or Less
UL 50	Cabinets and Boxes
UL 414	Standard for Meter Sockets
UL 869A	Reference Standard for Service Equipment
UL 891	Switchboards

C. PERFORMANCE REQUIREMENTS

1. Seismic Performance: Switchboards shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.

2. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."

D. Action Submittals

1. The Power System Analysis Report as specified in Section 16025 shall be approved by the Engineer prior to submitting electrical equipment shop drawings.

2. Product Data: Submit switchboard and ATS product data sheets for approval.

3. Shop Drawings: Manufacturer's approval drawings for equipment, including:

    a. Floor plan

    b. Elevations

    c. Single line diagram and schematic diagrams

    d. Nameplate schedule

    e. Assembly ratings as applicable:

        i. Voltage

        ii. Continuous current

        iii. Short circuit current

    f. Cable terminal sizes

E. Informational Submittals

1. Coordination Drawings: Floor plans, drawn to scale, showing dimensioned layout, required working clearances, and required area above and around MCCs where pipe and ducts are prohibited. Show MCC layout and relationships between electrical components and adjacent structural and mechanical elements. Show support locations, type of support, and weight on each support. Indicate field measurements.

2. Seismic Qualification Certificates: For MCCs, accessories, and components, from manufacturer.

3. Product certificates.

4. Source quality-control reports.

5. Field quality-control reports.

F. Closeout Submittals

1. Operation and maintenance data

G. Quality Assurance

1. Testing Agency Qualifications: Member Company of NETA or an NRTL.

2. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

3. Comply with NFPA 70.

H. Delivery, Storage, and Handling

1. Deliver in 60-inch maximum width shipping splits, individually wrapped for protection, and mounted on shipping skids.

2. Store in clean, dry space. Maintain factory wrapping or provide additional canvas or plastic cover to protect units from dirt, water, construction debris, and traffic.

3. Handle in accordance with NEMA ICS 2.3. Lift only with lugs provided. Handle carefully to avoid damage to switchboard components, enclosure, and finish.

I. Environmental Requirement

1. Conform to NEMA ICS 2 service conditions during and after installation of switchboards.

PART 2 – MATERIALS

A. Acceptable Manufacturers

1. Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:

   a. Eaton / Cutler Hammer

   b. General Electric

   c. Schneider Electric / Square D

   d. Siemens

   e. ABB

B. General Requirements for Switchboards

1. Comply with NEMA PB 2 and UL 891.

2. Provide switchboard with voltage, continuous current, and short circuit current rating as indicated on the drawings.

3. Switchboard shall consist of the required number of vertical sections bolted together to form a rigid assembly. The sides and rear shall be covered with removable bolt-on covers. All edges of front covers or hinged front panels shall be formed. Provide adequate ventilation within the enclosure.

C. Bus

1. Provide a silver plated copper bus, standard size.

2. Bolted connections, accessible from the front.

3. A copper ground bus shall be firmly secured to each vertical section structure and shall extend the entire length of the switchboard.

D. Wiring/Terminations

1. Small wiring, necessary fuse blocks and terminal blocks within the switchboard shall be furnished as required. Control components mounted within the assembly, such as fuse blocks, relays, pushbuttons, switches, etc., shall be suitably marked for identification corresponding to appropriate designations on manufacturer's wiring diagrams.

2. Mechanical-type terminals shall be provided for all line and load terminations suitable for copper or aluminum cable rated for 75°C of the size as indicated on the drawings.

3. Lugs shall be provided in the incoming line section for connection of the main grounding conductor. Additional lugs for connection of other grounding conductors shall be provided as indicated on the drawings.

4. All control wire shall be type SIS, bundled and secured with nylon ties. Insulated locking spade terminals shall be provided for all control connections, except where saddle type terminals are provided integral to a device. All current transformer secondary leads shall first be connected to conveniently accessible short-circuit terminal blocks before connecting to any other device. All groups of control wires leaving the switchboard shall be provided with terminal blocks with suitable numbering strips. Provide wire markers at each end of all control wiring.

E. Enclosures

1. Unless otherwise indicated, provide freestanding steel enclosures in accordance with Section 16135 “Cabinets and Enclosures.”

2. Enclosure Finish: Factory-applied finish in manufacturer's standard gray finish over a rust-inhibiting primer on treated metal surface.

PART 3 – EXECUTION

A. Installation

1. Floor Mounting: Install Switchboards on 4-inch nominal thickness concrete base as shown on the Drawings.

   a. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of concrete base.

   b. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.

   c. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.

   d. Install anchor bolts to elevations required for proper attachment to supported equipment.

2. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.

3. Contractor shall install all equipment per the manufacturer’s instructions, contract drawings, and all applicable codes and standards.

4. Ground and bond switchboards in accordance with Section 16060 “Grounding and Bonding.”

5. Comply with NEMA PB 2.1 and NECA 1.

B. Identification

1. Comply with requirements in Section 16075 “Electrical Identification" for identification of switchboard, switchboard components, and control wiring.

a. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs.

b. Label switchboard and each cubicle with engraved nameplate.

C. Adjusting

1. The Contractor shall perform field adjustments of the protective devices as required to place the equipment in final operating condition. The settings shall be in accordance with the approved protective device evaluation study and protective device coordination study.

2. Necessary field settings of devices, adjustments and minor modifications to equipment to accomplish conformance with an approved short circuit and protective device coordination study shall be carried out by the Contractor at no additional cost to the owner.

END OF SECTION

SECTION 16442

PANELBOARDS

PART 1 – GENERAL

A. Summary

Section includes distribution panelboards, lighting and appliance branch-circuit panelboards, and mini power centers.

B. References

NEMA PB 1	Panelboards
UL 67	Standard for Panelboards

C. Performance Requirements

1. Seismic Performance: Panelboards shall withstand the effects of earthquake motions determined according to SEI/ASCE 7.

    a. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."

D. Action Submittals

1. The Power System Analysis Report as specified in Section 16025 shall be approved by the Engineer prior to submitting electrical equipment shop drawings.

2. Product Data: For each type of product indicated.

    a. Shop Drawings: For each panelboard and related equipment.

    b. Include dimensioned plans, elevations, sections, and details. Show tabulations of installed devices, equipment features, and ratings.

    c. Detail enclosure types and details for types other than NEMA 250, Type 1.

    d. Detail bus configuration, current, and voltage ratings.

    e. Short-circuit current rating of panelboards and overcurrent protective devices.

    f. Include evidence of NRTL listing for series rating of installed devices.

g. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.

h. Include wiring diagrams for power, signal, and control wiring.

i. Include time-current coordination curves for each type and rating of overcurrent protective device included in panelboards.

E. Informational Submittals

1. Seismic Qualification Certificates: Submit certification that panelboards, overcurrent protective devices, accessories, and components will withstand seismic forces.

2. Field quality-control reports.

3. Panelboard schedules for installation in panelboards.

F. Closeout Submittals

1. Operation and maintenance data.

G. Quality Assurance

1. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2. Comply with NEMA PB 1.

3. Comply with NFPA 70.

H. Warranty

1. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace transient voltage suppression devices that fail in materials or workmanship within specified warranty period.

   a. Warranty Period: One year from startup date.

I. Extra Materials

1. Furnish two of each panelboard key.

PART 2 – PRODUCTS

A. Acceptable Manufacturers

1. Subject to compliance with requirements, provide products by one of the following:

    a. Eaton / Cutler Hammer

    b. General Electric

    c. Schneider Electric / Square D

    d. Siemens

    e. ABB

B. General Requirements for Panelboards

1. Fabricate and test panelboards according to IEEE 344 to withstand seismic forces

2. Enclosures: Flush- and surface-mounted cabinets, as indicated on the Drawings.

    a. NEMA rating: as indicated on the Drawings.

    b. Front: Secured to box with concealed trim clamps. For surface-mounted fronts, match box dimensions; for flush-mounted fronts, overlap box.

    c. Hinged Front Cover: Entire front trim hinged to box and with standard door within hinged trim cover.

    d. Directory Card: Inside panelboard door, mounted in transparent card holder.

3. Incoming Mains Location: Top and bottom.

4. Phase, Neutral, and Ground Buses: Tin-plated aluminum or Hard-drawn copper, 98 percent conductivity.

5. Conductor Connectors: Suitable for use with conductor material and sizes.

    a. Material: Tin-plated aluminum or Hard-drawn copper, 98 percent conductivity.

    b. Main and Neutral Lugs: Compression or Mechanical type.

    c. Ground Lugs and Bus Configured Terminators: Compression or Mechanical type.

d. Feed-Through Lugs: Compression or Mechanical type, suitable for use with conductor material. Locate at opposite end of bus from incoming lugs or main device.

6. Subfeed (Double) Lugs: Compression or Mechanical type suitable for use with conductor material. Locate at same end of bus as incoming lugs or main device.

7. Service Equipment Label: NRTL labeled for use as service equipment for panelboards with one or more main service disconnecting and overcurrent protective devices.

8. Future Devices: Mounting brackets, bus connections, filler plates, and necessary appurtenances required for future installation of devices.

9. Panelboard Short-Circuit Current Rating: Rated for series-connected system with integral or remote upstream overcurrent protective devices and labeled by an NRTL. Include size and type of allowable upstream and branch devices, and listed and labeled for series-connected short-circuit rating by an NRTL.

10. Panelboard Short-Circuit Current Rating: Fully rated to interrupt symmetrical short-circuit current available at terminals.

C. Distribution Panelboards

1. Panelboards: NEMA PB 1, power and feeder distribution type.

2. Doors: Secured with vault-type latch with tumbler lock; keyed alike.

3. Mains: Circuit breaker.

4. Branch Overcurrent Protective Devices: For Circuit-Breaker Frame Sizes 125 A and Smaller: Bolt-on circuit breakers.

5. Branch Overcurrent Protective Devices: For Circuit-Breaker Frame Sizes Larger than 125 A: Bolt-on circuit breakers; plug-in circuit breakers where individual positive-locking device requires mechanical release for removal.

6. Branch Overcurrent Protective Devices: Fused switches.

D. Disconnecting and Overcurrent Protective Devices

1. Molded-Case Circuit Breaker (MCCB): Comply with UL 489, with interrupting capacity to meet available fault currents.

a. Thermal-Magnetic Circuit Breakers: Inverse time-current element for low-level overloads, and instantaneous magnetic trip element for short circuits. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.

b. Adjustable Instantaneous-Trip Circuit Breakers: Magnetic trip element with front-mounted, field-adjustable trip setting.

c. Electronic trip circuit breakers with rms sensing; field-replaceable rating plug or field-replicable electronic trip; and the following field-adjustable settings:

i. Instantaneous trip.

ii. Long- and short-time pickup levels.

iii. Long- and short-time time adjustments.

iv. Ground-fault pickup level, time delay, and I^2t response.

d. Current-Limiting Circuit Breakers: Frame sizes 400 A and smaller; let-through ratings less than NEMA FU 1, RK-5.

e. GFCI Circuit Breakers: Single- and two-pole configurations with Class A ground-fault protection (6-mA trip).

f. Ground-Fault Equipment Protection (GFEP) Circuit Breakers: Class B ground-fault protection (30-mA trip).

g. Arc-Fault Circuit Interrupter (AFCI) Circuit Breakers: Comply with UL 1699; 120/240-V, single-pole configuration.

2. Molded-Case Circuit-Breaker (MCCB) Features and Accessories:

a. Standard frame sizes, trip ratings, and number of poles.

b. Lugs: Compression style, suitable for number, size, trip ratings, and conductor materials.

c. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HID for feeding fluorescent and high-intensity discharge (HID) lighting circuits.

d. Ground-Fault Protection: Integrally mounted relay and trip unit with adjustable pickup and time-delay settings, push-to-test feature, and ground-fault indicator.

e. Handle Padlocking Device: Fixed attachment, for locking circuit-breaker handle in off position.

f. Handle Clamp: Loose attachment, for holding circuit-breaker handle in on position.

3. Fused Switch: NEMA KS 1, Type HD; clips to accommodate specified fuses; lockable handle.

E. Accessory Components and Features

1. Portable Test Set: For testing functions of solid-state trip devices without removing from panelboard. Include relay and meter test plugs suitable for testing panelboard meters and switchboard class relays.

PART 3 – EXECUTION

A. Installation

1. Receive, inspect, handle, store and install panelboards and accessories according to NEMA PB 1.1.

2. Comply with mounting and anchoring requirements

3. Mount panelboard cabinet plumb and rigid without distortion of box. Mount recessed panelboards with fronts uniformly flush with wall finish and mating with back box.

4. Install overcurrent protective devices and controllers not already factory installed.

   a. Set field-adjustable, circuit-breaker trip ranges.

5. Install filler plates in unused spaces.

6. Stub four 1-inch empty conduits from panelboard into accessible ceiling space or space designated to be ceiling space in the future. Stub four 1-inch empty conduits into raised floor space or below slab not on grade.

7. Arrange conductors in gutters into groups and bundle and wrap with wire ties.

8. Comply with NECA 1.

B. Identification

1. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs complying with Section 16075 "Electrical Identification."

2. Create a directory to indicate installed circuit loads and incorporating Owner's final room designations. Obtain approval before installing. Revise directory to reflect circuiting changes to balance phase loads. Use a computer or typewriter to create directory; handwritten directories are not acceptable.

3. Panelboard Nameplates: Label each panelboard with a nameplate complying with requirements for identification specified in Section 16075 "Electrical Identification."

4. Device Nameplates: Label each branch circuit device in distribution panelboards with a nameplate complying with requirements for identification specified in Section 16075 "Electrical Identification."

C. Field Quality Control

1. Perform tests and inspections.

2. Acceptance Testing Preparation:

   a. Test insulation resistance for each panelboard bus, component, connecting supply, feeder, and control circuit.

   b. Test continuity of each circuit.

3. Tests and Inspections:

   a. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.

   b. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.

4. Panelboards will be considered defective if they do not pass tests and inspections.

5. Prepare test and inspection reports, including a certified report that identifies panelboards included and that describes scanning results. Include notation of deficiencies detected, remedial action taken and observations after remedial action.

END OF SECTION

SECTION 16443

MOTOR CONTROL CENTERS

PART 1 – GENERAL

A. Summary

1. Section includes motor control centers (MCC) for use with AC circuits rated 600 volts and less, having the following factory-installed components:

    a. Incoming main lugs and overcurrent protective devices.

    b. Reduced-voltage, solid-state controllers.

    c. Instrumentation.

    d. Auxiliary devices.

B. Related Work Specified Elsewhere

1. Panelboards: 16442.

2. Low Voltage Transformers: 16461.

3. Low Voltage Solid State Starters: 16481.

C. References

IEEE C57.12.28	Standard for Pad-Mounted Equipment – Enclosure Integrity
NEMA 250	Enclosures for Electrical Equipment (1000 Volts Maximum)
UL 845	Motor Control Centers

D. Performance Requirements

1. Seismic Performance: MCCs shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.

    a. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."

E. Action Submittals

1. The Power System Analysis Report as specified in Section 16025 shall be approved by the Engineer prior to submitting electrical equipment shop drawings.

2. Product Data: For each type of controller and each type of MCC.

3. Shop Drawings: For each MCC, manufacturer's approval drawings as defined in UL 845. In addition to requirements specified in UL 845, include dimensioned plans, elevations, and sections; and conduit entry locations and sizes, mounting arrangements, and details, including required clearances and service space around equipment.

    a. Show tabulations of installed devices, equipment features, and ratings.

    b. Schematic wiring Diagrams: For power, signal, and control wiring for each installed controller.

    c. Nameplate legends.

    d. Vertical and horizontal bus capacities.

    e. Features, characteristics, ratings, and factory settings of each installed unit.

F. Informational Submittals

1. Coordination Drawings: Floor plans, drawn to scale, showing dimensioned layout, required working clearances, and required area above and around MCCs where pipe and ducts are prohibited. Show MCC layout and relationships between electrical components and adjacent structural and mechanical elements. Show support locations, type of support, and weight on each support. Indicate field measurements.

2. Seismic Qualification Certificates: For MCCs, accessories, and components, from manufacturer.

3. Product certificates.

4. Source quality-control reports.

5. Field quality-control reports.

G. Closeout Submittals

1. Operation and maintenance data.

H. Quality Assurance

1. Testing Agency Qualifications: Member Company of NETA or an NRTL.

2. Source Limitations: Obtain MCCs and controllers of a single type from single source from single manufacturer.

3. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

4. Comply with NFPA 70.

5. IEEE Compliance: Fabricate and test enclosed controllers according to IEEE 344 to withstand seismic forces.

PART 2 – PRODUCTS

A. Acceptable Manufacturers

1. Subject to compliance with requirements, provide products by Rockwell Automation Arc Resistant MCC, no equal.

2. General Requirements for MCCs: Comply with NEMA ICS 18 and UL 845

B. Functional Features

1. Description: Modular arrangement of main units, controller units, control devices, feeder-tap units, instruments, metering, auxiliary devices, and other items mounted in vertical sections of MCC. MCC shall be of arc-resistant design.

2. Future Units: Compartments fully bused and equipped with guide rails or equivalent, ready for insertion of drawout units.

3. Spare Units: Installed in compartments indicated "spare."

C. Incoming Mains

1. Incoming Mains Location: bottom.

2. Main Lugs Only: Conductor connectors suitable for use with conductor material and sizes.

   a. Material: Hard-drawn copper, 98 percent conductivity

   b. Main and Neutral Lugs: Compression type.

3. MCCB: Comply with UL 489, with interrupting capacity to meet available fault currents.

    a. Thermal-Magnetic Circuit Breakers: Inverse time-current element for low-level overloads, and instantaneous magnetic trip element for short circuits. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.

    b. Electronic trip circuit breakers with rms sensing; field-replaceable rating plug or field-replicable electronic trip; and the following field-adjustable settings:

        i. Instantaneous trip.

        ii. Long- and short-time pickup levels.

        iii. Long- and short-time time adjustments.

        iv. Ground-fault pickup level, time delay, and I^2t response.

    c. MCCB Features and Accessories:

        i. Standard frame sizes, trip ratings, and number of poles.

        ii. Lugs: Compression style, suitable for number, size, trip ratings, and conductor material.

        iii. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HID for feeding fluorescent and high-intensity discharge (HID) lighting circuits.

        iv. Ground-Fault Protection: Integrally mounted relay and trip unit with adjustable pickup and time-delay settings, push-to-test feature, and ground-fault indicator.

        v. Shunt Trip: 120-V trip coil energized from separate circuit, set to trip at 55 percent of rated voltage.

        vi. Auxiliary Contacts: Two SPDT switches with "a" and "b" contacts; "a" contacts mimic circuit-breaker contacts, "b" contacts operate in reverse of circuit-breaker contacts.

D. External Overload Reset Push Button

1. External overload reset push button shall be provided on the outer door of the MCC compartment. The operator shall be able to reset the overload without opening of the compartment door.

E. Instrumentation

1. Instrument Transformers: IEEE C57.13, NEMA EI 21.1, and the following:

    a. PTs: IEEE C57.13; 120 V, 60 Hz, single secondary; disconnecting type with integral fuse mountings. Burden and accuracy shall be consistent with connected metering and relay devices.

    b. Current Transformers: IEEE C57.13; 5 A, 60 Hz, secondary; bar or window type; single secondary winding and secondary shorting device. Burden and accuracy shall be consistent with connected metering and relay devices.

    c. CPTs: Dry type, mounted in separate compartments for units larger than 3 kVA.

2. Multifunction Digital-Metering Monitor: Microprocessor-based unit suitable for three- or four-wire systems and with the following features:

    a. Listed or recognized by a nationally recognized testing laboratory.

    b. Inputs from sensors or 5-A current-transformer secondaries, and potential terminals rated to 600 V.

    c. Switch-selectable digital display of the following values with the indicated maximum accuracy tolerances:

        i. Phase Currents, Each Phase: Plus or minus 1 percent.

        ii. Phase-to-Phase Voltages, Three Phase: Plus or minus 1 percent.

        iii. Phase-to-Neutral Voltages, Three Phase: Plus or minus 1 percent.

        iv. Three-Phase Real Power (Megawatts): Plus or minus 2 percent.

        v. Three-Phase Reactive Power (Megavars): Plus or minus 2 percent.

        vi. Power Factor: Plus or minus 2 percent.

        vii. Frequency: Plus or minus 0.5 percent.

viii. Accumulated Energy, Megawatt Hours: Plus or minus 2 percent; accumulated values unaffected by power outages up to 72 hours.

d. Mounting: Display and control unit flush or semiflush mounted in instrument compartment door.

3. Ammeters, Voltmeters, and Power-Factor Meters: ANSI C39.1.

a. Meters: 4-inch diameter or 6 inches square, flush or semiflush, with antiparallax 250-degree scale and external zero adjustment.

b. Voltmeters: Cover an expanded-scale range of nominal voltage plus 10 percent.

4. Instrument Switches: Rotary type with off position.

a. Voltmeter Switches: Permit reading of all phase-to-phase voltages and phase-to-neutral voltages where a neutral is included.

b. Ammeter Switches: Permit reading of current in each phase and maintain current-transformer secondaries in a closed-circuit condition at all times.

F. MCC Control Power

1. Control Circuits: 120-V ac, supplied through secondary disconnecting devices from CPT.

G. Enclosures

1. Enclosures: Freestanding steel cabinets unless otherwise indicated. NEMA 250, **Type 1** unless otherwise indicated to comply with environmental conditions at installed location.

2. Space Heaters: Factory-installed electric space heaters of sufficient wattage in each vertical section to maintain enclosure temperature above expected dew point.

a. Space-Heater Control: Thermostats to maintain temperature of each section above expected dew point.

b. Space-Heater Power Source: Transformer, factory installed in MCC.

3. Enclosure Finish: Factory-applied finish in manufacturer's standard gray finish over a rust-inhibiting primer on treated metal surface.

4. Compartments: Modular; individual lift-off doors with concealed hinges and quick-captive screw fasteners. Interlocks on units requiring disconnecting means

in off position before door can be opened or closed, except by operating a permissive release device.

5. Interchangeability: Compartments constructed to allow for removal of units without opening adjacent doors, disconnecting adjacent compartments, or disturbing operation of other units in MCC; same size compartments to permit interchangeability and ready rearrangement of units, such as replacing three single units with a unit requiring three spaces, without cutting or welding.

6. Wiring Spaces:

    a. Vertical wireways in each vertical section for vertical wiring to each unit compartment; supports to hold wiring in place.

    b. Horizontal wireways in bottom and top of each vertical section for horizontal wiring between vertical sections; supports to hold wiring in place.

H. Auxiliary Devices

1. General Requirements for Control-Circuit and Pilot Devices: NEMA ICS 5; factory installed in controller enclosure cover unless otherwise indicated.

    a. Push Buttons, Pilot Lights, and Selector Switches: **Standard** duty type.

        i. Push Buttons: Recessed Unguarded types; maintained contact unless otherwise indicated.
        ii. Pilot Lights: LED types; push to test.

        iii. Selector Switches: Rotary type.

    b. Elapsed Time Meters: Heavy duty with digital readout in hours; nonresettable.

    c. Meters: Panel type, 2-1/2-inch minimum size with 90- or 120-degree scale and plus or minus 2 percent accuracy with selector switches having an off position.

2. Reversible NC/NO contactor auxiliary contact(s).

3. Control Relays: Auxiliary and adjustable solid-state time-delay relays.

4. Phase-Failure, Phase-Reversal, and Undervoltage and Overvoltage Relays: Solid-state sensing circuit with isolated output contacts for hard-wired connections. Provide adjustable undervoltage, overvoltage, and time-delay settings.

5. Space heaters, with NC auxiliary contacts, to mitigate condensation in enclosures installed outdoors or in unconditioned interior spaces subject to humidity and temperature swings.

6. Terminals for connecting power factor correction capacitors to the load side of overload relays.

I. Characteristics and Ratings

1. Wiring: NEMA ICS 18, Class I, Type B, for starters above Size 3.

2. Wiring: NEMA ICS 18, Class II Type B-D, for starter Size 3 and below.

3. Control and Load Wiring: Factory installed, with bundling, lacing, and protection included. Provide flexible conductors for No. 8 AWG and smaller, for conductors across hinges, and for conductors for interconnections between shipping units.

4. Nominal System Voltage: 480Y/277 V, three phase, four wire.

5. Nominal System Voltage: 208/120 V, three phase, four wire.

6. Short-Circuit Current Rating for Each Unit: Fully rated; 42 kA.

7. Short-Circuit Current Rating of MCC Fully rated with its main overcurrent device; 42 kA.

8. Environmental Ratings:

    a. Ambient Temperature Rating: Not less than 0 deg F and not exceeding 120 deg F, with an average value not exceeding 95 deg F over a 24-hour period.

    b. Ambient Storage Temperature Rating: Not less than minus 4 deg F and not exceeding 140 deg F.

    c. Humidity Rating: Less than 95 percent (noncondensing).

    d. Altitude Rating: Not exceeding 3300 feet if MCC includes solid-state devices.

9. Main-Bus Continuous Rating: 600 A.

10. Horizontal and Vertical Bus Bracing (Short-Circuit Current Rating): Match MCC short-circuit current rating.

11. Main Horizontal and Equipment Ground Buses: Uniform capacity for entire length of MCC's main and vertical sections. Provide for future extensions from both ends.

12. Vertical Phase and Equipment Ground Buses: Uniform capacity for entire usable height of vertical sections, except for sections incorporating single units.

13. Phase and Neutral Bus Material: Hard-drawn copper of 98 percent conductivity, silver plated.

14. Neutral Buses: 50 percent of the ampacity of phase buses unless otherwise indicated, equipped with compression connectors for outgoing circuit neutral cables.

15. Ground Bus: Minimum size required by UL 845 hard-drawn copper of 98 percent conductivity, equipped with compression connectors for feeder and branch-circuit equipment grounding conductors.

16. Front-Connected, Front-Accessible MCCs:

    a. Main Devices: Drawout mounted.

    b. Controller Units: Drawout and fixed mounted.

    c. Feeder-Tap Units: fixed mounted.

    d. Sections front and rear aligned.

17. Pull Box on Top of MCC:

    a. Adequate ventilation to maintain temperature in pull box within same limits as MCC.

    b. Set back from front to clear circuit-breaker removal mechanism.

    c. Removable covers forming top, front, and sides. Top covers at rear easily removable for drilling and cutting.

    d. Insulated bottom of fire-resistive material with separate holes for cable drops into MCC.

    e. Cable supports arranged to facilitate cabling and adequate to support cables, including those for future installation.

18. Future Devices: Equip compartments with mounting brackets, supports, bus connections, and appurtenances at full rating of unit.

J. Source Quality Control

1. MCC Testing: Inspect and test MCCs according to requirements in NEMA ICS 18.

2. MCCs will be considered defective if they do not pass tests and inspections.

3. Prepare test and inspection reports.

PART 3 – EXECUTION

A. Installation

1. Floor-Mounting Controllers: Install MCCs on 4-inch nominal thickness concrete base. Comply with requirements for concrete base specified in Section 03300 "Cast-In-Place Concrete."

    a. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of concrete base.

    b. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.

    c. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.

    d. Install anchor bolts to elevations required for proper attachment to supported equipment.

2. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.

3. Install fuses in each fusible switch.

4. Install fuses in control circuits if not factory installed.

5. Install heaters in thermal-overload relays. Select heaters based on actual nameplate full-load amperes after motors have been installed.

6. Install, connect, and fuse thermal-protector monitoring relays furnished with motor-driven equipment.

7. Install power factor correction capacitors. Connect to the line side of overload relays. If connected to the load side of overload relays, adjust overload heater sizes to accommodate the reduced motor full-load currents.

8. Comply with NECA 1.

B. Identification

1. Comply with requirements in Section 16075 "Electrical Identification" for identification of MCC, MCC components, and control wiring.

   a. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs.

   b. Label MCC and each cubicle with engraved nameplate.

   c. Label each enclosure-mounted control and pilot device.

C. Control Wiring Installation

1. Install wiring between enclosed controllers and remote devices and facility's central-control system.

2. Bundle, train, and support wiring in enclosures.

3. Connect selector switches and other automatic-control selection devices where applicable.

   a. Connect selector switches to bypass only those manual- and automatic-control devices that have no safety functions when switch is in manual-control position.

   b. Connect selector switches within enclosed controller circuit in both manual and automatic positions for safety-type control devices such as low- and high-pressure cutouts, high-temperature cutouts, and motor overload protectors.

D. Connections

1. Comply with requirements for installation of conduit in Section 16130 "Raceways and Boxes." Drawings indicate general arrangement of conduit, fittings, and specialties.

2. Comply with requirements in Section 16060 "Grounding and Bonding."

E. Field Quality Control

1. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

2. Perform tests and inspections.

3. Acceptance Testing Preparation:

    a. Test insulation resistance for each enclosed controller, component, connecting supply, feeder, and control circuit.

    b. Test continuity of each circuit.

4. Tests and Inspections:

    a. Inspect controllers, wiring, components, connections, and equipment installation.

    b. Test insulation resistance for each enclosed controller element, component, connecting motor supply, feeder, and control circuits.

    c. Test continuity of each circuit.

    d. Verify that voltages at controller locations are within 10 percent of motor nameplate rated voltages. If outside this range for any motor, notify Engineer before starting the motor(s).

    e. Test each motor for proper phase rotation.

    f. Perform each electrical test and visual and mechanical inspection stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.

    g. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.

    h. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.

5. Enclosed controllers will be considered defective if they do not pass tests and inspections.

6. Prepare test and inspection reports, including a certified report that identifies enclosed controllers and that describes scanning results. Include notation of

deficiencies detected, remedial action taken, and observations after remedial action.

F. Adjusting

1. Set field-adjustable switches, auxiliary relays, time-delay relays, timers, and overload-relay pickup and trip ranges.

2. Adjust overload relay heaters or settings if power factor correction capacitors are connected to the load side of the overload relays.

3. Adjust the trip settings of MCPs and thermal-magnetic circuit breakers with adjustable, instantaneous trip elements. Initially adjust to six times the motor nameplate full-load amperes and attempt to start motors several times, allowing for motor cool-down between starts. If tripping occurs on motor inrush, adjust settings in increments until motors start without tripping. Do not exceed eight times the motor full-load amperes (or 11 times for NEMA Premium Efficient motors if required). Where these maximum settings do not allow starting of a motor, notify Engineer before increasing settings.

4. Set field-adjustable switches and program microprocessors for required start and stop sequences in reduced-voltage, solid-state controllers.

G. Demonstration

1. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain enclosed controllers, and to use and reprogram microprocessor-based, reduced-voltage, solid-state controllers.

END OF SECTION

SECTION 16446

AUTOMATIC TRANSFER SWITCHES

PART 1 – GENERAL

A. Summary

1. Section includes automatic transfer switches (ATS).

B. References

IEEE C57.12.28	Standard for Pad-Mounted Equipment – Enclosure Integrity
NECA 1	Standard Practice of Good Workmanship in Electrical Construction
NEMA 250	Enclosures for Electrical Equipment (1000 Volts Maximum)
NETA ATS	Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems
UL 1008	Standard for Transfer Switch Equipment

C. Action Submittals

Product Data: For each type of product indicated.

D. Informational Submittals

Field quality-control reports and test reports. Indicate overall resistance to ground.

E. Quality Assurance

1. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2. Comply with UL 467 for grounding and bonding materials and equipment.

PART 2 – PRODUCTS

A. Acceptable Manufacturers

1. Subject to compliance with requirements, provide product by the following, no equal:

    a. Emerson / ASCO

B. General Requirements for Automatic Transfer Switches

1. Provide automatic transfer switch with the number of poles, amperage, voltage, and interrupting current ratings as indicated on the drawings. Each ATS shall consist of a power transfer switch and a control panel interconnected to provide complete automatic operation.

2. Transfer switches shall be open delayed transition and operate with a time delay in the neutral position, adjustable from 0 to 120 seconds.

3. Each transfer switch shall be positively interlocked both mechanically and electrically to prevent simultaneous closing of both sources under either automatic or manual operation. Main contacts shall be mechanically held in position in both normal and emergency positions.

4. The switching panel shall consist of the contactor assembly and a separate control or transformer panel. The transformer shall be multi-tap for ease of voltage adjustment in the field. Control power for all transfer operations shall be derived from the line side of the source to which the load is being transferred.

C. Enclosure

1. The ATS shall be housed in a NEMA 3R enclosure suitable for use in environments indicated on the drawings.

2. NEMA 3R enclosures shall be painted with the manufacturer's standard light gray ANSI 61 paint.

D. Controller Display and Keypad

1. The microprocessor-based controller display shall be UV resistant and include a 4.3 inch Color TFT (480x272), backlit display. The controller shall be capable of displaying transfer switch status, parameters, and diagnostic data. All set point parameters shall be password protected and programmable using the controller keypad, USB port, or remotely using serial port access. Limited abbreviations or codes shall be used for transfer switch functions.

2. The microprocessor-based controller shall include a mimic bus display consisting of six (6) individual LED's (3mm) for indicating the following:

    a. Availability status of source 1.

    b. Availability status of source 2.

    c. Connection status of source 1.

    d. Connection status of source 2.

    e. Source 1 Preferred.

    f. Source 2 Preferred.

PART 3 – EXECUTION

A. Factory Testing

1. The following standard factory tests shall be performed on the equipment provided under this section. All tests shall be in accordance with the latest version of UL and NEMA standards.

    a. Insulation check to ensure the integrity of insulation and continuity of the entire system

    b. Visual inspection to ensure that the switch matches the specification requirements and to verify that the fit and finish meet quality standards

    c. Mechanical tests to verify that the switch's power sections are free of mechanical hindrances

    d. Electrical tests to verify the complete electrical operation of the switch and to set up time delays and voltage sensing settings of the logic

2. The manufacturer shall provide a certified copy of factory test reports.

3. Transfer switch shall include a label indicating order number, catalog number and date.

B. Installation

1. Contractor shall install all equipment per the manufacturer's recommendations and the contract drawings.

2. All necessary hardware to secure the assembly in place shall be provided by the Contractor.

END OF SECTION

SECTION 16461

LOW VOLTAGE TRANSFORMERS

PART 1 – GENERAL

A. Summary

1. Section includes distribution dry-type transformers installed in the motor control center with primary and secondary windings rated 600 volts or less.

B. References

IEEE C57.12.28	Standard for Pad-Mounted Equipment – Enclosure Integrity
NEMA 250	Enclosures for Electrical Equipment (1000 Volts Maximum)
NEMA ST 20	Dry Type Transformers for General Applications
UL 1561	Dry-Type General Purpose and Power Transformers

C. Action Submittals

1. The Power System Analysis Report as specified in Section 16025 shall be approved by the Engineer prior to submitting electrical equipment shop drawings.

2. Product Data: For each product indicated.

3. Shop Drawings: Indicate dimensions and weights.

    a. Wiring Diagrams

4. Transformer ratings:

    a. kVA

    b. Primary and secondary voltage

    c. Taps

    d. Basic Impulse Level (BIL)

    e. Impedance

D. Informational Submittals

1. Manufacturer Seismic Qualification Certification: Submit certification that transformers, accessories, and components will withstand seismic forces.

2. Production test reports

3. Installation information

4. Field quality-control test reports

E. Closeout Submittals

Operation and maintenance data.

F. Quality Assurance

1. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

2. Comply with IEEE C57.12.91, "Test Code for Dry-Type Distribution and Power Transformers."

PART 2 – PRODUCTS

A. Acceptable Manufacturers

1. Subject to compliance with requirements, provide products by one of the following, or equal:

   a. Acme Electric

   b. Eaton

   c. General Electric

   d. Schneider Electric / Square D

   e. Siemens

B. General Transformer Requirements

1. Description: Factory-assembled and tested, air-cooled units for 60-Hz service.

2. Cores: Grain-oriented, non-aging silicon steel.

3. Coils: Continuous windings without splices except for taps.

    a. Internal Coil Connections: Brazed or pressure type.

    b. Coil Material: Copper.

C. Distribution Transformers

1. Comply with NEMA ST 20, and list and label as complying with UL 1561.

2. Cores: One leg per phase.

3. Enclosure: Ventilated, NEMA 250, Type 1

    a. Core and coil shall be encapsulated within resin compound, sealing out moisture and air.

4. Transformer Enclosure Finish: Comply with NEMA 250.

    a. Finish Color: Gray.

5. Taps for Transformers Smaller than 3 kVA: None.

6. Insulation Class: 220 deg C, UL-component-recognized insulation system with a maximum of 150 deg C rise above 40 deg C ambient temperature.

7. Energy Efficiency for Transformers Rated 15 kVA and Larger:

    a. Complying with NEMA TP 1, Class 1 efficiency levels.

    b. Tested according to NEMA TP 2.

8. K-Factor Rating: Transformers indicated to be K-factor rated shall comply with UL 1561 requirements for nonsinusoidal load current-handling capability to the degree defined by designated K-factor.

    a. Unit shall not overheat when carrying full-load current with harmonic distortion corresponding to designated K-factor.

    b. Indicate value of K-factor on transformer nameplate.

9. Electrostatic Shielding: Each winding shall have an independent, single, full-width copper electrostatic shield arranged to minimize interwinding capacitance.
10. Wall Brackets: Manufacturer's standard brackets.

D. Identification Devices

1. Provide nameplates as specified in Section 16075 "Electrical Identification."

PART 3 – EXECUTION

A. Field Quality Control

1. Perform tests and inspections:

   a. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.

   b. Infrared Scanning: Two months after Substantial Completion, perform an infrared scan of transformer connections.

   c. Use an infrared-scanning device designed to measure temperature or detect significant deviations from normal values. Provide documentation of device calibration.

   d. Perform 2 follow-up infrared scans of transformers, one at 4 months and the other at 11 months after Substantial Completion.

   e. Prepare a certified report identifying transformer checked and describing results of scanning. Include notation of deficiencies detected, remedial action taken, and scanning observations after remedial action.

END OF SECTION

SECTION 16481

LOW VOLTAGE SOLID STATE STARTERS

PART 1 - GENERAL

A. Summary

1. Section includes reduced voltage solid state starters installed in the motor control center rated 600 volts or less.

B. Related Sections

General Electrical Requirements: 16010.

Motor Control Centers: 16443.

C. References

IEEE C57.12.28	Standard for Pad-Mounted Equipment – Enclosure Integrity
IEEE C57.12.29	Standard for Pad-Mounted Equipment – Enclosure Integrity for Coastal Environments
NEMA 250	Enclosures for Electrical Equipment (1000 Volts Maximum)

D. Performance Requirements

1. Seismic Performance: MCCs shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.

    a. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."

E. Action Submittals

1. Product Data: For each type of controller and each type of MCC.

2. Shop Drawings: For each MCC, manufacturer's approval drawings as defined in UL 845. In addition to requirements specified in UL 845, include dimensioned plans, elevations, and sections; and conduit entry locations and sizes, mounting arrangements, and details, including required clearances and service space around equipment.

    a. Show tabulations of installed devices, equipment features, and ratings.

    b. Schematic wiring Diagrams: For power, signal, and control wiring for each installed controller.

    c. Nameplate legends.

d. Vertical and horizontal bus capacities.

e. Features, characteristics, ratings, and factory settings of each installed unit.

F. Informational Submittals

1. Coordination Drawings: Floor plans, drawn to scale, showing dimensioned layout, required working clearances, and required area above and around MCCs where pipe and ducts are prohibited. Show MCC layout and relationships between electrical components and adjacent structural and mechanical elements. Show support locations, type of support, and weight on each support. Indicate field measurements.

2. Seismic Qualification Certificates: For MCCs, accessories, and components, from manufacturer.

3. Product certificates.

4. Source quality-control reports.

5. Field quality-control reports.

G. Closeout Submittals

1. Operation and maintenance data.

H. Quality Assurance

1. Testing Agency Qualifications: Member Company of NETA or an NRTL.

2. Source Limitations: Obtain MCCs and controllers of a single type from single source from single manufacturer.

3. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

4. Comply with NFPA 70.

5. IEEE Compliance: Fabricate and test enclosed controllers according to IEEE 344 to withstand seismic forces.

PART 2 - PRODUCTS

A. Acceptable Manufacturers

1. Subject to compliance with requirements, provide products by one of the following, or equal:

a. Eaton

b. General Electric

c. Rockwell Automation / Allen-Bradley

d. Schneider Electric / Square D

e. Siemens

2. Solid state starters installed in the motor control center shall be provided by the MCC manufacturer and installed at the factory.

B. Functional Features

1. The solid-state reduced-voltage starter shall be UL and CSA listed. The solid-state reduced-voltage starter shall be an integrated unit with power SCRs, logic board, paralleling bypass contactor, and electronic overload relay enclosed in a single molded housing

2. The SCR-based power section shall consist of six (6) back-to-back SCRs and shall be rated for a minimum peak inverse voltage rating of 1500 volts PIV

3. Units using triacs or SCR/diode combinations shall not be acceptable

4. Resistor/capacitor snubber networks shall be used to prevent false firing of SCRs due to dV/dT effects

5. The logic board shall be mounted for ease of testing, service and replacement. It shall have quick disconnect plug-in connectors for current transformer inputs, line and load voltage inputs and SCR gate firing output circuits

6. The logic board shall be identical for all ampere ratings and voltage classes and shall be conformally coated to protect environmental concerns

7. The paralleling run bypass contactor shall energize when the motor reaches 90 of full speed and close/open under one (1) times motor current

8. The paralleling run bypass contactor shall utilize an intelligent coil controller to limit contact bounce and optimize coil voltage during varying system conditions

9. Starter shall be provided with electronic overload protection as standard and shall be based on inverse time-current algorithm. Overload protection shall be capable of being disabled during ramp start for long acceleration loads via a DIP switch setting on the device keypad

10. Overload protection shall be adjusted via the device keypad and shall have a motor full load ampere adjustment from 30 to 100% of the maximum continuous ampere rating of the starter

11. Starter shall have selectable overload class setting of 5, 10, 20 or 30 via a DIP switch setting on the device keypad

12. Starter shall be capable of either an electronic or mechanical reset after a fault

13. Units using bimetal overload relays are not acceptable

14. Overtemperature protection (on heat sink) shall be standard

15. Starters shall provide protection against improper line-side phase rotation as standard. Starter will shut down if a line-side phase rotation other than A-B-C exists. This feature can be disabled via a DIP switch on the device keypad

16. Starters shall provide protection against a phase loss or unbalance condition as standard. Starter will shut down if a 50% current differential between any two phases is encountered. This feature can be disabled via a DIP switch on the device keypad

17. Start shall provide protection against a motor stall condition as standard. This feature can be disabled via a DIP switch on the device keypad

18. Starter shall provide protection against a motor jam condition as standard. This feature can be disabled via a DIP switch on the device keypad

19. Starter shall be provided with a Form C normally open (NO), normally closed (NC) contact that shall change state when a fault condition exists. Contacts shall be rated 60 VA (resistive load) and 20 VA (inductive load). In addition, an LED display on the device keypad shall indicate type of fault (Overtemperature, Phase Loss, Jam, Stall, Phase Reversal and Overload)

20. The following control function adjustments on the device keypad are required:

    a. Selectable Torque Ramp Start or Current Limit Start

    b. Adjustable Kick Start Time: 0–2 seconds

    c. Adjustable Kick Start Torque: 0–85%

    d. Adjustable Ramp Start Time: 0.5–180 seconds

    e. Adjustable Initial Starting Ramp Torque: 0–85%

    f. Adjustable Smooth Stop Ramp Time: 0–180 seconds.

21. Units enclosed in motor control centers shall be of the same manufacturer as that of the circuit breaker and motor control center for coordination and design issues

22. Maximum continuous operation shall be at 115% of continuous ampere rating

23. Pump Control Option – Provide control algorithm for pump start-up and shut down sequences. Control algorithm shall reduce the potential for water hammer in a centrifugal pump system. Upon a start command, the speed of the motor is increased, under the control of the IT. Soft Starter microprocessor, to achieve a gentle start. After the speed has reached its nominal value, the bypass contactors close and the pump. Upon a stop command, the bypass contactors are opened and the motor speed is decreased in a tapered manner, to gradually slow the flow until the motor is brought to a stop. The start and stop ramp times are user adjustable and are to be set for the application requirements. The pump control option shall be factory installed.

24. Ethernet IP communication to ControlLogix PLC.

PART 3 - EXECUTION

A. Installation

1. Floor-Mounting Controllers: Install MCCs on 6-inch nominal thickness concrete base. Comply with requirements for concrete base specified in Section 03300 "Cast-In-Place Concrete."

    a. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of concrete base.

    b. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.

    c. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.

    d. Install anchor bolts to elevations required for proper attachment to supported equipment.

2. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.

3. Install fuses in each fusible switch.

4. Install fuses in control circuits if not factory installed.

5. Install heaters in thermal-overload relays. Select heaters based on actual nameplate full-load amperes after motors have been installed.

6. Install, connect, and fuse thermal-protector monitoring relays furnished with motor-driven equipment.

7. Install power factor correction capacitors. Connect to the line side of overload relays. If connected to the load side of overload relays, adjust overload heater sizes to accommodate the reduced motor full-load currents.

8. Comply with NECA 1.

B. Identification

1. Comply with requirements in Section 16075 "Electrical Identification" for identification of MCC, MCC components, and control wiring.

    a. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs.

    b. Label MCC and each cubicle with engraved nameplate.

    c. Label each enclosure-mounted control and pilot device.

C. Control Wiring Installation

1. Install wiring between enclosed controllers and remote devices and facility's central-control system.

2. Bundle, train, and support wiring in enclosures.

3. Connect selector switches and other automatic-control selection devices where applicable.

    a. Connect selector switches to bypass only those manual- and automatic-control devices that have no safety functions when switch is in manual-control position.

    b. Connect selector switches within enclosed controller circuit in both manual and automatic positions for safety-type control devices such as low- and high-pressure cutouts, high-temperature cutouts, and motor overload protectors.

D. Connections

1. Comply with requirements for installation of conduit in Section 16130 "Raceways and Boxes." Drawings indicate general arrangement of conduit, fittings, and specialties.

2. Comply with requirements in Section 16060 "Grounding and Bonding."

E. Field Quality Control

1. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

2. Perform tests and inspections.

3. Acceptance Testing Preparation:

    a. Test insulation resistance for each enclosed controller, component, connecting supply, feeder, and control circuit.

    b. Test continuity of each circuit.

4. Tests and Inspections:

    a. Inspect controllers, wiring, components, connections, and equipment installation.

    b. Test insulation resistance for each enclosed controller element, component, connecting motor supply, feeder, and control circuits.

    c. Test continuity of each circuit.

    d. Verify that voltages at controller locations are within 10 percent of motor nameplate rated voltages. If outside this range for any motor, notify Engineer before starting the motor(s).

    e. Test each motor for proper phase rotation.

f. Perform each electrical test and visual and mechanical inspection stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.

g. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.

h. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.

5. Enclosed controllers will be considered defective if they do not pass tests and inspections.

6. Prepare test and inspection reports, including a certified report that identifies enclosed controllers and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

F. Adjusting

1. Set field-adjustable switches, auxiliary relays, time-delay relays, timers, and overload-relay pickup and trip ranges.

2. Adjust overload relay heaters or settings if power factor correction capacitors are connected to the load side of the overload relays.

3. Adjust the trip settings of MCPs and thermal-magnetic circuit breakers with adjustable, instantaneous trip elements. Initially adjust to six times the motor nameplate full-load amperes and attempt to start motors several times, allowing for motor cool-down between starts. If tripping occurs on motor inrush, adjust settings in increments until motors start without tripping. Do not exceed eight times the motor full-load amperes (or 11 times for NEMA Premium Efficient motors if required). Where these maximum settings do not allow starting of a motor, notify Engineer before increasing settings.

4. Set field-adjustable switches and program microprocessors for required start and stop sequences in reduced-voltage, solid-state controllers.

G. Demonstration

1. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain enclosed controllers, and to use and reprogram microprocessor-based, reduced-voltage, solid-state controllers.

END OF SECTION

SECTION 16521

EXTERIOR LIGHTING

PART 1 – GENERAL

A. Summary

1. Section Includes:

    a. Exterior luminaires with lamps and ballasts.

    b. Luminaire-mounted photoelectric relays.

    c. Poles and accessories.

B. References

IEEE C62.41.1	Guide on the Surge Environment in Low-Voltage (1000 V and Less) AC Power Circuits
IEEE C62.41.2	Recommended Practice on Characterization of Surges in Low-Voltage (1000 V and Less) AC Power Circuits
NFPA 70	National Electrical Code (NEC)
UL 924	Standard for Emergency Lighting and Power Equipment
UL 1598	Luminaires

C. Structural Analysis Criteria for Pole Selection

1. Dead Load: Weight of luminaire and its horizontal and vertical supports, lowering devices, and supporting structure, applied as stated in AASHTO LTS-4-M.

2. Live Load: Single load of 500 lbf, distributed as stated in AASHTO LTS-4-M.

3. Ice Load: Load of 3 lbf/sq. ft., applied as stated in AASHTO LTS-4-M Ice Load Map.

4. Wind Load: Pressure of wind on pole and luminaire and banners and banner arms, calculated and applied as stated in AASHTO LTS-4-M.

    a. Basic wind speed for calculating wind load for poles 50 feet high or less is 100 mph.

i. Wind Importance Factor: 1.0.

ii. Minimum Design Life: 50 years.

iii. Velocity Conversion Factors: 1.0.

D. Action Submittals

1. Product Data: For each luminaire, pole, and support component, arranged in order of lighting unit designation. Include data on features, accessories, and finishes.

2. Shop Drawings: Anchor-bolt templates keyed to specific poles and certified by manufacturer.

E. Quality Assurance

1. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2. Comply with IEEE C2, "National Electrical Safety Code."

3. Comply with NFPA 70.

PART 2 – PRODUCTS

A. Acceptable Manufacturers

1. Subject to compliance with requirements, provide product indicated on Drawings, or approved equal.

B. General Requirements for Luminaries

1. Luminaires shall comply with UL 1598 and be listed and labeled for installation in wet locations by an NRTL acceptable to authorities having jurisdiction.

   a. LER Tests Incandescent Fixtures: Where LER is specified, test according to NEMA LE 5A.

   b. LER Tests HID Fixtures: Where LER is specified, test according to NEMA LE 5B.

2. Lateral Light Distribution Patterns: Comply with IESNA RP-8 for parameters of lateral light distribution patterns indicated for luminaires.

3. Metal Parts: Free of burrs and sharp corners and edges.

4. Sheet Metal Components: Corrosion-resistant aluminum unless otherwise indicated. Form and support to prevent warping and sagging.

5. Housings: Rigidly formed, weather- and light-tight enclosures that will not warp, sag, or deform in use. Provide filter/breather for enclosed luminaires.

6. Doors, Frames, and Other Internal Access: Smooth operating, free of light leakage under operating conditions, and designed to permit relamping without use of tools. Designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during relamping and when secured in operating position. Doors shall be removable for cleaning or replacing lenses. Designed to disconnect ballast when door opens.

7. Exposed Hardware Material: Stainless steel.

8. Plastic Parts: High resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.

9. Light Shields: Metal baffles, factory installed and field adjustable, arranged to block light distribution to indicated portion of normally illuminated area or field.

10. Reflecting surfaces shall have minimum reflectance as follows unless otherwise indicated:

    a. White Surfaces: 85 percent.

    b. Specular Surfaces: 83 percent.

    c. Diffusing Specular Surfaces: 75 percent.

11. Lenses and Refractors Gaskets: Use heat- and aging-resistant resilient gaskets to seal and cushion lenses and refractors in luminaire doors.

12. Luminaire Finish: Manufacturer's standard paint applied to factory-assembled and -tested luminaire before shipping. Where indicated, match finish process and color of pole or support materials.

13. Factory-Applied Finish for Steel Luminaires: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.

    a. Surface Preparation: Clean surfaces to comply with SSPC-SP 1, "Solvent Cleaning," to remove dirt, oil, grease, and other contaminants that could impair paint bond. Grind welds and polish surfaces to a smooth, even finish. Remove

mill scale and rust, if present, from uncoated steel, complying with SSPC-SP 5/NACE No. 1, "White Metal Blast Cleaning," or SSPC-SP 8, "Pickling."

b. Exterior Surfaces: Manufacturer's standard finish consisting of one or more coats of primer and two finish coats of high-gloss, high-build polyurethane enamel.

i. Color: As selected from manufacturer's standard catalog of colors.

14. Factory-Applied Finish for Aluminum Luminaires: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.

a. Finish designations prefixed by AA comply with the system established by the Aluminum Association for designating aluminum finishes.

b. Natural Satin Finish: Provide fine, directional, medium satin polish (AA-M32); buff complying with AA-M20; and seal aluminum surfaces with clear, hard-coat wax.

c. Class I, Clear Anodic Finish: AA-M32C22A41 (Mechanical Finish: medium satin; Chemical Finish: etched, medium matte; Anodic Coating: Architectural Class I, clear coating 0.018 mm or thicker) complying with AAMA 611.

d. Class I, Color Anodic Finish: AA-M32C22A42/A44 (Mechanical Finish: medium satin; Chemical Finish: etched, medium matte; Anodic Coating: Architectural Class I, integrally colored or electrolytically deposited color coating 0.018 mm or thicker) complying with AAMA 611.

i. Color: Dark bronze.

15. Factory-Applied Labels: Comply with UL 1598. Include recommended lamps and ballasts. Labels shall be located where they will be readily visible to service personnel, but not seen from normal viewing angles when lamps are in place.

a. Label shall include the following lamp and ballast characteristics:

i. "USES ONLY" and include specific lamp type.

ii. Lamp tube configuration (twin, quad, triple), base type, and nominal wattage for compact fluorescent luminaires.

iii. Lamp type, wattage, bulb type (ED17, BD56, etc.) and coating (clear or coated) for HID luminaires.

iv. Start type (preheat, rapid start, instant start) compact fluorescent luminaires.

v. ANSI ballast type (M98, M57, etc.) for HID luminaires.

vi. CCT and CRI for all luminaires.

C. Luminaire-Mounted Photoelectric Relays

1. Comply with UL 773 or UL 773A.

2. Contact Relays: Factory mounted, single throw, designed to fail in the on position, and factory set to turn light unit on at 1.5 to 3 fc and off at 4.5 to 10 fc with 15-second minimum time delay**.**

   a. Relay with locking-type receptacle shall comply with ANSI C136.10.

   b. Adjustable window slide for adjusting on-off set points.

D. Ballasts

1. Electronic ballasts with 10% THD (Total Harmonic Distortion) or less shall be provided with luminaires.

E. General Requirements for Poles and Support Components

1. Structural Characteristics: Comply with AASHTO LTS-4-M.

   a. Wind-Load Strength of Poles: Adequate at indicated heights above grade without failure, permanent deflection, or whipping in steady winds of speed indicated in "Structural Analysis Criteria for Pole Selection" Article.

   b. Strength Analysis: For each pole, multiply the actual equivalent projected area of luminaires and brackets by a factor of 1.1 to obtain the equivalent projected area to be used in pole selection strength analysis.

2. Luminaire Attachment Provisions: Comply with luminaire manufacturers' mounting requirements. Use stainless-steel fasteners and mounting bolts unless otherwise indicated.

3. Mountings, Fasteners, and Appurtenances: Corrosion-resistant items compatible with support components.

   a. Materials: Shall not cause galvanic action at contact points.

b. Anchor Bolts, Leveling Nuts, Bolt Caps, and Washers: Hot-dip galvanized after fabrication unless otherwise indicated.

c. Anchor-Bolt Template: Plywood or steel.

4. Handhole: Oval-shaped, with minimum clear opening of 2-1/2 by 5 inches, with cover secured by stainless-steel captive screws**.**

5. Concrete Pole Foundations: Cast in place, with anchor bolts to match pole-base flange. Concrete, reinforcement, and formwork are specified in Section 03300 "Cast-In-Place Concrete."

6. Power-Installed Screw Foundations: Factory fabricated by pole manufacturer, with structural steel complying with ASTM A 36/A 36M and hot-dip galvanized according to ASTM A 123/A 123M; and with top-plate and mounting bolts to match pole base flange and strength required to support pole, luminaire, and accessories.

7. Breakaway Supports: Frangible breakaway supports, tested by an independent testing agency acceptable to authorities having jurisdiction, according to AASHTO LTS-4-M.

F. Aluminum Poles

1. Poles: Seamless, extruded structural tube complying with ASTM B 429/B 429M, Alloy 6063-T6 with access handhole in pole wall.

2. Poles: ASTM B 209, 5052-H34 marine sheet alloy with access handhole in pole wall.

a. Shape: Square, straight.

b. Mounting Provisions: Butt flange for bolted mounting on foundation or breakaway support.

3. Pole-Top Tenons: Fabricated to support luminaire or luminaires and brackets indicated, and securely fastened to pole top.

4. Grounding and Bonding Lugs: Welded 1/2-inch threaded lug, complying with requirements in Section 16060 "Grounding and Bonding," listed for attaching grounding and bonding conductors of type and size listed in that Section, and accessible through handhole.

5. Brackets for Luminaires: Detachable, with pole and adapter fittings of cast aluminum. Adapter fitting welded to pole and bracket, then bolted together with stainless-steel bolts.

a. Tapered oval cross section, with straight tubular end section to accommodate luminaire.

b. Finish: Same as pole.

6. Prime-Coat Finish: Manufacturer's standard prime-coat finish ready for field painting.

7. Aluminum Finish: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.

a. Finish designations prefixed by AA comply with the system established by the Aluminum Association for designating aluminum finishes.

b. Natural Satin Finish: Provide fine, directional, medium satin polish (AA-M32); buff complying with AA-M20; and seal aluminum surfaces with clear, hard-coat wax.

c. Class I, Clear Anodic Finish: AA-M32C22A41 (Mechanical Finish: medium satin; Chemical Finish: etched, medium matte; Anodic Coating: Architectural Class I, clear coating 0.018 mm or thicker) complying with AAMA 611.

d. Class I, Color Anodic Finish: AA-M32C22A42/A44 (Mechanical Finish: medium satin; Chemical Finish: etched, medium matte; Anodic Coating: Architectural Class I, integrally colored or electrolytically deposited color coating 0.018 mm or thicker) complying with AAMA 611.

i. Color: Dark bronze.

PART 3 – EXECUTION

A. Luminaire Installation

1. Install lamps in each luminaire.

2. Fasten luminaire to indicated structural supports.

a. Use fastening methods and materials selected to resist seismic forces defined for the application and approved by manufacturer.

3. Adjust luminaires that require field adjustment or aiming**.**

B. Pole Installation

1. Alignment: Align pole foundations and poles for optimum directional alignment of luminaires and their mounting provisions on the pole.

2. Clearances: Maintain the following minimum horizontal distances of poles from surface and underground features unless otherwise indicated on Drawings:

   a. Fire Hydrants and Storm Drainage Piping: 60 inches.

   b. Water, Gas, Electric, Communication, and Sewer Lines: 10 feet.

   c. Trees: 15 feet from tree trunk.

3. Concrete Pole Foundations: Set anchor bolts according to anchor-bolt templates furnished by pole manufacturer. Concrete materials, installation, and finishing requirements are specified in Section 03300 "Cast-In-Place Concrete."

4. Foundation-Mounted Poles: Mount pole with leveling nuts, and tighten top nuts to torque level recommended by pole manufacturer.

   a. Use anchor bolts and nuts selected to resist seismic forces defined for the application and approved by manufacturer.

   b. Grout void between pole base and foundation. Use nonshrink or expanding concrete grout firmly packed to fill space.

   c. Install base covers unless otherwise indicated.

   d. Use a short piece of 1/2-inch- diameter pipe to make a drain hole through grout. Arrange to drain condensation from interior of pole.

5. Embedded Poles with Tamped Earth Backfill: Set poles to depth below finished grade indicated on Drawings, but not less than one-sixth of pole height.

   a. Dig holes large enough to permit use of tampers in the full depth of hole.

   b. Backfill in 6-inch layers and thoroughly tamp each layer so compaction of backfill is equal to or greater than that of undisturbed earth.

6. Embedded Poles with Concrete Backfill: Set poles in augered holes to depth below finished grade indicated on Drawings, but not less than one-sixth of pole height.

   a. Make holes 6 inches in diameter larger than pole diameter.

b. Fill augered hole around pole with air-entrained concrete having a minimum compressive strength of 3000 psi at 28 days, and finish in a dome above finished grade.

c. Use a short piece of 1/2-inch- diameter pipe to make a drain hole through concrete dome. Arrange to drain condensation from interior of pole.

d. Cure concrete a minimum of 72 hours before performing work on pole.

7. Poles and Pole Foundations Set in Concrete Paved Areas: Install poles with minimum of 6-inch- wide, unpaved gap between the pole or pole foundation and the edge of adjacent concrete slab. Fill unpaved ring with pea gravel to a level 1 inch below top of concrete slab.

8. Raise and set poles using web fabric slings (not chain or cable).

C. Corrosion Prevention

1. Aluminum: Do not use in contact with earth or concrete. When in direct contact with a dissimilar metal, protect aluminum by insulating fittings or treatment.

2. Steel Conduits: Comply with Section 16130 "Raceways and Boxes." In concrete foundations, wrap conduit with 0.010-inch- thick, pipe-wrapping plastic tape applied with a 50 percent overlap.

D. Grounding

1. Ground metal poles and support structures according to Section 16060 "Grounding and Bonding."

a. Install grounding electrode for each pole unless otherwise indicated.

b. Install grounding conductor pigtail in the base for connecting luminaire to grounding system.

2. Ground nonmetallic poles and support structures according to Section 16060 "Grounding and Bonding."

a. Install grounding electrode for each pole.

b. Install grounding conductor and conductor protector.

c. Ground metallic components of pole accessories and foundations.

END OF SECTION

SECTION 17010

GENERAL INSTRUMENTATION AND CONTROL SYSTEMS

PART 1 – GENERAL

A. Summary

1. Scope:

   a. General: This section specifies general requirements applicable to process instrumentation systems consisting of process sensors, monitoring and control devices, and accessories required to provide a complete and fully functional monitoring and control system.

   b. Responsibility: The Contractor shall provide, configure, calibrate, test, and commission all Mechanical and Electrical components of the instrumentation, control, communications, and network systems supplied unless specifically noted otherwise (UNO). The Contractor shall place the completed systems in operation, and making final adjustments to instruments as required during plant start-up. The Contractor shall provide the services of instrument technicians for testing and adjustment activities.

   c. Programming of PLC/SCADA systems, including the PLC Ladder Logic, HMI, network, and communications systems programming, will be performed by others, and is *excluded* from the contractor's scope of work.

   d. Programming of vendor supplied equipment is to be provided by the equipment vendor as part of the contractor's scope of work.

   e. Related Requirements: Division 17 is an extension of, and includes all of the requirements of Division 16, Electrical. All work performed under Division 17 shall also comply with the applicable sections of Division 16 as well as the general provisions of Divisions 0 & 1.

2. Contract Requirements:

   General Conditions, Supplementary Conditions, and Division 1 apply to Work in this section.

3. Definitions:

   a. General: The definitions of terminology used in these specifications shall be defined in ISA Standard S51.1, unless otherwise specified.

b. Approved Equal: Items that are accepted and approved by the owner, the owners designated project representative, or the engineer as being functionally equivalent for the application and acceptable substitutes for items specified in the contract documents.

c. Contractor: The general contractor is responsible for overall project construction. The party with whom the contract is executed.

d. CSI: Control System Integrator. An organization engaged in the business of programming PLC/SCADA systems in the municipal water and wastewater sector.

e. Data Sheets: Data sheets as used in this specification shall refer to ISA S20.

f. Galvanic Isolation: Pertaining to an electrical node having no direct current path to another electrical node. As used in this specification, galvanic isolation refers to a device with electrical inputs and/or outputs which are galvanically isolated from ground, the device case, the process fluid, and any separate power supply terminals, but such inputs and/or outputs are capable of being externally grounded without affecting the characteristics of the devices or providing path for circulation of ground currents.

g. HMI: Human Machine Interface.

h. Integrated Circuit: A number of circuit elements inseparably associated on or within a continuous body to perform the function of a circuit.

i. NA: Not Applicable

j. Panel: An instrument support system which may be either a flat surface, a partial enclosure, or a complete enclosure for instruments and other devices used in process control systems. Panels may provide mechanical protection, electrical isolation, and protection from dust, dirt, and chemical contaminants which may be present in the atmosphere. "Panel" shall be understood to include consoles, cabinets, and racks.

k. OIT: Touch screen Operator Interface Terminal. Used for HMI as specified.

l. Project: In reference to a person the term project shall be used to refer to the owner or representatives of the owner designated by the owner. Synonymous with Project Representative.

m. Packaged System: Integrated equipment systems that are specified in other divisions and sections of the specifications. These systems include process and mechanical equipment as well as electrical and controls equipment that conforms to the requirements of Division 16 and 17. These systems may

include skid mounted and loose items. Some items provided with the equipment may require installation and connection by others. Some related items identified as "supplied by others" may not be supplied with the system but may nonetheless be required for some of the functions of the system.

n. SCADA: Supervisory Control and Data Acquisition.

o. Signal Types: The following types of signals are used in systems specified in this division.

i. Low Level Analog: A signal that has a full output level of 100 millivolts or less. This group includes thermocouples and resistance temperature detectors.

ii. Digital Code: Coded information such as that derived from the output of an analog to digital converter or the coded output from a digital computer or other digital transmission terminal. This type includes those cases where direct line driving is utilized and not those cases where the signal is modulated.

iii. Pulse Frequency: Counting pulses such as those emitted from speed transmitters.

iv. High Level Analog: Signals with full output level greater than 100 millivolts but less than 30 volts, including 4-20 mA transmission.

v. Modulated Signals: Signals emanating from modems or low level audio signals. Normal signal level is plus 4 dBm to minus 22 dBm. Frequency range is 300 to 10,000 hertz.

vi. Discrete Events: Dry contact closures monitored by solid-state equipment. If the conductors connecting to dry contacts enter enclosures containing power or control circuits and cannot be isolated from such circuits in accordance with NEC Article 725, this signal shall be treated as low voltage control.

vii. Low Voltage Control: Contact closures monitored by relays, or control circuits operating at less than 30 volts and 250 milliamperes.

viii. High Level Audio Signals: Audio signals exceeding plus 4 dBm, including loud speaker circuits.

ix. Radio Frequency Signals: Continuous wave, alternating current signals with fundamental frequency greater than 10 kilohertz.

x. 120 VAC control: Contact closures monitored by relays, or control circuits operating at 120 volts AC.

p. Solid State: Circuitry or components of a type which convey electrons by means of solid material such as silicon or crystals, or which work on magnetic principles such as ferrite cores. Vacuum tubes, gas tubes, slide wires, stepping motors, or other devices are not acceptable substitutes for solid-state components or circuitry.

q. Two-wire Transmitter: A transducer which derives operating power supply from the signal transmission circuit and therefore requires no separate power supply connections. As used in this specification, two-wire transmitter refers to a transmitter which produces a 4 to 20-milliampere, current-regulated signal in a series circuit with a 24-volt direct current driving potential and a maximum circuit resistance of 600 ohms.

r. UNO: Unless specifically Noted Otherwise. All general requirements statements shall apply as stated except where specific exceptions are stated, in which case the general requirement shall be modified by the stated exception.

4. Reference Sections: Requirements of the sections listed below apply to and are related to the work of this Section. Other Sections, not referenced below, may also apply and be related to the proper performance of this work. The Contractor is responsible to perform all the work required by the Contract.

a. Division 01: All Sections, as applicable

b. Section 16010: General Electrical Requirements

c. Section 16123: Control-Voltage Electrical Power Cables

d. Section 16130: Raceways and Boxes

e. Division 17: Instrumentation and Control, all included sections

B. Quality Assurance

1. Referenced Standards: The latest edition of the documents listed below are included in the Contract where referenced. The most stringent collective interpretation of the requirements shall govern where conflict or overlap exists between any of these documents and the Contract Documents.

a. American National Standards Institute (ANSI)

b. Institute of Electrical and Electronic Engineers (IEEE)

c. Underwriters' Laboratories (UL)

d. The Instrumentation, Systems, and Automation Society (ISA)

e. API RP550: Manual on Installation of Refinery Instruments and Control Systems, Part I – Process Instrumentation and Control Sections 1 Through 13

f. API RP 551: Process Measurement Instrumentation

g. API RP 552: Transmission Systems - First Edition

h. ANSI/ISA S5.4: Instrument Loop Diagrams

i. ISA S20: Specification Forms for Process Measurement and Control Instrumentation, Primary Elements, and Control Valves

j. ANSI/ISA S5.1: Instrumentation symbols and Identification

k. ANSI/ISA S51.1: Process Instrumentation Terminology

l. ISA S5.3: Graphic Symbols for Distributed Control/Shared Display Instrumentation, Logic, and Computer systems

m. ISA RP12.2.02: Recommendations for the Preparation, Content, and Organization of Intrinsic Safety Control Drawings

n. NFPA 70 National Electric Code (NEC), Title 24, Part 3, California Electrical Code (CEC)

o. NFPA 79 Electrical Standards for Industrial Machinery

p. NFPA 820 Fire Protection in Wastewater Treatment and Collection Facilities

q. IBC 1632 International Building Code

r. UL 508 Industrial Control Equipment

2. Listing:

a. All materials and equipment specified herein shall be within the scope of Nationally Recognized Testing Laboratory (NRTL) examination services, be approved by the NRTL for the purpose for which they are used, and shall bear the appropriate listing/label.

b. Equipment shall be listed/labeled by an NRTL acceptable to the local authority having jurisdiction.

c. When a product is not available with a listing/label for the purpose for which it is to serve, the product may be required by the inspection authority to undergo a special inspection at the manufacturer's place of assembly or as a completed assembly in the field. All costs and expenses incurred for such inspections shall be included in the original contract price.

C. **Submittals**

1. General: Submit information per Division 1.

2. Media: All submittals shall be provided in hard copy (paper) in accordance with Division 1 and electronic format. Electronic format shall be PDF format on CD that is compatible with Microsoft Windows / Adobe Reader. One CD shall be provided for each hard copy required per Division 1.

3. Organization and Format: Submittal organization shall be the same as the specifications. Provide submittals bound with section coversheets and tabbed dividers with specification section numbers for submittal organization. Bill of materials, cut sheets, shop drawings, schematics, panel layouts, schedules, etc., shall be cross-referenced, indexed, or otherwise related by unique identifier for each item. The project may reject improperly organized or notated submittals. Provide .pdf file page numbers in table of contents as well as bookmark links to section coversheets in pdf file.

4. Reviews and Re-Submittals: Suppliers shall provide re-submittals which include responses to all submittal review comments separately and at a level of detail commensurate with each comment. Supplier responses shall indicate how the supplier resolved the issue pertaining to each review comment. Responses that only indicate that the review comment was noted, will be looked into, etc., are not satisfactory. Re-submittals which do not comply with this requirement may be rejected and returned without review. Contractor shall be allowed no extensions of any kind to any part of their contract due to the rejection of non-compliant submittals. Submittal review comments not addressed by the contractor in re submittals shall continue to apply whether restated or not in subsequent reviews until adequately addressed by the contractor to the satisfaction of the reviewing and approving authority.

5. Product Data: Submit catalog cut sheets for all products. Identify all cut sheets by unique bill of material item number, index, or key. Notate catalog cuts to indicate only those items, models, options, or series of equipment to be furnished. Cross out or otherwise obliterate all extraneous materials and information. Clearly identify all configuration options for the equipment to be furnished.

6. Bill of Materials: Submit bill of materials including all items, products, and assemblies supplied. Documents shall be updated following submittal review, factory test, and commissioning. Updates shall be provided to the Project Representative in a timely manner. Bill of materials shall include the following information:

    a. Item number, index, or key relating to submitted cut sheets, drawings, schedules, etc.

    b. Item manufacturer's name, model, and part numbers. Supplier unique part numbers are not acceptable.

    c. Description

    d. Quantity supplied

    e. Supplier contact information

7. NOTATED SPECIFICATIONS: Submit copies of all Division 17 specification sections with each paragraph notated to indicate compliance. A check mark shall indicate complete compliance. Explanations shall be provided for all non-compliant items in accordance with Division 1.

8. Notated P&ID Drawings: Submit copies of all project Process and Instrumentation drawings with each drawing element notated to indicate compliance. A check mark shall indicate complete compliance. Explanations and markups shall be provided for all non-compliant items and in accordance with Division 1

9. Notated Electrical and Instrumentation Drawings: In the case of deviations from the contract documents, particularly related to the impact of the configuration of submitted packaged equipment supplied to the project, submit marked up copies of applicable Electrical and Instrumentation contract drawings notated to identify and explain all proposed deviations from the contract documents. Items not notated on the submitted marked up copies shall be assumed to be 100% compliant with the bid documents. This requirement applies to electrical one lines, MCCs, MCC control schematics, panel schedules, and control schematics. This requirement does not apply to plan drawings and conduit schedule which shall be marked up to reflect the as constructed project configuration and submitted as record drawings.

10. Seismic: Submit Seismic design information. Include a list of equipment weighing 200 pounds or more.

11. O&M: Submit operation and maintenance information as specified in any Division 17 specification section. O&M manuals shall include product data for all materials and items supplied in compliance with the submittal requirements of this section.

12. DIV 17: Submit information as required by all Division 17 specification sections.

13. CSI: The CSI will be engaged under separate contract with the Owner. Contractor shall not be responsible for work carried out by the CSI.

14. Drawings: Submit all drawings described in this and other Division 17 sections including elementary, loop, schematic, fabrication, installation, field wiring, panel layout and assembly, etc., drawings. Drawings shall be updated following submittal review, factory test, and commissioning. Updates shall be provided to the Project Representative in a timely manner. Cross reference drawing elements with BOM and catalog cut sheet unique references. Drawings shall use project tag formats and numbers. Unique and separate drawings shall be provided for each item supplied including but not limited to all panels and all MCC units. Typical drawings that apply to multiple panels or multiple MCC motor control units are not acceptable. Individual I/O schematics diagrams are to be provided for each I/O slot based on the typicals in the design and the PLC I/O List. Individual motor starter schematics are to be provided for each starter unit including FVNR, VFD and breaker units as well as spare or space units.

15. Packaged Equipment: All packaged equipment suppliers shall provide submittals in compliance with Division 17. This shall include packaged equipment purchased under the contract as well as any pre purchased packaged equipment assigned to the contractor.

16. Component Drawings: Dimensional, installation, and wiring diagrams and drawings for all supplied components.

17. Testing and Calibration: Test plans, calibration forms, test forms, test results, and test reports required by any Division 17 specification section. Per Section 17804.

18. Spare Parts: Spare parts lists

19. Submit PLC, I/C, VFD drawing in AutoCAD editable form.

D. Service Requirements

1. Environmental Conditions: All equipment shall be suitable for operation in the following ambient conditions. Modify equipment if necessary as required to function in the specified environment.

   a. Atmospheric contaminants:

Hydrogen sulfide	0.1 mg/L
Chlorine	0.01 mg/L
Ammonia	0.5 mg/L
Dust	50.0 ug/m3

   b. Electromagnetic radiation:

27/500 MHz	10 volts/m

   c. Control Rooms:

Temperature	60 to 95 degrees F
Humidity	20 to 80 percent

   d. Outdoor Field Locations:

Temperature	-10 to 120 degrees F
Humidity	10 to 100 percent

E. Description of System

1. System control is designed by El Toro Water District.

F. Contractor and Subcontractor Scopes of Work

1. GC Responsibility:

   a. All programmed functions of the PLC/SCADA instrumentation and industrial electronic shall be provided under the supervision of a single Control System Integrator, contracted directly by Owner, who is regularly engaged in the design, configuration, and installation of similar systems of equal or greater scope and complexity. The Control System Integrator shall NOT be enjoined by the Contractor as a Subcontractor. Programming of the Plant PLC and the Plant SCADA system will be performed by the CSI, but the associated hardware will be supplied by Contractor. Contractor shall be responsible for ensuring operability of all equipment in the instrument and control system including network systems, field equipment, panels, work stations, server racks, control panels, and instruments. Programmed functionality of all

equipment in the instrument and control system shall be the responsibility of the CSI. The Contractor shall work with CSI, equipment vendors, and any third party PLC/SCADA programmer to test, commission and start up the automated and programmed functions of the plant.

b. Itemized Responsibilities: The Contractor shall be responsible for the following equipment and services:

i. Motor Control Centers: Supplying the Motor Control Equipment and/or Motor Control Centers (MCCs) in accordance with Division 16.

ii. Equipment Testing: Testing of the Motor Control Equipment in the Contractor's shop.

iii. Integration Testing: Integration testing of all system and related components simultaneously in the Contractor's facility. This testing shall include all panels, instruments, process switches, test fixtures, MCCs, motor controllers, available equipment packages, etc. Per Section 17804

iv. Calibration: Calibration of all field instruments UNO. Per Section 17804.

v. Communications and Networks: Set up, configure, test, and verify all communications equipment, channels, and networks including new and reused telephone circuits.

vi. Startup and Testing: System start up, commissioning, electrical and mechanical testing, and functional testing of systems that are not programmed following installation. Per Section 17804. Contractor shall provide electrical and mechanical support to the CSI during the CSI functional testing of systems that are programmed.

vii. Instruments: Provide all instruments specified unless specifically noted otherwise. Some instruments shall be provided by packaged equipment vendors. The Contractor shall be responsible for program integration of vendor provided instruments and equipment into the packaged equipment control system.

viii. Configuration: Configure all supplied devices, and equipment unless specifically noted otherwise. All computers are to be configured for application programming by others. Configuration and programming of devices and equipment supplied as a part of packaged systems shall be provided by the vendor of each packaged system and is the responsibility of the Contactor. Per Section 17802

ix. Equipment Submittal Review: Review all equipment and packaged system submittals which include Division 17 items. Notify the CSI of any and all

needed modifications to submitted equipment, package system scope of services or supply, or CSI programming required to accommodate and integrate submitted equipment into the Contractor's work. Specifically note how submittals which include variances from the contract documents will impact CSI provided programs if accepted by the contractor.

2. Intent of Drawings and Specifications:

    a. General: Due to the fact that the contract documents cannot dictate the use of specific brands or models of components and equipment unless there is a compelling reason to do so, the control system drawings are intended to primarily convey detailed functional and operational requirements of the control system rather than specific component selection, assembly, and interconnection information. The substantial interconnection information provided in the Contract Drawings is general in nature and is provided for the purpose of indicating the general scope of work and the aforementioned functional and operational requirements, and shall not be construed to represent detailed shop drawings or parts thereof.

    b. Ancillary Components Required: Components not explicitly indicated in the Contract Documents but none-the-less implied, required for the environment or area classification indicated, or required for the proper functioning of the system as indicated shall be considered required just as though they had been explicitly indicated. The aforementioned components shall be considered incidental to the Contract and shall not constitute a basis for claim by the Bidder for additional compensation or time allowed to complete the Work.

    c. Conflicts In Documents: In any case of conflicting statements or requirements in the contract drawings and specifications, the most demanding statement or combination of statements shall govern. All stated requirements shall be met or exceeded.

3. Control System Integrator’s Responsibilities:

    a. Sole Responsibility: In accordance with A and B above, the Control System Integrator (CSI) shall be solely and completely responsible for programming of the Plant PLC/SCADA system and commissioning of the programmed functions of the control system with the exception of control equipment provided as a part of packaged equipment systems or otherwise noted as exceptions.

    b. Design and Performance: The control system hardware and assemblies shall be designed by the Contractor to provide the control capabilities and functions indicated in and implied by the drawings and these specifications and to provide trouble-free operation with a minimum of maintenance.

c. Coordination and Integration: The CSI shall coordinate the programming of the Plant PLC/SCADA system with motor controls, packaged equipment controls, and other related equipment. The Contractor shall be responsible to provide information on equipment provided by the Contractor or other suppliers or disciplines and to support the CSI as necessary to integrate all the equipment into the control system to form a complete working system as outlined by the Contract Documents.

d. Proactive Communication: The CSI shall communicate directly with the Contractor, manufacturer(s) and supplier(s) of all related equipment to determine all details of the equipment that may influence or affect the programmed functions of the Plant PLC/SCADA system. The CSI shall determine all requirements for and shall cause integration of the control system into a unified operating system. All correspondence shall include Carbon Copying (cc:) the General Contractor.

e. Itemized Responsibilities: The CSI shall be responsible for the following equipment and services:

   i. Integration Testing: Integration testing of all programmed systems and related components simultaneously in the Contractor's facility. This testing shall include all panels, instruments, process switches, test fixtures, MCCs, motor controllers, available equipment packages, communications and networking equipment, SCADA system software (UNO), PLC system software (UNO), etc. Per Section 17804.

   ii. Coordination with Contractor: The CSI shall supply the Contractor with Plant PLC/SCADA programming information if necessary for installation of control components and sensing devices as required for proper system operation.

   iii. Calibration: PLC/SCADA system calibration of and scaling of all field instruments into the PLC/SCADA UNO. Per Section 17804.

   iv. Communications and Networks: Set up, configure, test, and verify of all programmed communications equipment, channels, and networks including new and reused telephone circuits. All equipment hardware and installation is by the contractor.

   v. Startup and Testing: System start up, commissioning, and functional testing of all programmed systems following installation. Per Section 17804.

   vi. Instruments: The CSI shall integrate software alarms, data points, etc. of vendor provided controllers into the PLC/SCADA system program application via the control system network.

vii. Configuration: Configure all supplied devices, and equipment into the PLC/SCADA software unless specifically noted otherwise. All computers are to be configured for application programming by the CSI. Configuration and programming of devices and equipment supplied as a part of packaged systems shall be provided by the vendor of each packaged system. Per Section 17802

viii. Equipment Submittal Review: Review all equipment and packaged system submittals which include Division 17 items. Notify the Contractor of any and all needed modifications to submitted equipment, package system scope of services or supply, or CSI supplied programming required to accommodate and integrate submitted equipment into the Contractor's work. Specifically note how submittals which include variances from the contract documents will impact Contractor provided control panels and MCC's if accepted by the Contractor.

4. General And Electrical Contractor's Responsibility: The General and Electrical Contractor shall be responsible for the following equipment and services:

   a. CSI Submittal Review: Review of the CSI's for functional and logic diagrams submittals for coordination with contractor's installation.

   b. Equipment Submittals: Supply the CSI with information submittals on all equipment which impacts or connects to the control system, which the Integrator must incorporate into their PLC/SCADA programs and integrate into the project. This includes items such as pumps, motors, packaged control panels, other equipment, valve actuators, etc.

   c. Installation:

      i. Installation of control panels provided by the Contractor.

      ii. Installation of Motor Control Equipment (MCC) provided by the Contractor.

      iii. Installation of interconnecting wiring in accordance with the contract documents and the Contractor's wiring diagrams.

      iv. Installation of Instrumentation and Control System components in accordance with the contract documents and instructions of the Contractor.

G. Shop Drawings

1. General: The Contractor, suppliers of packaged control systems, suppliers of control panels, and suppliers of MCCs shall develop all shop drawings required for

design, fabrication, assembly, installation, operation, and maintenance of the supplied control system components. Drawings shall be prepared utilizing a computer aided drafting program. CAD shop drawings shall be updated and provided to the Project Representative prior to factory testing, prior to system installation, and with the O&M manuals. All drawings shall be supplied in hardcopy and electronic file formats per paragraph 1.3.B of this section.

a. Diagrams: Submit detailed interconnection diagrams, wiring diagrams, elementary diagrams, communications diagrams, and loop diagrams with all electrical and electronic components clearly identified by project tag number consistent with the contract drawings and schedules. Diagrams for each circuit or element shall be separate and unique. Typical diagrams are not allowed. Diagrams shall carry a date and brief description of the revisions. Diagrams shall carry a uniform and coordinated set of wire and terminal block numbers in compliance with panel work wiring, Section 17110 and the contract drawings.

b. Panel Layouts: Submit detailed construction drawings for panel layouts and equipment enclosures with dimensions in inches. Show both exterior and interior views.

c. Wire and TB Numbers: Wiring, schematic and loop diagrams shall carry a uniform and coordinated set of wire numbers and terminal block numbers in compliance with Division 16 and Section 17110 and with the numbering schemes shown on the contract drawings.

d. Unique Drawings: Each control circuit, control loop, control panel layout design, motor control schematic, PLC I/O slot schematic, etc., shall be presented on a unique drawing. Control circuits, loop diagrams, and panel layouts referenced to typical diagrams are not acceptable.

e. Symbols: Drawing symbol format shall comply with NFPA 79, ISA 5.1, ISA 5.3 and where appropriate, ISA RP 12.2.02.

f. Record Drawings: Provide record drawings per Division 1.

g. Format: Drawings shall be prepared utilizing a computer based drafting program and shall be formatted as follows:

   i. Size: Hardcopy plots shall be 11-inch by 17-inch (half-size).

   ii. Text: Minimum Text size: 0.125 inch for 22 x 34 inch drawings, 0.063 inch for 11 x 17 inch drawings.

   iii. Borders: Drawings shall have borders and title blocks identifying the Contract, facility, system, revisions to the drawing, and type of drawing.

iv. Revisions: Each release of a drawing shall carry a revision number, date, and a brief description of the changes. All changes associated with a given release shall be indicated on the drawing by a revision flag. Changes on the latest revision shall be indicated by clouding.

v. CAD: Drafting software shall be AutoCAD 2008 or latter. Bind all x-refs.

h. Field Equipment Terminals: All schematics, diagrams, and drawings showing connections to field equipment shall provide correct terminal block numbers for the connections at the field equipment. This includes packaged system control panels, control panels, MCCs, stand-alone motor controls, valve actuators, instruments, switches, etc. The contractor, subcontractors, and suppliers shall coordinate as needed to accomplish this.

2. Elementary and Loop Diagrams: Provide elementary diagrams for all discrete loops. Loop diagrams shall be prepared in compliance with ISA S5.4 and shall be provided for all analog loops. Elementary diagrams and loop diagrams shall show circuits and devices of a system. These diagrams shall be arranged to emphasize device elements and their functions as an aid to understanding the operation of a system and maintaining or troubleshooting that system.

   a. Provide complete elementary diagrams for equipment control.

   b. Comply with NFPA 79.

   c. Show wire numbers, color codes, signal polarities, and terminal block numbers. Tables for wire numbers, signal polarity, and terminal block numbers are not acceptable.

3. Schematic Diagrams: Provide schematic drawings showing all control panel components, the interconnection of all control panel components, all field devices, and the connection of all field devices to control panels. Schematic diagrams shall also show all communications components, their interconnection, and their interface with other control panel components. Provide wire and terminal block numbers in compliance with panel work wiring, Section 17110 and the contract drawings.

4. Panel Fabrication and Arrangements Drawings: Provide arrangement drawings of all panel front and internal-mounted instruments, switches, devices, and equipment indicated. All panel mounting details shall be shown. Outer dimensions of all panels shall be included on the drawing. Deviations from approved arrangements shall require Project Representatives approval prior to installation. Arrangement drawings shall be drawn to scale using standard Architectural or Engineering scales.

5. Record Drawings:

    a. Also referred to as as-built drawings.

    b. Shop Drawings: All submitted drawings shall be updated over the course of the construction project to reflect the installations and equipment as-built. A full set of record drawings shall be provided to the Project Representative upon completion of the project and shall be included in the O&M manuals. Record drawing requirements shall be the same as submittal drawing requirements.

    c. Contract Drawings: The contractor shall maintain a set of record plan and P&ID markup drawings on site during construction. The contractor shall mark up the record drawing set to indicate any and all deviations of the installed systems from the contract documents. The marked-up drawings shall be provided to the project representative at project close out.

6. Wiring Diagrams:

    a. Panels: comply with NFPA79.

    b. Show components of a control panel in an arrangement similar to the actual layout of the panel.

    c. Show internal wiring between devices within the panel.

    d. Show all terminal blocks whether used for internal or field wiring. Those used for field wiring shall be clearly identified as such.

    e. Wiring diagrams shall indicate insulation color code, signal polarities, wire numbers, and terminal block numbers.

7. Interconnection Diagrams:

    a. Submit complete interconnection diagrams for field wiring.

    b. Show each panel and field devices.

    c. Show wire numbers, cable numbers, panel numbers, and field device tag numbers.

    d. Comply with NFPA79.

8. Certifications:

    a. Temperature: Provide test data certified by the manufacturer to demonstrate that field electronic devices are suitable for the specified ambient temperatures.

b. Corrosion: Provide test data showing design features of the electronic equipment provided to protect against damage by the specified atmospheric contaminants and specific evidence that similarly protected electronic equipment has operated in similar environments for a period of not less than five years without failure due to corrosion.

H. Seismic Design

1. Procedure and submittals: per Section 16010.

2. Structures and equipment shall be braced to prevent damage from specified forces.

3. Equipment shall not be required to function properly during periods of seismic disturbance, but shall be capable of manual restart without repair or modification following a disturbance.

I. Precedence of Requirements

The Contractor, Sub Contractors and equipment suppliers shall comply with all requirements specified in the contract documents, individually and in combination. In the case of redundant, overlapping, or conflicting requirements, the most stringent and demanding interpretation of the requirements statements collectively shall govern unless specifically clarified by the project. The Contractor and equipment suppliers shall request needed clarification of requirements during bid, otherwise the project's interpretation shall govern. The System Supplier shall diligently scrutinize all parts of all bid documents prior to bid.

PART 2 – PRODUCTS

A. Acceptable Manufacturers

Products: All products provided by the Contractor shall be manufactured to comply with the listing requirements identified in Part 1 and other requirements as indicated in the Contract. System components shall be commercial, off-the-shelf components to the maximum extent possible. Custom designed or manufactured components shall require Project Representative's approval.

B. Materials

1. General: Material shall be new, free from defects, and of the quality specified. All equipment and materials utilized in the system shall be the products of Manufacturers with at least five (5) years of experience in the manufacture of similar equipment. Similar items in the system shall be the products of the same Manufacturer. All equipment shall be of industrial grade and of standard construction, shall be capable of long, reliable, trouble-free service, and shall be

specifically intended for control and monitoring of operation of motor-driven pumps and process equipment. All equipment shall be of modular design to facilitate interchangeability of parts and to assure ease of servicing.

2. Electronic Components: Unless otherwise specified, electronic equipment shall be of solid-state construction. Components of standard electronic assemblies shall not be replaced with components of different characteristics in order to meet the performance requirements of the specification. Parts shall be as shown in the instruction manuals and shall be replaceable with standard commercial components of the same description without degrading the performance of the completed assembly.

C. Instruments

Application requirements are specified in the individual specification sections, and/or on the drawings. The major instruments required to implement the process instrumentation and control systems are identified on the P&IDs. Instruments identified shall be supplied with the exception of those identified within the limit of supply of vendor equipment. Instruments within vendor boundaries will be supplied by equipment suppliers. All instrument functions specified on the P&IDs and contract drawings have Division 17 specification references and shall be provided by the Contractor. Any additional instruments or devices required to complete the instrument loops because of unique characteristics of the particular equipment selected by the Contractor (such as isolation I/Is) shall be provided. Such additional instruments shall be considered incidental to the contract and shall be provided and included in the original contract price even when not specified in the contract drawings.

D. Spare Parts

1. In addition to spare parts mentioned elsewhere in Division 16 & 17 specification sections, the Contractor shall supply the following spare parts for use by the Owner:

    a. Qty 1 Relay of each type used or 10%, whichever is the greater amount

b. Qty 10 lamps of each type used or 100%, whichever is the greater amount.

c. Qty 200% spare fuses, two spare fuses for each type of fuse supplied minimum

PART 3 – EXECUTION

A. Design and Assembly

1. General: With the exception of any packaged equipment control systems, the supplied control systems shall be designed by the Contractor per paragraph 1.06. The supplied control system shall be completely assembled in the shop of and by

the Contractor. All components and equipment shall be prewired to the maximum extent possible.

2. Electrical and Mechanical Integration: The Contractor shall determine all requirements for and shall cause electrical, mechanical and network integration of the supplied control systems, MCCs, and any supplied packaged equipment control systems into a complete and unified system. The Contractor shall be responsible for the electrical and mechanical coordination and integration of the supplied control system with motor controls and other related equipment.

3. Program Integration: The CSI shall determine all requirements for and shall cause programmed integration of the supplied control systems, MCCs, and any supplied packaged equipment control systems into a complete and unified system. The CSI shall be responsible for the programmable coordination and integration of the supplied control system with motor controls and other related equipment. Vendor package equipment programming will be the responsibility of the contractor/equipment vendor.

4. Review of Submittals: The Contractor shall be directly responsible to obtain submittal information on related equipment supplied by others and to integrate this information as required with the overall control system to form a complete working package.

5. Coordination: The Contractor shall communicate directly with the Manufacturer(s) and Supplier(s) of all related equipment to determine all details of the equipment that may influence or affect the supplied control system components. The Contractor shall work with the CSI to make any and all adjustments or revisions required to integrate the submitted equipment into the job at no additional expense to the owner and with no extension of the schedule.

B. Delivery, Storage, and Handling

1. Shipping:

   a. Anchor, brace, and protect equipment during shipping handling.

   b. No internal wiring shall be disconnected for transportation.

2. Delivery Inspection: Notify the Project Representative and provide access for inspection upon arrival of any material or equipment to be incorporated into the work. Remove protective covers when required.

3. Supplied Control Panels:

   a. Completely wired and tested in the factory prior to being shipped to the job site.

b. Shipped as a single unit to job site after testing is complete.

c. No internal wiring shall be disconnected for transportation.

C. Installation

1. General:

   a. Installation by Contractor: The control system and associated instruments and connections shall be installed by the contractor.

   b. Installation Instructions: The control system shall be installed in accordance with the installation drawings and instructions provided by the manufacturer, packaged system suppliers, and other equipment suppliers.

   c. Supervision: The Contractor's instrumentation and controls project engineer shall supervise and coordinate all activities related to the installation of Division 17 requirements.

   d. Expertise of Installer: Installation shall be performed by the workers who are skilled and experienced in the installation of electrical instrumentation and control systems. Installation shall include all elements and components of the control systems and all conduit and interconnecting wiring between all elements, components, sensors, valve operators, etc.

   e. Location: Equipment shall be located so that it is readily accessible for operation and maintenance.

   f. Instrument Technician: The Contractor shall provide the services of skilled instrument technicians for testing, calibration, and adjustment activities per 17804.

2. Signal Connection And Transmission:

   a. Unless otherwise specified, analog signal transmission between electric or electronic instruments not located within a common panel shall be 4 to 20 milliamperes and shall have a loop compliance of at least 500 ohms.

   b. Two-wire loop transmitters shall operate at 24 VDC.

   c. Loops shall be grounded at the field terminal block by bonding to the instrument panel signal ground bus. Separate grounded conductors shall be provided for each loop. Daisy chaining of grounded conductors from one loop to another is not allowed.

d. Provide isolating amplifiers for field equipment possessing a grounded input or output, or having a common mode voltage other than system ground.

e. All other transmission systems, such as impulse duration, low frequency pulse rate, and voltage regulated, will not be permitted. When transmitters with non-standard outputs are specified, their output shall be converted to 4 to 20 milliamperes at the field instrument.

f. Equipment located in classified areas shall be explosion-proof or intrinsically safe. Provide intrinsic safety barriers approved by UL, CSA, or FM.

3. Tagging: All field devices shall be labeled with tag number indicated in the bid documents or consistent with project tagging conventions when not shown in the bid documents. Comply with project naming and numbering conventions. Tag shall be 10ga, 316 stainless steel with stamped letters and numbers attached to device with 12ga, 316 stainless steel wire.

4. Field Equipment:

   a. Installation: Equipment shall be provided as specified on the drawings such that ports and adjustments are accessible for in-place testing and calibration. Where possible, equipment shall be located between 48 inches and 60 inches above the floor or a permanent work platform. Instrumentation equipment shall be mounted for unobstructed access, but mounting shall not obstruct walkways. Equipment shall be mounted where shock or vibration will not impair its operation. Support systems shall not be attached to handrails, process piping or mechanical equipment except for measuring elements and valve positioners. Instruments and cabinets supported directly by concrete or concrete block walls shall be spaced out not less than 5/8 inch by framing channel between instrument and wall.

   b. Support Systems: Steel used for support of equipment shall be hot-dip galvanized after fabrication. Support systems including panels shall be designed in accordance with the applicable building code and seismic zone and shall prevent deformation greater than 1/8 inch under the attached equipment load and an external load of 200 pounds in any direction.

5. Electrical Power Connections:

   a. Division 16: Electric power wiring and equipment shall be in compliance with Division 16.

   b. Disconnect Switches: Power disconnect switches shall be provided within sight of equipment and shall be labeled to indicate opened and closed positions and specific equipment served. "Within sight of" is defined as having a clear unobstructed view from the equipment served and within 50 feet of the

equipment served. Disconnect switches shall be mounted between 36 inches and 72 inches above the floor or permanent work platform. Where equipment location is such that the above requirements cannot be met by a single disconnect switch, two switches, one at the equipment and one at the work platform, shall be provided.

c. Surge Arrestors: Each disconnect switch serving equipment located outdoors shall be provided with a surge arrestor, General Electric 9L15CCB001, or equal. The surge arrestor shall be bonded to the plant ground grid with a No. 8 AWG bare copper conductor.

d. Control Panels: All control panels shall be provided with a main power disconnect equipped with auxiliary contacts as required to disconnect all power sources to the panel or shall be labeled to indicate the multiple power sources not disconnected by the main disconnect. Field wiring for all power sources not disconnected by the main disconnect shall land on fused disconnect type terminal blocks.

D. Tests and Inspections:

Per Section 17804.

E. Calibration, Start-Up, and Commissioning:

Per Section 17804.

F. System Maintenance and Warranty

1. Contractor Solely Responsible: The Contractor shall be solely and completely responsible for all electrical and mechanical maintenance of control systems they supply from time of installation to the date of substantial completion of all work under the contract. The Contractor shall correct all deficiencies and defects and make any and all repairs, replacements, modifications, and adjustments as malfunctions or failures occur. The contractor shall perform all such work required or considered to be required by the owner to properly maintain the system.

2. Defects and Repairs: The Contractor shall make any and all repairs, replacements, modifications, and adjustments required to eliminate any and all defects in design, materials, and workmanship which are discovered within the one year guarantee period. The Contractor shall begin all repairs, replacements, modifications and adjustments within twenty-four (24) hours of notification by telephone by the owner and shall complete such repairs, replacements, modifications and adjustments within forty-eight (48) hours of notification.

3. Acceptance of Work: The Contractor shall anticipate that the Owner may delay acceptance of all work under the contract if, in the judgment of the Owner, malfunctions or failures in operation of the supplied control system repeatedly occur after start-up to an unacceptable extent. The Contractor shall not be entitled to an extension of time or to any claim for damages because of hindrances, delays, or complications caused by or resulting from delay by the owner in accepting the work because of malfunctions or failures in operation of the supplied control system.

4. Packaged Systems: Packaged system suppliers shall provide warranty support meeting the above stated requirements for their supplied systems.

G. Operation and Maintenance data

1. O&M Manuals: The Contractor shall prepare and assemble six (6) sets of electrical and mechanical operation and maintenance (O&M) manuals in accordance with the project general requirements and Paragraph 1.3 of this section. These manuals shall be submitted two weeks prior to training. O&M manuals shall include, but not be limited to, the following:

   a. Trouble-shooting procedures.

   b. Calibration procedures.

   c. Testing procedures.

   d. Component replacement procedures.

   e. Preventative maintenance procedures.

   f. Listing of recommended spare parts.

   g. Listing of recommended maintenance tools and equipment.

   h. Catalog data for all equipment and devices supplied, organized per submittal requirements.

   i. Configuration and setup manuals for all devices supplied including VFDs, instruments, etc.

   j. Communication channel test forms.

   k. Calibration and test forms for all field switches, instruments, PLC IO, VFD IO, etc., per Section 17804.

l. Configuration files for all configurable electronic devices and equipment supplied for this project.

m. System user's manual covering all functions supplied by the contractor for this project as described below.

2. Record Documents: All contract P&ID drawings and control strategy specification sections and all submittal drawings shall be revised to reflect as-built conditions at the end of the project. Record drawings and documents shall be submitted in accordance with the project general requirements and Paragraph 1.3 of this section. Record drawings and documents shall be submitted with the O&M manuals. Record drawings and documents shall include the following:

a. Shop drawings per 1.7 of this section.

b. Wiring diagrams of cabinet and enclosure contained assemblies

c. Wiring diagrams of all system connections and interconnections including all loops, field equipment, communications interfaces, networks, etc.

d. All other submitted shop and installation drawings and details not listed

e. Bill of Material

f. Contract P&ID drawings

g. Contract control strategy specification sections

H. System Users Manual

1. Scope: The Contractor shall develop and submit a detailed user manual covering all aspects of the operation and use of the components and systems they supply. The manual shall cover the following

a. Overview: An overview of the architecture of the control system including control panels, MCC's, field devices, networks, remote access, etc.

b. Functions: All hardware/hardwired, manual, automatic, display, control, alarming, networking, etc. features and functions of the systems and components they supply.

c. Hardwired Elements: Descriptions of the meaning and function of all hardwired panel, MCC, and field mounted discrete operator interface monitoring and control devices. Correlate functions to the control strategies.

d. Start Up: System start up procedures for electrical and mechanical systems supplied and configured by the contractor for the project.

2. Used In Training: The system user's manual shall be completed prior to and shall be used for required training. The manual shall be updated to incorporate comments received during training and re submitted for inclusion in the O&M manual. Submit 2 weeks prior to training.

3. Packaged Equipment: Packaged equipment suppliers shall supply user's manuals per the above requirements for the systems they supply.

4. PLC/SCADA System Manuals: The PLC/SCADA system O&M Manuals shall be the responsibility of the Contractor. The Contractor shall obtain from the CSI the programming documents necessary for inclusion in the appropriate section of the OM&M Manuals.

I. Training

1. General: The Contractor shall conduct specifically organized training sessions to educate and train the owner's personnel in the maintenance and operation of all aspects and components of the control system they supply. Training on all system components shall include, but not be limited to, the following subjects:

   a. All electrical and mechanical O&M manual items

   b. All system users' manual items

2. Training Sessions: The Contractor shall provide a minimum of 16 hours of on-site instruction to the owner's employees after start-up and commissioning of the system. The owner shall be allowed to video tape all or any part of the training sessions. The Contractor shall prepare and assemble specific instruction materials for each training session and shall supply such materials to the Project Representative at least two (2) weeks prior to the time of the training. The O&M manuals and the system users' manual shall be complete and shall be used in the training sessions.

3. PLC/SCADA System Training: PLC/SCADA System Training shall be conducted by the CSI. The Contractor shall not be responsible for PLC/SCADA system training

4. VFD Training: Training shall cover details of operation of VFD's from the HIM (Human Interface Module). Training shall provide detailed instructions on the modification of VFD operating parameters typically requiring adjustment by operators. The contractor shall develop and provide "cheat sheets" which provide step by step instructions required to accomplish the following:

a. Copy VFD configuration to HIM

b. Copy HIM configuration to VFD

c. Switch between auto and manual modes

d. Manually adjust speed

e. Adjust minimum and maximum speed limits

f. Adjust acceleration and deceleration ramp times

g. Access parameters and fault codes

END OF SECTION

SECTION 17110

PANELS

PART 1 – GENERAL

A. Summary

1. This Section specifies requirements for panels for instrumentation and communication equipment. Additional requirements are specified in sections specifying the various instrumentation and communication systems.

2. Not all products listed are required for all applications. Submit only products required for the application.

B. Related Work Specified Elsewhere

1. Instrumentation and Control Systems: 17010.

C. Quality Assurance

1. Referenced Standards: This Section incorporates by reference the latest revision of the documents listed below. In case of conflict between the requirements of this Section and those of the listed documents, the more stringent requirements shall prevail.

    a. FED STD 595A — Federal Standard Colors

    b. IEC 60947-7-1 — Low Voltage Switchgear and Control gear - Terminal blocks for copper conductors

    c. NEMA 250 — Enclosures for Electrical Equipment (1000 Volts Maximum)

    d. NFPA 79 — Electrical Standards for Industrial Machinery

    e. UL 94 — Tests for Flammability of Plastic Materials for Parts in Devices and Appliances

    f. UL 508A — Industrial Control Panels

2. Listing:

a. All materials and equipment specified herein shall be within the scope of Nationally Recognized Testing Laboratory (NRTL) examination services, be approved by the NRTL for the purpose for which they are used, and shall bear the appropriate listing/label.

b. Equipment listed/labeled by an NRTL acceptable to the local authority having jurisdiction.

c. When a product is not available with a listing/label for the purpose for which it is to serve, the product may be required by the inspection authority to undergo a special inspection at the manufacturer's place of assembly or as a completed assembly in the field. All costs and expenses incurred for such inspections shall be included in the original contract price.

D. Submittals

1. Per Section 17010-1.3.

2. Dimensioned front view drawings.

3. Dimensioned internal equipment layout drawings.

4. Panel assembly drawings shall include sections showing clearances between face and rear mounted equipment with items keyed to the bills of materials.

5. Nameplate engraving schedule showing engraving by line, character size, and nameplate size.

6. Enclosure manufacturers' drawings.

7. Panel seismic calculations.

8. Panel wiring diagram for each panel. The diagram shall meet the requirements as set forth in the NFPA 79 Electrical standards for industrial machinery.

9. Calculations of percentage wire fill for wire ways including factory wiring and allowance for field wiring.

10. Panel load calculations.

11. UPS hold up time calculations.

E. Design Requirements

1. Enclosures shall be limited to the following NEMA 250 types:

a. NEMA 12 Control rooms, switchgear rooms, MCC rooms

b. NEMA 3R Outdoor locations

2. Panel Design:

a. General:

i. Panel size, equipment layout, and other requirements may be specified on the drawings.

b. No panel mounted operator interface devices, such as selector switches, will be mounted greater than 72" or less than 36" above the finished plant floor, with the exception of annunciators.

c. No panel mounted instruments, such as recorders, will be mounted greater than 66” or less than 40” above the finished plant floor, with the exception of the annunciator panel as described below.

d. Panelboards: each panel containing 120-volt powered equipment with an aggregate load greater than 1200 watts shall be provided with a panelboard.

e. Annunciators: Annunciators shall not be mounted with the top frame in excess of 90” above the finished plant floor.

f. Power supplies:

i. The control panels shall contain a dual redundant DC power supply system where indicated.

ii. The DC power supply system shall be per Section 17130.

3. Labeling:

a. Panels shall be manufactured and labeled in accordance with UL 508A and shall bear the UL label.

b. Design shown on Drawings is functional in nature and is for reference and shall be altered as required to make the panels UL 508A compliant.

PART 2 – PRODUCTS

A. Materials and Quality

1. General:

    a. Panel work shall be designed to local and state seismic requirements.

    b. Cutouts for future equipment shall be blanked off with suitable metal covers.

    c. Instrument tag numbers shall be identified on the panel rear per paragraph 17110-2.3.

    d. Nameplates shall identify face-mounted instruments per paragraph 17110-2.3.

    e. Instruments shall be mounted in a manner that allows ease of access to components and ease of removal.

    f. Face-mounted instruments that are more than six inches deep, weigh more than 10 pounds, or exert more than a 4 ft-lb moment force on the face of the panel shall be supported underneath at the rear by a 1-inch x 1/8-inch thick steel angle.

    g. Face-mounted equipment shall be flush or semi-flush with escutcheons.

    h. Floor mounted cabinets without touch screen operator interface panels or panel mounted computers that are less than 60 inches high shall be provided with floor stands to raise the top of the panel to a height as indicated on the drawings, or if not indicated, to at least 60 inches above the floor or work platform. Wall mounting may be used in lieu of a floor stand if panel weighs less than 100 pounds and wall space is available.

2. Fabrication of NEMA Type 12 Industrial Use, Indoor Cabinets with Front Doors:

    a. Enclosure fabricated from 16-gauge minimum thickness sheet steel for enclosures smaller than 24"x24", and 14-gauge minimum for larger enclosures. Face-mounted instruments shall be mounted in the door.

    b. Interior frame or otherwise formed so as to provide a rigid structure

    c. Doors shall be hung on full-length continuous (piano-type) hinges and equipped with vault-type latch capable of accepting a 3/8-inch-shackle padlock

    d. Three-point latch hardware shall be provided for doors exceeding 48 inches height. Door width shall not exceed 34 inches.

3. Fabrication of NEMA Type 4X Cabinets:

    a. NEMA 250, Type 4X requirements

    b. Fabricated from 14 gauge (minimum thickness) Type 316L stainless steel (or fiberglass when specifically specified) and provided with an interior frame or otherwise formed to provide a rigid structure.

    c. Where face-mounted instruments are specified mount on an interior sub-panel

    d. Doors:

        i. Vault-type latch and, if greater than 48 inches high, three-point latch hardware

        ii. Latch shall accept a 3/8-inch shackle padlock.

        iii. Unless shown otherwise, door width shall not exceed 36 inches.

        iv. Full length continuous (piano-type) hinge.

    e. For cabinets located outdoors, equip with rain and sun shields.

4. Outdoor, Door-in-Door Cabinet: NEMA 250, Types 3R and 12 requirements except dust test. Cabinet shall be force-ventilated and provided with a sun shield. Cabinet shall be fabricated from 1/8-inch minimum thickness sheet steel and shall be provided with an interior frame or otherwise formed to provide a rigid structure. Where face-mounted instruments are specified, they shall be mounted on an interior hinged subpanel arranged to swing completely out of the enclosure. Hinges shall be full-length piano-type. Door and subpanel shall be provided with vault-type latch and, if greater than 30 inches high, three-point latch hardware. Door latch shall accept a 3/8-inch shackle padlock. Door width shall not exceed 36 inches.

B. Heating and Ventilating

1. Cooling shall be provided to maintain the internal panel temperature below 104 degrees F (40 °C) when all equipment is operating at its maximum heat load and the ambient temperature is 86 degrees F (30 °C). Filtered forced air ventilation shall be provided for NEMA 12 cabinets and either closed glycol loop heat exchange system or a mechanical refrigeration system for NEMA 4X.

2. Fans shall be equipped with UL-approved washable filters and provide at least 240 CFM. Noise level at three feet from exterior wall and 30 degrees off axis shall not exceed 60 db.

3. Outdoor or below grade cabinets shall not be insulated and shall be provided with thermostatically controlled space heaters.

4. Heater wattage shall maintain the air temperature inside the cabinet above the dew point or 50 degrees F (10 °C), whichever is higher, at all times.

5. If space heater surface temperature exceeds 122 degrees F (50 °C), an expanded metal guard shall be provided.

6. When a strip type heater is used, the heater shall be a 240 VAC heater and connected to 120 VAC and sized to produce the required heat at 120 VAC.

7. Thermostat Acceptable Manufacturer:

   a. Honeywell T631B1054

   b. Johnson Controls A28AA-4

   c. Approved equal

C. Nameplates

1. Machine engraved laminated white phenolic nameplates with black lettering shall be provided for panel mounted equipment.

2. Nameplate engraving shall be as specified and shall carry the instrument tag number in 3/32-inch (2.4 mm) minimum size lettering on the bottom line, or engraved as shown on the Drawings.

3. Nameplates shall be attached to the panel with a minimum of two self-tapping 316 stainless steel screws.

4. Wording may be changed if changes are made prior to commencement of engraving.

5. Machine-printed laminated adhesive labels shall identify tag number of instruments and equipment inside panels.

6. Attach nameplates and labels to panel surfaces, not to instruments.

7. Machine embossed, adhesive backed nameplates shall identify the tag number of equipment inside cabinets.

D. Interconnection Wiring and Electrical Devices

1. Interconnection Wiring:

   a. Power, control, and signal wiring inside panels:

      i. Conductor insulation shall be rated for 600 volts and 90 degrees C in dry locations.

      ii. All conductors shall be stranded copper.

      iii. Power and control conductors in panels shall have insulation type MTW, minimum 16 AWG.

      iv. Wiring for instrumentation analog signals shall be minimum 18 AWG; aluminum foil twisted shielded pairs, Belden type 8760, or approved equal. Wiring for instrumentation analog signals shall be run continuously from measuring instrument to control cabinet terminal strips without splices.

      v. Conductor size vs. fuse rating for conductors inside panels shall be as follows UNO:

18 AWG	<1 AMP
16 AWG	5 AMPS
14 AWG	15 AMPS
12 AWG	20 AMPS

   b. Support wiring independent of terminations by slotted flame retardant plastic wiring channels.

   c. Wiring channels shall comply with UL94, Type V. Wiring channel fill shall not exceed 40 percent.

2. Wire Naming and Tagging:

   a. Wiring shall be tagged at terminations with machine printed plastic sleeves.

   b. Wire numbers shall be as shown on the Drawings. Each wire end shall be tagged.

3. Color Coding:

   a. Color coding of wires within control panels shall be as follows (subject to restriction by UL 508A):

WIRE COLOR CODES				
Code	**Type**	**Color**	**Use**	**Volts**
S1	TSP	BLACK	SIGNAL (+)	5-24 VDC
S2	TSP	WHITE or CLEAR	SIGNAL (-)	5-24 VDC
SG	TSP	BARE	SHIELD DRAIN	5-24 VDC
S1	TRIAD	BLACK	SIGNAL	0-24 VDC
S2	TRIAD	WHITE	SIGNAL	0-24 VDC
S3	TRIAD	RED	SIGNAL	0-24 VDC
SG	TRIAD	BARE	SHIELD DRAIN	0-24 VDC
24P	SINGLE	BROWN	POWER (+)	24 VDC
24C	SINGLE	WHITE/BLUE	COMMON (-)	24 VDC
D	SINGLE	BLUE	CONTROL	24 VDC
125P	SINGLE	BROWN	POWER	125 VDC
125C	SINGLE	WHITE/BLUE	COMMON	125 VDC
B	SINGLE	BLUE	CONTROL	125 VDC
L	SINGLE	BLACK	POWER	120 VAC
N	SINGLE	WHITE	NEUTRAL	120 VAC
C	SINGLE	RED	CONTROL	120 VAC
PG	SINGLE	GREEN	POWER GND	EARTH GND
SG	SINGLE	GREEN/YELLOW	SIGNAL GND	EARTH GND
UL	SINGLE	BLACK/WHT	UPS POWER	120 VAC
UN	SINGLE	WHITE/GREY	UPS NEUTRAL	120 VAC
EX	SINGLE	YELLOW	EXTERNAL	120 VAC
EXN	SINGLE	WHITE/YELLOW	EXTERNAL NEUTRAL	120 VAC GND'D
A	SINGLE	BLACK OR BLUE	ANNUNCIATOR	120 VAC/24VDC
IO	SINGLE	BLACK OR BLUE	ISOL I/O	120 VAC/24VDC
R	SINGLE	BLUE	RTU	12 VDC
IS	SINGLE	LIGHT BLUE	INTRINSIC SAFE	<12 VDC

b. Power and control wiring shall be carried in covered wiring channels separate from low voltage analog signal circuits.

c. All control wiring in control panels or other enclosures that is powered from an external source and is not disconnected by the control panel disconnect shall be terminated at a disconnecting terminal block (with energization indicator light upon entering the enclosure.) The color of the wire shall then be changed to yellow to identify it as being powered from an external source. Provide identification nameplate on exterior of enclosure to indicate sources of external power.

4. Terminal blocks and accessories:

a. UL listed

b. DIN rail mounted. Compliant with IEC 60947-7-1

c. Compression clamp type terminal rated for 600 volts and 30 Amperes

d. 22 AWG to 12 AWG copper wire size range

e. Mark using marker carrier and preprinted marker bars for the terminal numbers

f. Acceptable manufacturers:

i. Entrelec Series: Typical Entrelec catalog numbers are the following:

Terminal Block:	Type MS 4/6
Switch Block:	Type M 4/6.SNT
Fuse Block:	Types M 4/8.SFL, M 4/8.SFD, M 4/8.SFD1

ii. Phoenix Contact Series UK IEC Terminal Blocks, Switch blocks and Fuse blocks

iii. Allen-Bradley Series 1492 IEC Terminal Blocks, Switch blocks and Fuse blocks

iv. Omron series, Switch block and Fuse blocks.

v. IDEC series, Switch block and Fuse blocks.

vi. Approved equal

g. Field connections shall be to separate terminal blocks. Terminal blocks for field terminations shall be in a separate part of the panel close to where the field cables enter the panel.

h. External circuits shall be fused. Fuses shall include blown fuse indicator lamps.

i. Comply with UL 508A requirements in construction.

E. Panel Grounding

1. Each panel shall be provided with two copper ground bars. One bar shall be bonded to the panel frame or sheet metal and to the station ground system. The second (signal) ground bar shall be mounted on insulated stand-offs and shall be bonded to the frame ground bar at one point only.

2. Signal circuits, signal cable shields, and low-voltage DC power supply commons shall be bonded to the signal ground bar.

3. Surge protectors and separately derived AC power supplies shall be bonded to the frame ground bar.

F. Fuses

Circuits shall be fused. Fuses shall be 1/4 x 1-1/4 inch. Fuses on 120V AC circuits shall be ceramic tube type with 25,000 amperes interrupting capacity at 125 volts and neon blown fuse indicator lamps. Fuses for 24V DC circuits shall be fast acting glass tube type rated 1/8 or 1/10 amp for 4-20 mA loops and 1/2 amp for the power supply to individual instruments. Fuse holders for 120V AC shall be drawout type and molded from melamine plastic.

G. Surge Protection

Surge Protection: Per Section 17010

H. Panel Light, Switch, and Convenience Outlet

Provide a light with a door actuated switch in control panels that contain a PLC rack, relays, or other equipment that would require troubleshooting or operator access for normal operation. Provide a duplex outlet, 120VAC 15A, in all panels that require a computer or other maintenance tools that may need a power source. These shall be on a separate dedicated circuit.

I. Panel Disconnect Switch

All control panels shall be provided with a main power disconnect switch. Label panels with multiple power sources and identify power sources.

PART 3 – EXECUTION

A. General

1. Wired as shown on the wiring diagrams.

2. Control room cabinets:

   a. Mount on channel iron sills as specified.

   b. Sills shall be leveled so panel structures will not be distorted.

   c. Panels shall be shimmed to precise alignment so doors operate without binding.

   d. Sealant shall be provided under panels not located in dry control or electrical equipment rooms.

   e. Mount field panels and cabinets in compliance with Section 17010.

   f. Floor-mounted cabinets except in dry control rooms or electrical equipment rooms shall be mounted on 3-1/2-inch minimum height concrete pads or grouted bases as specified.

   g. Mount record drawings for wiring, connection and interconnection diagrams behind a piece of Plexiglas on the inside of one (or more) door(s).

3. Terminals and terminal blocks shall be sprayed with a silicone resin, similar to Dow Corning R-4-3117 conformal coating, after all terminations have been completed.

B. Coating

1. Except for stainless steel and fiberglass panels, all panels and cabinets shall be painted inside and out. Exterior finish shall be an enamel meeting ANSI 61 gray. Interior panel finish shall be an enamel meeting Federal Standard 595: 27880 white.

2. Treat cutouts to prevent corrosion.

3. Except for stainless steel enclosures, the metal surfaces of panels, cabinets, and consoles, shall be prepared, primed, and finish coated per Section 09900.

4. Except for stainless steel enclosures, the metal edges of cutouts for instruments, switches, lights, etc., in panels, cabinets, and consoles shall be prepared, primed, and finish coated per Section 09900.

END OF SECTION

SECTION 17221

FIELD INSTRUMENTS GENERAL

PART 1 – GENERAL

A. Summary

1. This Section specifies general requirements for field instruments. This section applies to instrumentation elements that quantitatively convert sensed process energy into a form/signal compatible with process measurement, control, and display devices and accessories.

2. Performance Benchmarks: Items listed by part number are intended to serve as performance benchmarks. Submit most current model meeting the benchmark performance requirements for items that have been superseded or are otherwise obsolete UNO.

3. Not all products listed are required for all applications. Submit only products required for the application.

B. Related Work Specified Elsewhere

1. Instrumentation and Control Systems: 17010.

C. Quality Assurance

1. Referenced Standards: This Section incorporates by reference the latest revision of the documents listed below. In case of conflict between the requirements of this Section and those of the listed documents, the more demanding requirements shall govern.

   a. ANSI B16,5 Pipe Flanges and Flanged Fittings

   b. API RP550 Manual on Installation of Refinery Instruments and Control Systems, Part 1- Process Instrumentation and Control

   c. ASTM A276 Stainless Steel Bars and Shapes

   d. NEMA 250 Enclosures for Electrical Equipment (1,000 Volts Maximum)

2. Listing:

a. All materials and equipment specified herein shall be within the scope of Nationally Recognized Testing Laboratory (NRTL) examination services, be approved by the NRTL for the purpose for which they are used, and shall bear the appropriate listing/label.

b. Equipment listed/labeled by an NRTL acceptable to the local authority having jurisdiction.

c. When a product is not available with a listing/label for the purpose for which it is to serve, the product may be required by the inspection authority to undergo a special inspection at the manufacturer's place of assembly or as a completed assembly in the field. All costs and expenses incurred for such inspections shall be included in the original contract price.

D. Submittals

1. Per Section 17010-1.3.

PART 2 – PRODUCTS

A. Float Switch:

1. The float switch shall be a direct acting micro switch, which actuates or deactuates with changes in fluid level.

2. The switch shall be inserted within a polypropylene body forming an impact and corrosion resistant watertight unit.

3. Cable shall be encased within a watertight cable suitable for wastewater.

4. The float shall be mounted to a 1-inch Type 316 stainless steel pipe with a stainless steel mounting clamp.

5. The float switch shall be Flyt ENM-10. No equal.

B. Level Transmitter – Ultrasonic Type

1. The system shall use ultrasonic level transducer to measure the level of liquid and shall consist of a sensor with interconnecting cable and an ultrasonic controller which can be located up to 250 feet from the transducer.

2. Controller shall be microprocessor based. Level sensing shall be automatically compensated over the system temperature range of at least 0°C to 50°C and shall incorporate digital algorithmic echo extraction and filtering. Synchronization capability shall be provided. When synchronized, no transmitter shall transmit a

signal within a certain time interval of the prior one. Application parameters shall be stored in non-volatile EEPROM. Calibration shall require no reference targets.

3. Accuracy shall be ±0.25% or better. Output shall be 4 mA to 20 mA proportional to the range of level sensing. Ultrasonic transmitter shall also have a minimum of three contact outputs (SPDT each) with adjustable setpoints and deadbands which can be used for pump control and alarming. In the case of momentary signal loss, relays shall maintain their last state. The transducer shall be FM approved for Class I, Division 1 and housed in a NEMA 4X enclosure. The ultrasonic unit shall be powered by 115 volts a-c. Transducer to transmitter interconnecting cable shall be provided and shall be the manufacturer provided cable. The transducer shall be mounted with a stainless steel wall mounted bracket.

4. Ultrasonic unit controller shall be Siemens HydroRanger 200 with EchoMax XPS-10 transducer

C. Pressure Transmitter

1. The transmitter shall be of the microprocessor-based type 2-wire system. The transmitter shall operate from a 24-volt DC source. The output signal shall be 4 mA to 20 mA DC. The transmitter shall be housed in a NEMA 4 enclosure.

2. Configuration data shall be stored in nonvolatile EEPROM memory in the transmitter electronics module. This data shall be retained in the transmitter when power is interrupted, so the transmitter shall be functional immediately upon power up. The transmitter shall perform continuous self-test. In the event of a problem, the transmitter shall activate the user-selected analog output warning. A HART Communicator or other HART-based communications device can then interrogate the transmitter to determine the problem. The transmitter shall output specific information to the communicator identifying the problem for fast and easy corrective action.

3. The pressure transmitter shall provide an electronic signal proportional to the calibrated pressure range. The pressure-sensing element shall be silicone oil filled with a process media operating temperature range of -40º to 250º F. An integral stainless steel block/bleed manifold (pre-assembled to the transmitter and leak checked) shall be provided for each transmitter. The manifold shall have block and a vent/test valves.

4. Isolation diaphragm shall be provided with Hastelloy C 276 material for corrosive service manufactured by Ashcroft series 200, Rosemount or equal.

5. Provide the pressure transmitter with the following features:

    a. Independent external zero and span adjustments.

b. Over-range protection.

c. Vent/drain valve.

d. Integral digital signal indicator.

6. Accuracy of the pressure transmitter shall be +/-0.2% of calibrated span.

7. The pressure transmitter shall be manufactured by Endress +Hauser , Rosemount, or equal

D. Output Indicators

1. Provide with any transmitter that does not include an integral indicator.

2. Output indicator shall be a loop powered current-to-digital display indicator.

3. Input current shall be 4-20 mA and display shall be a 3 1/2 active digit liquid crystal display with black numerals at least 0.35 inches high.

4. Display scalable with decimal point to read process engineering units.

5. Enclosed in a hockey puck type housing with glass window, classified as appropriate for the area in which the output indicator is installed.

6. A diode shall be provided to maintain loop continuity in case of indicator failure or removal.

7. Accuracy shall be +/- 0.1 percent of reading.

8. Indicators, whether integral or separate, shall be calibrated in process units.

9. The units shall be engraved on the indicator scale plate.

10. The installed orientation of the output indicator shall enable operators to easily read the display from the operating floor.

11. Acceptable Manufacturer:

    a. Action Instruments models V561/V565

    b. Precision Digital models 697/698

    c. Moore Industries models PSD/SPD

    d. Approved equal

E. Detailed Instrument Requirements

1. Detailed requirements for specific instruments are specified in other Division 17 specification sections.

F. Signal Current Isolator

1. Provides galvanic isolation of milliampere transmission signals from transmitters with inadequately isolated output circuits. House in a NEMA 250, type 4X/7 conduit body. Derive its operating power from external power supply.

2. Input and output signals shall be 4 to 20 mA and error shall not exceed 0.1 percent of span. Input resistance shall not exceed 550 ohms with an output load of 250 ohms.

3. Acceptable Manufacturer:

   a. Moore Industries model ECT

   b. Phoenix Contact model Mini MCR

   c. Approved equal

G. Intrusion Switch

1. Intrusion switch shall be held normally open switches, held close by the hatch or door.

2. Intrusion switch shall be roller level arm type with sealed contacts for hazardous location

3. Intrusion switch shall be Allen Bradley, Square D, Omron, IDEC or equal.

PART 3 – EXECUTION

A. Installation

1. Installation requirements per Section 17010.

2. Electrical Connections: Final connections between rigid raceway systems and instruments shall be made with jacketed flexible conduit with a maximum length of two feet.

3. Tagging: All field instruments shall be labeled with function and instrument number, i.e. (FIT-901-01/A-STREAM INFFLUENT FLOW METER). Tag shall

be 10ga 316 stainless steel with stamped letters and numbers attached to device with 12ga 316 stainless steel wire.

B. Testing

1. Testing requirements per Section 17010.

END OF SECTION

SECTION 17300

PROGRAMMABLE LOGIC CONTROLLERS AND PROGRAMMABLE OPERATOR INTERFACES

PART 1 – GENERAL

A. Description

This section includes materials, installation and testing of programmable logic controllers, and programmable operator interface equipment.

B. Related Work Specified Elsewhere

1. General Instrumentation and Control Requirements: 17000.

C. Submittals

1. Submit shop drawings in accordance with the General Provisions and the following:

   a. Provide a copy of program to the District on a CD for review.

PART 2 – MATERIALS

A. General Requirements

Provide PLC system as shown on drawings. Provide all I/O (analog and discrete), interface modules, and other cabling and hardware as needed to provide a fully functioning system.

B. Programmable Logic Control System

1. A fully integrated programmable logic control system shall be furnished as specified in this section and on the drawings. The PLC system shall come complete with processor, memory, power supply, interconnecting cables, and discrete and analog I/O interface modules.

   The A-C power of the control system will be 120-volt +/-10% a-c, 60 hertz, single phase derived from line power. The system shall be designed to operate satisfactorily from 0 C to 60 C ambient temperature for the PLC.

Input/Output: At the PLC locations, analog transmitters and receivers have 4- to 20-ma signals. Discrete (on/off) inputs originate from dry relay contacts. For discrete control output, provide relays with dry contacts. Refer to instrumentation diagrams for I/O requirements.

2. Discrete PLC I/O modules shall have individual LED status lights for each I/O point. All discrete and analog modules shall have terminal blocks for termination of the I/O wires. Individual I/O points shall be capable of withstanding low energy common mode transients to 1,500 volts.

3. Provide the following minimum spare I/O:

   a. Analog Inputs: Two

   b. Discrete Inputs: Six

   c. Discrete Outputs with Interposing Relay: Four

   d. Two Empty Rack Slots

C. Programmable Logic Controller (PLC) Component Manufacturer

The PLC components including I/O modules, shall be manufactured by Allen Bradley ControlLogix, no equal.

D. Programmable Logic Controller (PLC) Chassis

The PLC backplane mounting rack shall be a Controllogix Series, Model Number 1756-A4, four slot rack minimum. Refer to the minimum spare rack slot requirements above, and increase the size of the backplane mounting rack to a seven slot (1756-A7), anD ten slot (1756-A10) or thirteen slot (1756-A13) rack as required.

E. Programmable Logic Controller (PLC) Power Supply Module

1. For 120 VAC powered PLC, the PLC rack power supply shall be a Controllogix Series, Model Number 1756-PA72, 115/230 VAC.

2. For 24 VDC powered PLC, the PLC rack power supply shall be a Controllogix Series, Model Number 1756-PB75, 24-48 VDC.

F. Programmable Logic Controller (PLC) Controller Module

1. The logic and variable memory shall be read/write RAM. All RAM shall have integral battery backup that will maintain the memory for a minimum of six months upon a utility power failure. The logic and variable memory shall be sufficient for programming all specified functions plus 25% spare memory.

2. The PLC Controller module shall be Controllogix Series: Model 1756-L61, or as shown on the drawings. This controller is considered a minimum requirement and shall be larger as required by the specific application.

G. Programmable Logic Controller (PLC) Discrete Input Modules 16 Points, 24 VDC

1. The 24 VDC PLC discrete input modules shall have noise filters or use other techniques to reject short-time constant noise and 60-Hz pickup.

2. The 24 VDC discrete input modules shall be Controllogix Series: Model Number 1756-IB16, 16 inputs per module, 24 VDC.

H. Programmable Logic Controller (PLC) Discrete Output Modules, 16 Points, 24 VDC

1. The 24 VDC PLC discrete output modules shall have noise filters or use other techniques to reject short-time constant noise and 60-Hz pickup.

2. The 24 VDC discrete output modules shall be Controllogix Series: Model Number 1756-OB16I, 16 outputs per module but only 16 outputs to be used, 24 VDC, prefab cable.

I. Programmable Logic Controller (PLC) Analog Input Modules

1. The PLC analog inputs shall be suitable for accepting 4- to 20-ma from either 2- or 4-wire transmitters. The input power shall be from an external 24-volt DC power supply. The analog to digital converter shall have a 10-bit minimum resolution with an overall accuracy of +/-1% at 60º C.

2. The analog input modules shall be Controllogix Series: Model Number 1756-IF8, 8 inputs per module, 20 points terminal block.

J. Programmable Logic Controller (PLC) Analog Output Modules

1. The PLC analog outputs shall be 4- to 20-ma signals suitable for driving into a 0- to 600-ohm load without load adjustments. The digital to analog converter shall have a 10-bit minimum resolution with an overall accuracy of +/-2% at 60º C. The

output power shall be from an external, 24-volt DC power supply. If the PLC fails, the analog outputs shall retain their present value.

2. The analog output modules shall be Controllogix Series: Model Number 1756-OF4, 4 outputs per module.

K. Programmable Logic Controller (PLC) Ethernet Communications Module

Controllogix Series: Model Number 1756-EN2T.

PART 3 – EXECUTION

A. General Requirements

1. Contact the owner prior to installing I/O modules into existing PLC racks.

B. PLC Controller Programming Requirements

1. City integrator shall perform programming of the PLC Controller unless otherwise stated in the project documents or on the drawings.

C. Power Source

1. The power source for the PLC system shall be an Uninterruptible Power Supply for 120-volt AC powered systems.

2. The power source for the PLC system shall be from a battery backed or UPS backed power supply for 24 vdc-powered systems.

D. Testing

1. Test System per Section 17000.

E. Input/Output Wiring

1. All field wiring shall connect to field terminals. Do not connect field wires directly to the PLC Input/Output Modules.

2. Install wiring from the PLC Input/Output modules to field terminals for all spare module inputs and outputs.

END OF SECTION

SECTION 17804

TESTING AND COMMISSIONING

PART 1 – GENERAL

A. Summary

1. Scope: The Contractor shall test, verify, document, and demonstrate each and every aspect of the functionality and characteristics of all of the devices, equipment, and systems they supply, individually and as an interconnected system. The overriding purpose of required testing is to ensure and convince the project representative that the supplied equipment, systems, and programs are 100% functional and in full compliance with the contract and the needs of the process prior to being put into operational service. The items listed below as well as other items required by this section shall be tested in accordance with the requirements of this Section:

    a. All control system hardware, components, assemblies, wiring, interconnections, cabling, etc.

    b. PLC's

    c. OIT's

    d. SCADA HMI including data acquisition servers

    e. Data historian

    f. Remote alarm notification system

    g. Communications apparatus and channels

    h. Network devices and media

    i. All programming except the Plant PLC and SCADA programs developed to operate the plant (program development by others).

    j. All configurations including Plant PLC/SCADA.

    k. Control panels

    l. MCC's

    m. Packaged equipment control systems

2. Related Sections: The requirements of the Sections listed below are related to the work of this Section. Other Sections, not referenced below, may also be related to the proper performance of the work specified in this section. It is the Contractor's responsibility to comply with all of the requirements of all of the Contract Documents.

    a. Section 17010: Instrumentation and Control Systems.

3. Tests and Witnessing: A comprehensive series of Contractor conducted tests shall be performed and documented as specified. Tests shall be witnessed by the project at the projects discretion. The Contractor shall test and verify the performance of all equipment, software, and integrated systems supplied. If equipment or software does not have specific tests defined in the contract documents, then the Contractor shall develop testing procedures and submit to the project for approval.

4. Programs not provided by the CSI: All programming on the project will be provided by the CSI, the design consultant, or packaged equipment suppliers. Programs shall be tested by those who provide the programs. The contractor and CSI shall provide integration and testing support for hardware and non programmed system functions as required to support third party programmers in the installation, testing, commissioning, and demonstration of programming not provided by the CSI to the extent that the programming provided by others interfaces with or otherwise interacts with contractor and CSI provided systems.

5. Packaged equipment control systems: Suppliers of packaged equipment control systems shall comply with all requirements stated in this section for CSI supplied control systems and components for their scope of work and supply. The CSI shall not be responsible for the application of this section’s requirements to equipment supplied by others. The CSI shall be required to provide integration and testing support to packaged equipment suppliers to the extent that CSI supplied systems interface with or otherwise interact with packaged control systems. Packaged equipment suppliers shall, for their scope of work and supply, rigorously verify all control, monitoring, communications, and interface functionality required between vendor systems and plant systems and equipment, including MCC’s and plant SCADA system application software and equipment.

6. Test and Document All Data Points and Functions End to End: All process data points connected to the control systems shall be tested, verified, and documented by the contractor, end to end, to produce the required result from signal origin, thru logical processing and calculation functions, to signal and data destinations and process equipment responses. The test and verification of the correct reception, transmission, processing, and storage of all process data input and output points shall be individually and collectively documented in appropriate test forms, test logs, test reports, etc. All functions and logical processing of all process data input and output points shall be tested, verified, and documented individually and

collectively. The generation of all data calculated from process input and output data shall be tested and verified individually and collectively.

a. Signal origins include, but are not limited to the following:

    i. Process switches

    ii. Field instruments

    iii. MCC control circuitry

    iv. Packaged equipment control panels

    v. Valve actuators

b. Signal processing functions include but are not limited to the following:

    i. Control sequence functions per control strategy documents

        a) Relay logic

        b) PLC programming

    ii. Alarm generation and signal trip

    iii. Calculations such as counters, timers, and totalizers

    iv. Data logging

    v. Automatic remote alarm annunciation functions

    vi. Report generation

    vii. Network communications

c. Signal and data destinations and results include but are not limited to the following:

    i. Display devices of any kind

    ii. SCADA, Historian, PLC, Auto dialer data bases

    iii. Data reports and Historian queries

    iv. MCC control circuitry

v. Packaged equipment control panels

vi. Valve actuators

vii. Stand alone motor controls

viii. Remote access devices

B. Quality Assurance

1. Referenced Standards: This Section incorporates by reference the latest revision of the documents listed below. In case of conflict between the requirements of this Section and those of the listed documents, the more stringent requirements shall govern.

   a. None listed

C. Submittals

1. General: Per 17010-1.3.

2. Test plans and Documentation: Provide complete documentation of all test schedules, plans, procedures, and results. Test results documentation shall utilize a tracking process for each component of the system and the system as a whole. The tracking process shall document all tests, the outcome of each test, shall record failures, the reasons for failures, and the remedies used to correct the failures. Test schedules, plans, procedures, forms, formats, etc., shall be submitted the project for review and approval before the start of factory tests and site tests. Provide the documents listed below as well as any other documents required by this section:

   a. Factory test schedule, plan, procedures, forms, logs, reports, etc., as specified in Part 2.

   b. Site test schedule, plan, procedures, forms, logs, reports, etc., as specified in Part 2.

3. Submittal Format: All documentation shall be submitted in hard copy and electronic file format.

PART 2 – PRODUCTS

A. Test Plans

1. General: Prepare separate test plans for the Factory Tests and Site Tests (start up and commissioning).

2. Factory Test Plan: Test plan shall include the items listed below.

    a. Test Schedule

    b. Test procedures

    c. Test report format

    d. Test log format

    e. Door mounted discrete interface and display device test form

    f. PLC and MCC discrete and analog I/O test forms

    g. Instrument calibration form

    h. Loop test form

    i. Non programmed function test form

    j. Programmed function test form

    k. Test instrument list including calibration data

    l. Test fixture information, for simulating field wiring connections

    m. Integration Test Diagram: For factory test provide a test setup diagram showing all hardware and interconnections planned to accomplish factory integration testing of the supplied system. The diagram should include the following components:

        i. Control panels

        ii. MCC's

        iii. OIT's

        iv. SCADA components

        v. Cabling and wiring

        vi. Network devices and media

        vii. Communication devices and media

        viii. Test fixture

3. Site Test Plan: All system components must be re check after installation on site. Test plan shall include the items listed below.

    a. Test Schedule

    b. Test procedures

    c. Test report format

    d. Test log format

    e. Door mounted discrete interface and display device test form

    f. PLC and MCC discrete and analog I/O test forms

    g. Instrument calibration form

    h. Loop test form

    i. Non programmed function test form

    j. Programmed function test form

    k. Test instrument list including calibration data

B. Test Schedule

Provide test schedule to Project Representative 30 days prior to planned testing activities. Indicate itinerary for each planned day of testing. Indicate planned witnessed test dates. Indicate expected test report transmittal dates.

C. Test Procedures

1. General: Structure test procedures in a step-by-step manner. Provide separate procedures for separate function and test types. The procedures shall facilitate the generation and reporting of test results and the re-creation of error conditions. Procedures shall provide methods to test and document all required system functions, sequences, and responses to field conditions. Provide test procedures for the following types of tests as well as any others required by this section:

    a. Discrete input and output loop tests, PLC and MCC

    b. Analog input and output loop tests, PLC and MCC

    c. Panel front and MCC unit door device tests

d. Non programmed function tests

e. Programmed function tests

f. Programmed display device tests

g. Data bases, Historian, and reporting function tests

h. Software alarm dialer tests

D. Test Reports

1. General: Compile and prepare reports for documenting un-witnessed portions of Factory and Site Tests (start up and commissioning). Develop test report formats to record test results and conditions. Reports shall be completed and submitted for review and approval prior to witnessed portions of factory and site tests. Test reports shall include the items listed below. Complete and submit the following for review and approval:

   a. Test summary

      i. Summary description of tests being conducted

      ii. Test dates

      iii. Tester names

      iv. Witness names

      v. Prerequisite tests and status

      vi. Test objectives and methods summary

      vii. Test and monitoring equipment lists

      viii. Test results summary

   b. Test log

   c. Test procedures

   d. Test forms listed below, completed

   e. Test check off documents listed below, completed

f. Listing of all configurable device parameters and settings for all configurable equipment

E. Test Log

The CSI shall keep a test log that shall be developed during un-witnessed portions of factory and site testing which documents the performance of each device, loop, circuit, function, feature, etc., of the system. Failures shall be noted in the test log and corrected prior to witnessed portions of factory and site testing. Log format may be somewhat informal. Logs shall be kept for each day of testing. Logs shall be signed and dated by all testers.

F. Test Check Off Documents

1. Approved, as-built process and instrumentation drawings, contract or shop schematic drawings (factory test only), and control strategy documents shall be used as check lists during testing to ensure all items and functions are tested. All items on applicable documents shall be tested, verified to provide the required result, and checked off to indicate completion of testing for each element, feature, and function. All sheets of these documents shall be signed and dated by the tester and included in test report submittals.

2. Conformance of contract documents prior to testing: Applicable contract and shop documents and control strategies shall be revised by the contractor as needed to conform to the actual systems, equipment, and control strategies submitted and installed by the contractor or supplier prior to use in testing.

3. Screen shots of all OIT and SCADA HMI screens with all elements check marked to indicate successful testing of required functionality and characteristics. Correct and retest until all elements test successfully for inclusion, color usage, animation, and read-write functionality. Testers shall sign and date sheets and include with test report submittal.

G. Test Forms

1. Form Types: Form types may be combined where appropriate. Provide appropriate forms for the following types of tests:

   a. Door mounted discrete interface and display device test form for control panels and MCCs.

   b. PLC and VFD discrete and analog I/O test and calibration forms.

   c. Instrument calibration form.

   d. Field Loop test form.

e. Programmed and non programmed function test forms.

f. PID loop tuning form.

g. Programmable and non programmable display device test forms.

h. Data base, Historian, and reporting function test forms.

i. Software alarm dialer test form.

j. Communications channel test form.

k. Network connectivity test form.

2. General Information on Forms: Forms shall include appropriate general information such as the following:

a. Point or loop identification for all analog, discrete, or communications signals.

b. Applicable drawing and control strategy document numbers

c. Logical function of signal or complex function.

d. Test Procedure text or reference to typical procedure.

e. Test equipment used.

f. Signal stimulus method if signal is forced. Provide all thresholds and ranges in process engineering units.

g. Process manipulation method if process variation is used to test the signal. Provide all thresholds and ranges in process engineering units.

h. Expected result, allowable limits, success criteria.

i. Actual result.

j. Accuracy calculation.

k. Conclusion (successful or description of corrective action).

l. Tester name, test date.

3. Loop and Function Test Forms: The contractor or packaged system supplier, as applicable, shall test, verify, and document that all signal interfaces between

provided control system components and plant equipment, MCC's, devices, and other control systems correctly transmit and receive and produce the required results. The contractor and system supplier shall provide a separate test and verification form for each discrete, analog, and digital data connection to the provided systems as well as for all required system functions. The forms shall include the information listed above as well as any additional information needed to clearly demonstrate that each interface data communications signal functions as required and produces the desired result:

a. Provide for all discrete and analog input and output data points.

b. Provide for all hardwired and programmed functions.

c. Provide for control panel signal loops and motor control equipment signal loops.

d. Provide for digital data exchange between software components.

4. Calibration and Test Forms Provided With Specifications

a. Sample calibration and test forms are included with these specifications. Appropriate forms shall be used as needed and where ever calibration and test forms are referenced by Division 17 specifications. The CSI shall submit additional forms as needed where a suitable form is not included in the provided set of forms. Test forms shall be completed for all devices and subsystems as required by Division 17 specifications for all required test phases. Completed forms shall be submitted with test reports following un-witnessed potions of factory and site tests. Provide a final set of calibration and test forms with the O&M manual submittal.

b. Any testing, calibrations, and report forms provided in these documents are provided to the contractor as is and for use and modification, if needed, by the contractor. The provided forms do not necessarily provide all needed forms or data fields and do not necessarily support all required testing, documentation, and report formats. The contractor shall provide any additional forms or shall modify the provided forms as needed to meet the testing and reporting documentation requirements. Simply filling out the provided forms will not necessarily satisfy the requirements of this section. The specified testing and documentation requirements do not necessarily require all of the provided forms.

PART 3 – EXECUTION

A. Tests and Inspections General Requirements

1. Inspection: Materials, equipment, and construction included under this Specification shall be inspected in accordance with the contract plans, specifications, and the approved shop drawings. Any and all substitutions will require re submittal and rigorous quality control.

2. Notification and Schedule: No required test shall be performed without prior verifiable notice to the Project Representative. The Contractor shall provide test plans, schedules, and procedures per sections 2.01, 2.02, and 2.03, 30 days prior to the planned beginning of each test phase.

3. Scope: The CSI shall provide all programming and associated testing, documentation, and commissioning services specified UNO. The Contractor and the CSI shall provide all personnel, facilities, utilities, labor, tools, material, equipment, etc., required to accomplish the testing and documentation requirements.

4. Commissioning Support: The CSI and packaged system suppliers shall continuously support the Contractor during witnessed site testing (commissioning) of the completed project. The CSI and packaged equipment suppliers shall be required to provide this support to the extent and on the schedule requested by the project representative. Typically the CSI, packaged equipment suppliers, and the Contractor will be asked to have one qualified tradesman each onsite and available for the duration of testing tasks.

5. Packaged Equipment: Packaged system vendors shall perform factory testing of packaged control systems in vendor facilities and site testing on site. Packaged equipment vendors shall comply with all of the submittal, testing, and documentation requirements of this section applied to their scopes of supply. Packaged equipment test schedules shall parallel and integrate with contractor test schedules. The project representative may elect to or decline to witness packaged equipment factory tests at their discretion. The Contractor shall inform the project representative of the vendor's factory test schedule 30 days in advance of the planned start date.

6. Witnessed Testing Prerequisites: All systems shall be tested and tests documented by suppliers of all control systems prior to any scheduled witnessed testing. The un-witnessed factory and site test reports shall be provided to the project at least one week prior to planned witnessed testing. The project may request complete testing to be witnessed, may request to witness some but not all of the tests, or may waive the witnessed testing.

7. Duration: Test duration shall be per the contract documents and project schedule. The contractor, sub contractor, and equipment suppliers shall be sufficiently organized and have accomplished sufficient progress such that no witnessed test phase shall take more than 5 working days.

B. Factory Testing

1. General: Factory acceptance test and verification for all deliverable equipment, programs, and associated documentation shall be performed prior to shipment of the system to the site. The tests shall verify that all equipment including control panels, PLC, OIT, SCADA equipment, MCC's, etc., are manufactured, configured, and assembled correctly, and are operating as required. The tests shall verify that the software and hardware meet the quality, functional, and performance requirements of the project.

2. Un-Witnessed tests shall be documented: All test documents shall be completed and submitted to the project representative prior to witnessed testing.

3. Device and Assembly Verification (Un-Witnessed): The completed control systems assemblies shall be thoroughly verified in the shop of and by the supplier prior to witnessed factory testing. Testing shall verify the functionality of all supplied devices, the correctness of all panel wiring, and shall verify all required system functions and features including non programmable control logic, annunciation, alarming, networking, communications, etc. The CSI shall verify the proper operation of all system devices and circuits, including but not limited to all inputs, outputs, loops, circuits, control devices, etc. The CSI shall configure and verify the functionality of all supplied communications and network devices. Testing of the supplied control system shall include energizing each discrete input and output and simulating each analog input and output using a loop simulator and calibrator or other appropriate device. All circuits shall be energized simultaneously or as expected in maximum power supply loading operation during testing. Un-witnessed testing of the supplied control system shall be conducted continuously, 24 hours per day, for at least seven (7) days without a failure or interruption. Provide the documents listed below as well as others required by this specification section:

    a. PLC IO Wiring: Test and verify the correctness of all wiring of PLC discrete and analog input and output modules to the correct field terminals. Provide completed PLC IO verification forms to document this test. Include description of test methods.

    b. PLC Analog IO Calibration: Test the accuracy of all PLC analog input and analog output points to the field terminals. Provide PLC analog IO calibration forms to document this test. Include description of test methods.

c. VFD Analog IO: Configure supplied VFD's per the requirements and specifications. Test and verify the accuracy and response of VFD analog IO. Provide MCC analog IO calibration forms to document this test. Include description of test methods.

d. Discrete Interface and Display: Test and verify all discrete field located and control panel or MCC door mounted display and operator interface devices. Document these function tests individually or in logical groups on appropriate forms. Include description of test methods.

e. Non Programmed Functions: Test and verify the responses of all non programmed hardware driven logical functions at control panels and MCC's. Functions include signal trip, alarm generation, relay logic, interlocks, etc. Document these tests individually or in logical groups on appropriate forms. Include description of test methods.

4. Factory Integration Testing (Un-Witnessed): All packaged equipment supplier or CSI provided programs including PLC, OIT, SCADA components, historian, alarm dialer, etc., programs shall be 100% complete, installed, and functioning prior to factory integration testing. All programs shall be thoroughly tested and verified prior to factory test witnessing. This requirement applies to all programs within the scope of services of the contractor or packaged system supplier. The CSI or system supplier shall verify all required functions and features of the system. Testing shall verify all instrumentation, display, communications, network, automatic control, manual control, annunciation, alarming, OIT (UNO), SCADA HMI (UNO), etc., functions of the control system. For CSI or packaged equipment supplier provided programming, provide the following documentation as well as other documentation required by this section:

   a. Programmed Functions: Test and verify all programmed control strategy functions. Specified input conditions shall produce all specified output and operational results. Document these tests individually or in logical groups on appropriate forms. Include description of test methods.

   b. Programmable Displays: Test and verify the correct display, read-write functionality, and animation of all specified data points on programmable display devices. Document these tests by providing complete sets of contract P&ID drawings and display screen print outs with each item check marked to indicate compliance or other equivalent and appropriate means. Include description of test methods.

   c. Data Historian: Test and verify the correct logging of process data to the data historian and the correct rendering of required data reports from the process data historian. Document this test by providing tag lists and report formats with each item check marked to indicate compliance or other appropriate and equivalent means. Include description of test methods.

d. Remote Alarm Notification: Test and verify the correct configuration and callout functionality of all specified remote alarm notification system points. Document this test by providing the call out tag list with each tag check marked to indicate compliance. Include description of test methods. Coordinate and provide staff call list during the un-witnessed site test phase.

5. Field Wiring and Test Fixture: The electrical interfaces of all system equipment not present for factory testing shall be simulated with a test fixture provided by the CSI. The test fixture shall provide switches, indicator lights, digital signal displays, labeling, etc., as required to simulate field devices. All supplied control system I/O not connected to actual system equipment shall be connected to interface or indication devices on the test fixture. The test fixture devices connected to control system I/O shall be labeled to indicate the control system function being performed or indicated. Sufficient loop simulators (or other appropriate device) needed to satisfy all analog programming conditions simultaneously shall be provided by the CSI. Digital panel meters shall be provided for analog outputs not connected to actual system devices. It is essential that all I/O be simultaneously connected to actual project equipment or the simulation devices on the test fixture.

6. A PLC and OIT based test fixture of equivalent functionality and convenience may be used in lieu of the test box described above.

7. Test Log: A factory test log shall be kept per Part 2 of this document.

8. Factory Test Report: A test report shall be prepared to demonstrate thoroughness of testing and to document and communicate factory testing results. The report shall contain data and documentation as indicated in Part 2 of this document. The test report documentation shall be provided to the Project Representative prior to witnessed factory testing. The acceptability of the test results and report shall be determined by the Project Representative. Witnessed factory testing shall not be scheduled prior to verifiable receipt of acceptance of the test results and report by the Project Representative. Prior to witnessed testing all aspects of the control system should be fully checked out and verified. All that should remain to be done is for the supplier to demonstrate this to the witness.

9. Witnessed Factory Testing: Following acceptance of un-witnessed factory test report documents the CSI shall demonstrate system compliance to the project representative. The project shall not be expected to orchestrate or lead the testing. The CSI shall demonstrate all required functions and features of the system, or requested subset thereof, including but not specifically limited to control, indication, alarming, monitoring, data logging (UNO), network, communications, PLC (UNO), OIT (UNO), SCADA HMI (UNO), etc functions to the Project Representative. The CSI shall revise, correct, modify, calibrate, and adjust the system as required by the Project Representative during witnessed testing to

achieve and successfully demonstrate all required functions and features. All deficiencies discovered shall be corrected by the CSI. Testing shall continue until the system is approved by the Project Representative. Upon approval, the Project Representative shall provide verifiable notice of factory test approval to indicate the completion of factory testing. The panels shall not be shipped prior to receipt of the Project Representative's notice of acceptance of factory testing.

10. Update Shop Drawings: All shop drawings shall be corrected and updated following factory testing. All corrections and revisions made to the system or the drawings shall be incorporated by CAD into the shop drawings and provided to the Project Representative and the contractor prior to installation of the equipment by the contractor.

11. Third Party Programmers: Third party programmers will provide, install, test, and demonstrate programming they provide. The CSI shall provide integration testing support as needed and as requested by the project representative. The CSI shall support the third party programmer throughout the programmers testing activities as required to verify that contractor provided equipment responds and reports to third party provided programs as specified by the contract documents. The CSI shall support testing activities of the third party programmer on all issues concerning interface of contractor provided equipment and functions with third party provided programming.

12. Packaged Equipment: Suppliers of packaged control systems shall provide and accomplish factory testing and documentation equivalent to that described above for their systems.

C. Control System Installation and Calibration

1. General: Supplied control systems shall be installed and all field wiring and interconnections verified. When the installation of the supplied control system is substantially complete, the CSI shall calibrate all components of the supplied control system including but not limited to all instruments, indicators, recorders, loops, etc. The CSI shall configure all communications and network devices and shall verify proper communications of devices across all network and communications channels and media. Each component shall be adjusted to be within the Manufacturer's required performance range for the specific application. Components supplied by the CSI that do not function properly, that cannot be properly calibrated, or that are found to not meet the Manufacturer's performance specifications shall be removed and replaced at no additional cost to the owner.

2. Documentation: The CSI shall complete device calibration forms and network and communications channel test forms. Calibration forms identifying each process switch, instrument, final elements such as actuators and VFD's, and test forms for each network and communications device and channel tested shall be completed

and included in the un-witnessed site test report. Provide the following calibration documentation as well as other documentation required by this section:

a. Test and calibrate all devices which provide an analog input to control system equipment. Test and calibrate all analog instruments, VFD analog outputs, valve actuator analog outputs, packaged control system analog outputs, etc. Document these tests on appropriate calibration forms, one each per device. Describe test procedure. All field wiring shall be included in the test procedure. Provide correlation of process parameter value to analog signal and PLC register value at 0, 25, 50, 75, and 100 percent of range. Compare to expected values and calculate accuracy. Include all display device calibration.

b. Test and calibrate all analog outputs from control systems to other equipment. Test and calibrate all VFD analog inputs, valve actuator analog inputs, packaged control system analog inputs, etc. Document these tests on appropriate calibration forms, one each per device. Describe test procedure. All field wiring shall be included in the test procedure. Provide correlation of PLC register and analog signal value at 0, 25, 50, 75, and 100 percent of range to process and equipment parameter or response. Compare to expected values and calculate accuracy. Include display device calibration.

c. Test and calibrate all devices which provide discrete input to the control system. Document these tests on appropriate test forms. Describe test procedures. All field wiring shall be included in the tests. Record increasing and decreasing trip points and correlate to process parameter values. Compare with expected values and calculate accuracy.

d. Test and calibrate all devices which receive discrete outputs from the control system. Verify the correct response occurs. Document these tests on appropriate test forms. Describe test procedures. All field wiring shall be included in the tests.

e. Configure and verify the functionality of all communications, networks, and connected devices. Document these tests on appropriate test forms. Describe test procedures. Provide all device configuration settings.

f. Analytical Instruments: Provide test gasses, buffer solutions, and reference fluids for tests and calibration of all analytical instruments. Test per manufacturer's instructions.

3. Third Party Programmers: The Contractor shall complete all calibration documents and provide to third party programmers prior program installation and system site testing.

4. Packaged Systems: Packaged system suppliers shall perform and document the calibration tasks described above for their scopes of supply.

5. Field Wiring: All field wiring shall be included and verified in calibration and site testing tasks.

D. Un-Witnessed Site Testing (Start-Up)

1. General: Control systems shall be fully tested prior to any witnessed site testing. Control systems shall be put into operation by the CSI or the packaged system supplier. The functionality of all aspects of the system shall be verified by the CSI or packaged system supplier. All aspects of the control systems, including but not limited to all inputs, outputs, circuits, loops, instruments, annunciation, display, alarming, automatic control, manual control, PLC (UNO), OIT (UNO), SCADA (UNO), data logging, reporting, remote alarm notification, PID loops, etc shall be verified to be working correctly. A test log shall be kept per Part 2 of this document. A Test Report shall be prepared by the CSI for this phase per Part 2 of this document. All deficiencies shall be corrected and the test report provided to the Project Representative prior to scheduling of witnessed site testing (commissioning) with the Project Representative present. The acceptability of the calibration and un-witnessed site test results and report shall be determined by the Project Representative. All plant systems shall be complete, integrated, fully tested, fully verified, and all tests fully documented by the contractor prior to witnessed site testing (commissioning). All that should remain to be done is to demonstrate system compliance to the project representative. The system shall be complete, fully integrated, fully tested; all tests and operational data documented, and ready to be put into continuous production operation at this point in the process. The system capabilities listed below and all other capabilities specified shall be tested, verified, and documented in the un-witnessed site test report:

    a. All automatic and manual control functions specified.

    b. All programmed and non programmed functions specified.

    c. All programmed and non programmed display and annunciation functions specified.

    d. All operator interface and monitoring functions specified.

    e. All communications functions specified.

    f. All network functions specified.

    g. All SCADA functions specified.

    h. All data historian functions specified.

    i. All motor control and MCC functions specified.

j. All control panel functions specified.

k. All packaged equipment control system functions specified.

l. All Remote alarm notification and auto dialer functions specified.

m. Provide all PID loop tuning parameters.

2. Packaged Control Systems: Package equipment vendors shall install, calibrate, startup, test, and verify their supplied systems as described above for CSI supplied systems per the project site test schedule. Packaged equipment suppliers shall document testing of their systems as described above. Communications and interface functionality required between vendor systems and plant systems and equipment, including MCC's and plant SCADA system application software and equipment shall be tested, verified, and documented during this test phase.

3. Third Party Programmers: Where specifically noted, the programmer shall install, test, and verify programs provided for the Contractor supplied PLC's, OIT's, and SCADA components. The contractor shall provide support as needed and as requested by the Project Representative to support testing of these programs and to verify the proper responses of related equipment.

4. Process Conditions: The contractor shall provide conditions at the facility which fully exercise process equipment to enable realistic testing and verification of the control system and associated equipment. This includes but is not limited to adequate flow quantities and flow rates of water required to simulate operational process conditions.

E. Witnessed Site Testing (Commissioning)

1. General: After un-witnessed site testing (start-up) is completed by the CSI, packaged system suppliers, third party programmers, and the contractor, and the required test report approved by the Project Representative, commissioning demonstrations shall be presented to and witnessed by the Project Representative and the Owner. The contractor shall lead and orchestrate commissioning demonstrations of the complete and integrated systems. Commissioning shall include demonstration of all instruments, components, features, and functions of the entire control and communication system and all sub systems. Commissioning shall be considered complete when the Project Representative has determined that all of the system requirements have been met.

2. Scope: The project representative may request the rerun of all un-witnessed site tests or a subset thereof. The required un-witnessed site test report and associated documentation may be verified in whole or in part during commissioning at the project representatives discretion.

3. Support: During the commissioning phase, the CSI, the Electrical Contractor, and packaged equipment suppliers shall revise, correct, modify, and make adjustments as required by the Project Representative to achieve the operation required. The CSI, packaged equipment suppliers, and the Contractor shall be continuously present during commissioning to exercise all aspects of the control system and associated process equipment and to correct deficiencies as they are found.

4. Third Party Programmers: When a third party programmer is used to program contractor supplied PLC's, OIT's, and SCADA components, the programmer shall conduct the commissioning for the programs provided and the contractor shall provide support as requested by the project representative.

F. Loop Test Stages

1. General: Test and document each instrument loop in the following sequence:

Testing sequence	Form
a. Wiring	17000-A
b. Piping	17000-B
c. Individual components	17000-C through I
d. Individual loops	17000-J
e. Loop commissioning	17000-K

2. Testing of piping, wiring, and individual components: Shall be completed with certified test reports completed which shall be provided to the Project Representative prior to commencement of individual loop testing.

3. Individual component calibration and test:

   a. Each instrument and final element shall be field calibrated in accordance with the manufacturer's recommended procedure. Instruments shall then be tested in compliance with ISA S51.1 and the data entered on the applicable test form.

   b. The Project Representative may elect to witness these tests.

   c. Alarm trips, control trips, and switches shall be set to initial values specified in Section 17900 Schedules.

   d. Final elements shall be checked for range, dead-band, and speed of response.

e. Any component that fails to meet the required tolerances shall be repaired by the manufacturer or replaced.

f. Repeat above tests until the component is within tolerance.

g. Record all threshold, range, and dead band data in engineering units appropriate to the process on test forms.

4. Loop Test:

a. Test each instrument loop as an integrated system. This test shall check operation from transmitter to signal receiving components, and from the supplied control panels to final control elements.

b. The Project Representative may elect to witness these tests.

c. Manipulate the process or inject signals at the field terminations to simulate primary measuring elements. Record method of signal stimulus on test forms.

d. Output of each auto/manual control function shall be manually varied from 0 to 100 percent, and correct operation of final control element verified.

e. Each process switch and alarm circuit shall be manually actuated at the field sensor.

f. Verify correct operation of all annunciator windows, indicator lights, or OIT/HMI screen elements as applicable.

g. Record all threshold, range, and dead band data in engineering units appropriate to the process on test forms.

5. Closed-Loop Test:

a. Project Representative may elect to witness these tests.

b. Test shall demonstrate stable operation of each loop under actual process operating conditions. This test includes adjustment of loop tuning parameters. Loops shall be tuned and documented prior to witnessing by the project. Record all loop parameters on test forms for each loop test.

c. Unless otherwise specified, adjust tuning parameters (proportional gain, integral time constant, and derivative time constant) for each control loop to provide ¼-amplitude damping.

d. Prepare a chart recording showing loop response to a step disturbance for each loop.

e. Make two charts for cascade loops if applicable, one showing the secondary loop response with its set point on manual, and the second showing overall loop response.

f. Chart recordings shall be made at sufficient speed and amplitude to clearly show specified amplitude damping and shall be annotated to show loop number and title, and settings of parameters and set points.

6. Programmers other than the CSI: Third party programmers and packaged system suppliers shall tune and commission all loops controlled by supplied programs. The contractor and sub contractors shall provide integration support as requested by the project representative.

G. OIT, HMI, SCADA Test

1. Test and verify all required read and write functionality. Verify correct addressing to the correct PLC registers.

2. Test and verify correct presentation and function of all display elements on all display screens.

3. Provide the services of a qualified technician for the needed duration to assist in this test.

4. Test and verify all process data communications between PLC's, OIT's, packaged equipment HMI, plant SCADA system, data historian, and remote alarm annunciation software.

5. Test and verify all displayed historical and real time trends are functioning correctly.

6. Test and verify the process data historian is configured and logging required data correctly.

7. Test and verify that all parts of the process network are functioning correctly.

8. Provide screen shots of all OIT and SCADA HMI screens. Notate screen shots to indicate the test status of each screen element. A check mark shall indicate that the element was fully and successfully tested. Make corrections until all elements test successfully. Tester shall sign and date each screen shot and shall provide the documents with other test reports and forms to the project.

9. Test and verify all required historical data reports are configured and functioning correctly.

10. Programmers Other than the CSI: Third party programmers and packaged system suppliers shall test and commission all programs they supply. The contractor and sub contractors shall provide integration support as requested by the project representative.

H. Calibration Equipment and Testing Apparatus

1. The contractor shall have available test and calibration equipment for factory panel tests, installation, start-up, service contract, and maintenance or troubleshooting purposes. The equipment required for these tests is as follows:

2. Digital Multimeter with an accuracy of plus or minus 0.1 percent - sufficient number to satisfy simultaneous field signal requirements.

3. Signal calibrator for analog signals - sufficient number to satisfy simultaneous field signal requirements.

4. One - 60-inch Water Manometer with 0.1-inch graduations. Include accessories of floor stand, pipe clamp, tubing, air bulb with shutoff and fittings for 0.25 inch and 0.375 inch threaded taps for "Tee" fittings to connect manometer.

5. One - 20-inch Mercury Manometer graduated in inches of water. Include accessories of floor stand, pipe clamp, tubing, air bulb with shutoff and fittings for 0.25 inch and 0.375 inch threaded taps and "Tee" fittings to connect manometer.

6. One - 0 to 100 psi, 6-inch-diameter pressure gauge with 1 psi graduations and plus or minus 1 percent accuracy. Include "Tee" fittings and fittings for 0.25 inch through 1 inch threaded taps to connect gauge.

7. One - Air tank pressurized to 150 psi with 2 regulators. One regulator for the 0 to 30 psi range, and one regulator for the 30 to 100 psi range. Include accessories of fittings for 0.25 inch through 1 inch threaded taps to connect air tank.

8. One - 30-foot supply of 0.375-inch PVC clear plastic tubing with fittings for 0.25 inch and 0.375 inch threaded taps to make manometers for Venturi tubes, orifice plates, etc., for calibration checks.

9. One - Decibel meter for telemetry work capable of reading minus 40 db to plus 10 db over frequency range of 300 to 2,500 hertz with a selective narrow band filter.

10. One - High-impedance earplug speaker with alligator clips for telemetry monitoring of transmitter keying.

11. One - Signal generator for telemetry adjustable over 300 to 2,500 hertz with 1 milliwatt output into 600 ohm line.

12. One - Set of portable radios capable of operating within buildings at one location and 5 miles outside of buildings in hilly terrain.

13. One - Programming terminal with software to configure programmable equipment.

14. Modify and add to the list as required to fully and efficiently start up, calibrate, test, and commission all supplied equipment.

END OF SECTION